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HAWAIIAN COMMERCIAL AND SUGAR
COMPANY

COMMISSION ON WATER RESOURCE MANAGEMENT

OF THE STATE OF HAWAII

In the Matter of:

IAO GROUND WATER MANAGEMENT AREA HIGH-LEVEL SOURCE WATER USE WUPAS AND PETITION TO AMEND INTERIM INSTREAM FLOW STANDARDS OF WAIHEE, WAIEHU, IAO, & WAIKAPU STREAMS CONTESTED CASE HEARING

Case No. CCH-MA06-01

HAWAIIAN COMMERCIAL AND SUGAR COMPANY'S EXHIBIT LIST FOR OPENING SUBMISSION (REMAND); EXHIBITS E-R1 –E-R29; CERTIFICATE OF SERVICE

Hearings Officer: Dr. Lawrence Miike

HAWAIIAN COMMERCIAL AND SUGAR COMPANY'S EXHIBIT LIST FOR OPENING SUBMISSION (REMAND)

EXHIBIT NUMBER	DESCRIPTION	REFERENCES	ADM
E-R1	2007 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	
E-R2	2008 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	
E-R3	2009 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	

EXHIBIT NUMBER	DESCRIPTION	REFERENCES	ADM
E-R4	2010 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	
E-R5	2011 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	
E-R6	2012 A&B, Inc. Form 10-K (excerpts relating to agribusiness segment)	Declaration of Rick W. Volner, Jr.	
E-R7	Chart of historical prices of U.S. raw sugar (Contract. No. 14/16, duty fee paid New York) published by USDA Economic Research Service (http://ers.usda.gov/datafiles/Sugar_and_Sweeteners_Yearbook_Tables/World_and_US_Sugar_and_Corn_Sweetener_Prices/Table04.xls)	Declaration of Rick W. Volner, Jr.	
E-R8	Model Scenario 1	Declaration of Rick W. Volner, Jr.	
E-R9	Model Scenario 2	Declaration of Rick W. Volner, Jr.	
E-R10	Model Scenario 3	Declaration of Rick W. Volner, Jr.	
E-R11	Model Scenario 4	Declaration of Rick W. Volner, Jr.	
E-R12	Model Scenario 5	Declaration of Rick W. Volner, Jr.	
E-R13	Printout of page from California Department of Water Resources website (http://www.water.ca.gov/wateruseefficiency/leak)	Declaration of Rick W. Volner, Jr.	

EXHIBIT NUMBER	DESCRIPTION	REFERENCES	ADM
E-R14	Wayne B. Solley, Robert R. Pierce & Howard A. Perlman, *USGS Circular 1200: Estimated Use of Water in the United States in 1995* (1998)	Declaration of Rick W. Volner, Jr.	
E-R15	Fourth Stipulation and Order (South Waiehu)	Declaration of Garret Hew	
E-R16	Spreadsheet reporting monthly total of water pumped from Well No. 7 (1/2007 – 11/2013)	Declaration of Garret Hew	
E-R17	Spreadsheet reporting measurements of gage height and chloride levels in Well No. 7 (2/8/2011 – 11/9/2013)	Declaration of Garret Hew	
E-R18	Photograph of HC&S seed cane field after harvesting (12/2013)	Declaration of Mae Nakahata	
E-R19	Photograph of HC&S seed cane regenerating (12/2013)	Declaration of Mae Nakahata	
E-R20	Photograph of pit in HC&S Field 920 (12/2013)	Declaration of Mae Nakahata	
E-R21	USDA Soil Conservation Service Soil Survey of Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii (August 1972)	Declaration of Mae Nakahata	
E-R22	Letter from Michael Kolman to Mae Nakahata re Trip Report – Soil Investigation for HC&S Field 921 (12/18/2013) with attachments	Declaration of Mae Nakahata	
E-R23	Photograph of soil pit in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	
E-R24	Photograph of soil pit in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	
E-R25	Photograph of soil pit in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	
E-R26	Photograph of soil pit in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	

EXHIBIT NUMBER	DESCRIPTION	REFERENCES	ADM
E-R27	Photograph of sand river in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	
E-R28	Photograph of pit dug within the area of sand river in HC&S Field 922 (12/2013)	Declaration of Mae Nakahata	
E-R29	Table comparing HC&S irrigation water applied to HC&S Fields 921 and 922 vs. Hoopoi Seed Fields (2009-2012)	Declaration of Mae Nakahata	

DATED: Honolulu, Hawaii, January 7, 2014.

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COMMISSION ON WATER RESOURCE MANAGEMENT

OF THE STATE OF HAWAII

IAO GROUND WATER MANAGEMENT AREA HIGH-LEVEL SOURCE WATER USE WUPAS AND PETITION TO AMEND INTERIM INSTREAM FLOW STANDARDS OF WAIHEE, WAIEHU, IAO, & WAIKAPU STREAMS CONTESTED CASE HEARING & COMPLAINT C04-31 REGARDING WASTE OF SURFACE WATER, WAILUKU MAUI CONTESTED CASE HEARING	Case No. CCH-MA-06-01 CERTIFICATE OF SERVICE

CERTIFICATE OF SERVICE

The undersigned hereby certifies that, on this date, a true and correct copy of the foregoing document was duly served on the following parties by U.S. Mail:

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DATED: Honolulu, Hawaii, January 7, 2014.

CADES SCHUTTE LLP

DAVID SCHULMEISTER
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UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2007

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _______ to _______

Commission file number 0-565

ALEXANDER & BALDWIN, INC.
(Exact name of registrant as specified in its charter)

Hawaii	**99-0032630**
(State or other jurisdiction of incorporation or organization)	(I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	NASDAQ

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 15, 2008:
41,307,295

Aggregate market value of Common Stock held by non-affiliates at June 30, 2007:
$2,231,299,861

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒ Accelerated filer ☐
Non-accelerated filer ☐ (Do not check if a smaller reporting company) Smaller reporting company ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement dated March 13, 2008 (Part III of Form 10-K)

Exhibit E-R1

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PART I

PART II

ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2007

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Alexander & Baldwin, Inc. ("A&B") is a multi-industry corporation with its primary operations centered in Hawaii. It was founded in 1870 and incorporated in 1900. Ocean transportation operations, related shoreside operations in Hawaii, and intermodal, truck brokerage and logistics services are conducted by a wholly-owned subsidiary, Matson Navigation Company, Inc. ("Matson"), and two Matson subsidiaries. Property development and agribusiness operations are conducted by A&B and certain other subsidiaries of A&B.

The business industries of A&B are generally as follows:

A. *Transportation* - carrying freight, primarily between various U.S. Pacific Coast, Hawaii, Guam, other Pacific island, and China ports; chartering vessels to third parties; arranging domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services; and providing terminal, stevedoring and container equipment maintenance services in Hawaii.

B. *Real Estate* - engaging in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property.

C. *Agribusiness* - growing sugar cane and coffee in Hawaii; producing bulk raw sugar, specialty food-grade sugars, molasses and green coffee; marketing and distributing roasted coffee and green coffee; providing sugar, petroleum and molasses hauling, general trucking services, mobile equipment maintenance and repair services, and self-service storage in Hawaii; and generating and selling, to the extent not used in A&B's operations, electricity.

For information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2007, see Note 13 ("Industry Segments") to A&B's financial statements in Item 8 of Part II below.

DESCRIPTION OF BUSINESS AND PROPERTIES

A. Transportation

(1) Freight Services

Matson's Hawaii Service offers containership freight services between the ports of Long Beach, Oakland, Seattle, and the major ports in Hawaii on the islands of Oahu, Kauai, Maui and Hawaii. Roll-on/roll-off service is provided between California and the major ports in Hawaii.

Matson is the principal carrier of ocean cargo between the U.S. Pacific Coast and Hawaii. Principal westbound cargoes carried by Matson to Hawaii include dry containers of mixed commodities, refrigerated commodities, building materials, automobiles and packaged foods. Principal eastbound cargoes carried by Matson

(ii) *Centre Pointe Marketplace.* In April 2005, A&B entered into a joint venture with Intertex Centre Pointe Marketplace, LLC for the development of a 105,700-square-foot retail center on a 13.0-acre parcel in Valencia, California. Vertical construction commenced in 2007, and the sale of several pad site buildings closed in 2007 and the remainder of the center is expected to be sold in 2008.

(iii) *Bridgeport Marketplace*. In July 2005, A&B entered into a joint venture with Intertex Bridgeport Marketplace, LLC for the development of a 27.8-acre parcel in Valencia, California. The parcel was subdivided into a 5-acre parcel for a public park, a 7.3-acre parcel sold to a church in 2007, and a 15.5-acre parcel for the development of a 131,000-square-foot retail center. Vertical construction of the center commenced in the first quarter of 2007 and the center is expected to open in late-2008.

(iv) *Bakersfield - Panama Grove.* In November 2006, A&B entered into a joint venture with Intertex P&G Retail, LLC, for the development of a 550,000-square-foot retail center on a 57.3-acre commercial parcel in Bakersfield, California. The parcel was acquired in November 2006. Planning, permitting and pre-leasing activities are ongoing.

(v) *Palmdale Trade & Commerce Center.* In December 2007, A&B entered into a joint venture with Intertex Palmdale Trade & Commerce Center LLC, for the development of a 315,000-square-foot mixed-use commercial office and light industrial condominium complex on 18.2 acres in Palmdale, California, located 60 miles northeast of Los Angeles and 25 miles northeast of Valencia. Planning and development work are ongoing.

(vi) *Savannah Logistics Park.* In October 2007, A&B entered into an agreement to purchase a 1.0 million-square-foot industrial facility consisting of two warehouse buildings located on 63 acres in Savannah, Georgia, approximately 12 miles from the Port of Savannah, the second largest U.S. container port on the east coast. A&B closed the acquisition of both buildings in February 2008. The property will be treated as a development property until the completion of tenant improvements by A&B and the delivery of the space to one or more tenants.

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870, and the production of coffee in Hawaii since 1987. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) a coffee farm on the island of Kauai, operated by its Kauai Coffee Company, Inc. ("Kauai Coffee") subsidiary, and (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide all types of trucking services, including sugar and molasses hauling on Maui and Kauai, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai.

HC&S is Hawaii's largest producer of raw sugar, producing approximately 164,500 tons of raw sugar in 2007, or about 80 percent of the raw sugar produced in Hawaii for the year (compared with 173,600 tons, or about 81 percent, in 2006). The decrease in production was due to a number of reasons, including adverse weather conditions, the age of the crop, and various farming practices. HC&S harvested 16,895 acres of sugar cane in 2007 (compared with 16,950 in 2006). Yields averaged 9.7 tons of sugar per acre in 2007 (compared with 10.2 in 2006). As a by-product of sugar production, HC&S also produced approximately 51,700 tons of molasses in 2007 (compared with 55,900 in 2006).

In 2007, approximately 21,200 tons of sugar (compared with 15,500 tons in 2006) were processed by HC&S into specialty food-grade sugars that were sold under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. A multi-phase expansion of the production facilities for these sugars commenced in 2006 and will be complete in early 2008.

During 2007, Kauai Coffee had approximately 3,000 acres of coffee trees under cultivation. The 2007 harvest yielded approximately 2.5 million pounds of green coffee, compared with 2.7 million pounds in 2006. The mix of green coffee resulted in a slightly higher percentage of specialty and commodity green beans and a lower percentage of mid-grade green beans than in 2006.

HC&S and McBryde Sugar Company, Limited ("McBryde"), a subsidiary of A&B and the parent company of Kauai Coffee, produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels, whereas McBryde produces power solely by hydroelectric generation. The price for the power sold by HC&S and McBryde is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. See "Energy" below for power production and sales data.

(2) Marketing of Sugar and Coffee

Approximately 87 percent of the bulk raw sugar produced by HC&S in 2007 was purchased, refined and marketed by C&H Sugar Company, Inc. ("C&H"), in which A&B divested its equity position in 2005. C&H processes the raw cane sugar at its refinery at Crockett, California, and markets the refined products primarily in the western and central United States.

The remaining 13 percent of the raw sugar is used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" products.

Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative consisting of two sugar cane growers in Hawaii (including HC&S), has a supply contract with C&H, ending in December 2008. Pursuant to the supply contract, the growers sell their raw sugar to C&H at a price equal to the New York No. 14 Contract settlement price, less a discount and less costs of sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Hawaii sugar growers, including HC&S. Notwithstanding the supply contract, HC&S arranged directly with C&H for the forward pricing of a portion of its 2007 harvest, as described in Item 7A ("Quantitative and Qualitative Disclosures About Market Risk") of Part II below.

At Kauai Coffee, coffee marketing efforts are directed toward developing a market for premium-priced, estate-grown Kauai green bean (unroasted) coffee. Most of the coffee crop is being marketed on the U.S. mainland as green bean coffee. In addition to the sale of green bean coffee, Kauai Coffee produces and sells roasted, packaged coffee under the Kauai Coffee® trademark. Kauai Coffee's customers include specialty and commodity brokers, hotels, and large regional roasters.

(3) Sugar Competition and Legislation

Hawaii sugar growers produce more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the U.S. mainland market. Hawaiian refined sugar is marketed primarily west of Chicago. This is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

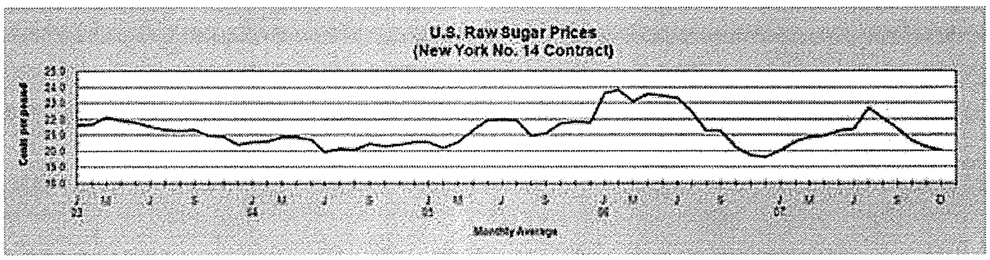
The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current protective legislation is the Farm Security and Rural Investment Act of 2002 ("2002 Farm Bill"). The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount.

The 2002 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18 cents per pound for raw cane sugar is in effect for the 2003 through 2007 crops. The supply agreement between HS&TC and C&H provides for a floor minimum price that is based on the loan rate. The 2002 Farm Bill expires on September 30, 2008, and Congress is currently in deliberations on a new Farm Bill.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement ("CAFTA-DR"). In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately, while others were phased out over periods of 5 to 15 years with full elimination beginning January 1, 2008. In 2008, Mexico can ship an unlimited quantity of sugar duty-free to the U.S. each year, even though the U.S. sugar market is already oversupplied.

U.S. domestic raw sugar prices remain suppressed. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 14 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



Liberalized international trade agreements, such as the General Agreement on Tariffs and Trade, or GATT, include provisions relating to agriculture that can affect the U.S. sugar or sweetener industries materially. Negotiations under the U.S.-Central America Free Trade Agreement, or CAFTA, as well as other trade discussions, have resulted in lower U.S. sugar prices.

(4) Coffee Competition and Prices

Kauai Coffee competes with coffee growers located worldwide, including in Hawaii. Coffee commodity prices have recovered from near record lows and, in late 2007, rebounded to their highest levels in ten years. The market for specialty coffee in the United States is very competitive. Because of its quality and branding, Kauai Coffee has been successful at selling most of its coffee at a premium, above commodity market prices. Kauai Coffee has long-term, repeat customers that account for the bulk of its sales, though there is strong competition and the contracts are subject to renegotiation each year.

Approximately one-fifth of Kauai Coffee's production is off-grade coffees, which are loosely tied to world commodity market prices. Kauai Coffee engages in short-term contracts with established customers to ensure that it receives the best price possible for these coffees. These prices are subject to price adjustments on an annual basis.

Kauai Coffee's green bean coffee production volume and unit costs vary each year depending upon growing and harvesting conditions. The unit cost per pound impacts the cost of goods for Kauai Coffee's wholesale roasted and retail programs.

(5) Properties and Water

The HC&S sugar plantation, the largest in Hawaii, consists of approximately 43,300 acres, including a small portion of leased lands. Approximately 34,600 acres are under cultivation, and the balance is leased to third parties, is not suitable for cane cultivation, or is used for plantation purposes such as roads, reservoirs, ditches and plant sites.

On Kauai, approximately 3,000 acres are cultivated by Kauai Coffee.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to protect agricultural lands, promote diversified agriculture, increase the State's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. The Legislature is currently considering a package of incentives whose passage is necessary to trigger the IAL system of land designation. A&B continues to work with the Legislature, as well as other farmers and landowners, to ensure a satisfactory package of agricultural incentives is provided for IAL.

It is crucial for HC&S and Kauai Coffee to have access to reliable sources of water supply and efficient irrigation systems. A&B's plantations conserve water by using a "drip" irrigation system that distributes water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated. All of Kauai Coffee's fields are drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years has supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provides approximately one-tenth of the irrigation water used by HC&S. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

D. Employees and Labor Relations

As of December 31, 2007, A&B and its subsidiaries had approximately 2,255 regular full-time employees. About 965 regular full-time employees were engaged in the agribusiness segment, 1,130 were engaged in the transportation segment, 65 were engaged in the real estate segment, and the remaining were in administration. Approximately 49 percent were covered by collective bargaining agreements with unions.

At December 31, 2007, the active Matson fleet employed seagoing personnel in 275 billets. Each billet corresponds to a position on a ship that typically is filled by two or more employees because seagoing personnel rotate between active sea duty and time ashore. Approximately 22 percent of Matson's regular full-time employees and all of the seagoing employees were covered by collective bargaining agreements.

Historically, collective bargaining with longshore and seagoing unions has been complex and difficult. However, Matson and Matson Terminals consider their relations with those unions, other unions and their non-union employees generally to be satisfactory.

Matson's seagoing employees are represented by six unions, three representing unlicensed crew members and three representing licensed crew members. Matson negotiates directly with these unions. Matson's agreements with the Seafarer's International Union and shore-based units of the Sailors Union of the Pacific ("SUP") and the Marine Firemen's Union ("MFU") were renewed in mid-2005 through June 2008 without service interruption. In addition, the contracts that Matson has with the shipboard-based units of the SUP and MFU expire on July 1, 2008 for Matson's ships built prior to 2003. Negotiations on the seagoing contracts have customarily commenced in May.

SSAT, the previously-described joint venture of Matson and SSA, provides stevedoring and terminal services for Matson vessels calling at U.S. Pacific Coast ports. Matson, SSA and SSAT are members of the Pacific Maritime Association ("PMA") which, on behalf of its members, negotiates collective bargaining agreements with the ILWU on the U.S. Pacific Coast. The current six-year PMA/ILWU Master Contract, which covers all Pacific Coast longshore labor, will expire on July 1, 2008. Matson Terminals provides stevedoring and terminal services to Matson vessels calling at Honolulu and on the islands of Hawaii, Maui and Kauai, and for customer vessels on the island of Hawaii. Matson Terminals is a member of the Hawaii Stevedore Industry Committee ("SIC"), which negotiates with the ILWU in Hawaii on behalf of its members. The ILWU contract in Hawaii expires on June 30, 2008. Negotiations on both of these agreements are expected to begin in spring of 2008.

During 2007, Matson renewed its collective bargaining agreement with ILWU clerical workers at Long Beach through June 2010 without service interruption.

During 2007, Matson contributed to multiemployer pension plans for vessel crews. If Matson were to withdraw from or significantly reduce its obligation to contribute to one of the plans, Matson would review and evaluate data, actuarial assumptions, calculations and other factors used in determining its withdrawal liability, if any. In the event that any third parties materially disagree with Matson's determination, Matson would pursue the various means available to it under federal law for the adjustment or removal of its withdrawal liability. Matson Terminals participates in a multiemployer pension plan for its Hawaii ILWU non-clerical employees. For a discussion of withdrawal liabilities under the Hawaii longshore and seagoing plans, see Note 9 ("Employee Benefit Plans") to A&B's financial statements in Item 8 of Part II below.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the ILWU. The agreements with the HC&S production unit employees and clerical bargaining unit employees covering approximately 640 workers, expired on January 31, 2008, and are being renegotiated. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. The agreement with the bulk sugar employees will expire June 30, 2008 and is being renegotiated, while the agreement with all other employees was renegotiated in 2006 and will expire March 31, 2009. There are two collective bargaining agreements with KCC employees represented by the ILWU. The agreements covering the production unit, as well as clerical employees, expired on April 30, 2007, and are being renegotiated. A tentative agreement was reached with the KCC production unit in February 2008. The clerical unit negotiations will start in February 2008. The collective bargaining agreement with the ILWU for the production unit employees of Kauai Coffee was renegotiated and will expire on January 31, 2010.

E. Energy

Matson and Matson Terminals purchase residual fuel oil, lubricants, gasoline and diesel fuel for their operations. Residual fuel oil is by far Matson's largest energy-related expense. In 2007, Matson vessels used approximately 2.3 million barrels of residual fuel oil (compared with 2.2 million barrels in 2006).

Residual fuel oil prices paid by Matson in 2007 started at $41.51 per barrel and ended the year at $80.10. The low for the year was $41.51 per barrel in January and the high was $87.44 in December. Sufficient fuel for Matson's requirements is expected to be available in 2008.

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory operations, HC&S sells electricity. In 2007, HC&S produced and sold, respectively, approximately 218,000 MWH and 94,000 MWH of electric power (compared with 208,000 MWH produced and 98,000 MWH sold in 2006). The decrease in power sold was due to drought conditions, which hindered hydro power produced and increased the use of power for irrigation pumping. HC&S increased its use of oil from 28,500 barrels in 2006 to 31,100 barrels in 2007, most of which was low-cost, recycled motor oil. Coal used for power generation was 68,100 short tons, about 8,400 tons more than that used in 2006.

In 2007, McBryde produced approximately 31,800 MWH of hydroelectric power (compared with approximately 35,100 MWH in 2006). The decline was due to an extended drought. To the extent it is not used in A&B's coffee operations, McBryde sells electricity to Kauai Island Utility Cooperative. Power sales in 2007 amounted to approximately 21,200 MWH (compared with 27,100 MWH in 2006).

F. Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

The business of A&B and its subsidiaries (collectively, the "Company") faces numerous risks, including those set forth below or those described elsewhere in this Form 10-K or in the Company's filings with the SEC. The risks described below are not the only risks that the Company faces, nor are they necessarily listed in order of significance. Other risks and uncertainties may also impair its business operations. Any of these risks may have a material adverse effect on the Company's business, financial condition, results of operations and cash flows. All forward-looking statements made by the Company or on the Company's behalf are qualified by the risks described below.

GENERAL

An economic decline or decrease in market demand for the Company's services and products in Hawaii, the U.S. mainland, Guam or Asia may adversely affect the Company's operating results and financial condition.

A weakening of the economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, or a decrease in market demand may adversely impact the level of freight volumes and real estate activity in Hawaii. A decline in the overall economy or market demand in the U.S. mainland may reduce the demand for goods from Hawaii and Asia, travel to Hawaii and domestic transportation of goods, adversely affecting inland and ocean transportation volumes and/or rates, the sale of Hawaii real estate to Mainland buyers, and the Hawaii real estate markets generally. A change in the cost of goods or currency exchange rates may decrease the freight volume and/or rates from Asia to the United States.

The Company may face new or increased competition.

The Company's transportation segment may face new competition by established or start-up shipping operators that enter the Company's markets. The entry of a new competitor or the addition of ships or capacity by existing competition on any of the Company's routes could result in a significant increase in available shipping capacity that could have an adverse effect on the Company's business. See also discussion under "Business and Properties - Transportation - Competition" above.

For the Company's real estate segment, there are numerous other developers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with the Company for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Such competition could have an adverse effect on the Company's business.

The Company's significant operating agreements and leases could be replaced.

The significant operating agreements and leases of the Company in its various businesses expire at various points in the future and could be replaced, thereby adversely affecting future revenue generation. For example, the Company's agribusiness segment sells substantially all of its bulk raw sugar through the cooperative HS&TC, which has a supply contract with C&H Sugar Company, Inc., ending in December 2008. Replacement of this supply contract on less favorable terms to the Company may adversely affect the Company's sugar business.

The reduction in availability of mortgage financing and the volatility and reduction in liquidity in the financial markets may adversely affect the Company's business.

During 2007, the mortgage lending industry experienced significant instability due to, among other things, defaults on subprime loans and a resulting decline in the market value of such loans. In light of these developments, lenders, investors, regulators and other third parties have questioned the adequacy of lending standards and other credit requirements for several loan programs made available to borrowers in recent years. This has led to tightened credit requirements, reduced liquidity and increased credit risk premiums. A deterioration in credit quality among subprime and other nonconforming loans has caused almost all lenders to eliminate subprime mortgages and most other loan products that are not conforming loans, FHA/VA-eligible loans or jumbo loans (which meet conforming underwriting guidelines other than loan size). Fewer loan products and tighter loan qualifications may make it more difficult for some borrowers to finance the purchase of homes in the Company's residential projects. In addition, the tightening of credit in the commercial markets may adversely affect the Company's ability to secure construction and other financing for the Company's residential and commercial projects. Furthermore, any protracted contraction of liquidity in the commercial markets may adversely affect the Company's ability to renew its committed lines of credit in the future on equal or more favorable terms. These developments may adversely affect the Company's operations and financial results.

Rising fuel prices and availability may adversely affect the Company's profits.

Fuel is a significant operating expense for the Company's shipping and agribusiness operations. The price and supply of fuel is unpredictable and fluctuates based on events beyond the Company's control. Increases in the price of fuel may adversely affect the Company's results of operations based on market and competitive conditions. Increases in fuel costs also can lead to other expense increases, through, for example, increased costs of energy, petroleum-based raw materials and purchased transportation services. In the Company's ocean transportation and logistics segments, the Company is able to utilize fuel surcharges to partially recover increases in fuel expense, although increases in the fuel surcharge may adversely affect the Company's competitive position and may not correspond exactly with the timing of increases in fuel expense. Changes in the Company's ability to collect fuel surcharges may adversely affect its results of operations. Increases in energy costs for the Company's leased real estate portfolio are typically recovered from lessees, although higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices may also increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting the Company's development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Changes to federal, state or local law or regulations may adversely affect the Company's business.

The Company is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, government administration of the U.S. sugar program, environmental regulations including those relating to air quality initiatives at port locations, and cabotage laws. Changes to the laws and regulations governing the Company's business could impose significant additional costs on the Company and adversely affect the Company's financial condition. For example, if the Jones Act and the regulations promulgated thereunder were repealed, amended, or otherwise modified, non-U.S. competitors with significantly lower costs may consequently enter any of the Jones Act routes or the Company's business may be significantly altered, all of which may have an adverse effect on the Company's shipping business. In addition, changes in federal, state and local environmental laws impacting the shipping business may require costly vessel modifications, the use of higher-priced fuel and changes in operating practices that may not all be able to be recovered through increased recovery from customers. The real estate segment is subject to numerous federal, state and local laws and regulations, which, if changed, may adversely affect the Company's business. The agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the Farm Bill that the U.S. Congress is working on, and the Company may be affected by any changes.

Work stoppages or other labor disruptions by the unionized employees of the Company or other companies in related industries may adversely affect the Company's operations.

As of December 31, 2007, the Company had approximately 2,255 regular full-time employees, of which approximately 49 percent were covered by collective bargaining agreements with unions. The Company's transportation, real estate and agribusiness segments may be adversely affected by actions taken by employees of the Company or other companies in related industries against efforts by management to control labor costs, restrain wage increases or modify work practices. Strikes and disruptions may occur as a result of the failure of the Company or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its real estate segment, the Company may be unable to complete construction of its projects if building materials or labor is unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor and customer relationships may adversely affect the Company's business.

The Company's business is dependent on its relationships with key vendors, customers and tenants. The ocean transportation business relies on its relationships with freight forwarders, large retailers and consumer goods and automobile manufacturers, as well as other larger customers. Relationships with railroads and shipping companies are important in the Company's intermodal business. For agribusiness, HC&S's relationship with C&H Sugar Company, Inc. is important. The loss of or damage to any of these key relationships may affect the Company's business adversely.

Interruption or failure of the Company's information technology and communications systems could impair the Company's ability to operate and adversely affect its business.

The Company is highly dependent on information technology systems. For example, in the transportation segment, these dependencies primarily include accounting, billing, disbursement, cargo booking and tracking, vessel scheduling and stowage, equipment tracking, customer service, banking, payroll and employee communication systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. The Company may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at the Company's facilities. Any failure of the Company's systems could result in interruptions in its service or production, reducing its revenue and profits and damaging its reputation.

The Company is susceptible to weather and natural disasters.

The Company's transportation operations are vulnerable to disruption as a result of weather and natural disasters such as bad weather at sea, hurricanes, typhoons, tsunamis, floods and earthquakes. Such events will interfere with the Company's ability to provide on-time scheduled service, resulting in increased expenses and potential loss of business associated with such events. In addition, severe weather and natural disasters can result in interference with the Company's terminal operations, and may cause serious damage to its vessels, loss or damage to containers, cargo and other equipment, and loss of life or physical injury to its employees, all of which could have an adverse effect on the Company's business.

For the real estate segment, the occurrence of natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, could damage its real estate holdings, resulting in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, the Company's properties.

For the agribusiness segment, drought, greater than normal rainfall, hurricanes, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar and coffee planting, harvesting and production, and the agribusiness segment's facilities, including dams and reservoirs.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact the Company's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability of tourists to get to Hawaii, thereby adversely affecting the Company. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets. Acts of war or terrorism may be directed at the Company's shipping operations or real estate holdings, or may cause the U.S. government to take control of Matson's vessels for military operation. Heightened security measures are likely to slow the movement of freight through U.S. or foreign ports, across borders or on U.S. or foreign railroads or highways and could adversely affect the Company's business and results of operations.

Loss of the Company's key personnel could adversely affect its business.

The Company's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, the Company may have to incur significant costs to replace them and its ability to execute its business model could be impaired if it cannot replace them in a timely manner. The Company does not expect to maintain key person insurance on any of its key personnel.

The Company is involved in joint ventures and is subject to risks associated with joint venture relationships.

The Company is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as:

- the Company may not have voting control over the joint venture;
- the Company may not be able to maintain good relationships with its joint venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with the Company's;
- the venture partner may fail to fund its share of operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to the Company; and
- the joint venture or venture partner could lose key personnel.

In connection with its real estate joint ventures, the Company is sometimes asked to guarantee completion of a joint venture's construction and development of a project, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If the Company were to become obligated under such arrangement, the Company may be adversely affected.

The Company is subject to, and may in the future be subject to, disputes, or legal or other proceedings, that could have an adverse effect on the Company.

The nature of the Company's business exposes it to the potential for disputes, or legal or other proceedings, relating to labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section or in other Company filings with the SEC. In addition, Matson is a common carrier, whose tariffs, rates, rules and practices in dealing with its customers are governed by extensive and complex foreign, federal, state and local regulations, which may be the subject of disputes or administrative and/or judicial proceedings. These disputes, individually or collectively, could harm the Company's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by the Company, or result in significant changes to Matson's tariffs, rates, rules and practices in dealing with its customers, all of which could have an adverse effect on the Company's future operating results, including profitability, cash flows, and financial condition. For a description of significant legal proceedings involving the Company, see "Legal Proceedings" below.

TRANSPORTATION

The Company is subject to risks associated with conducting business in a foreign shipping market.

In February 2006, Matson launched its Hawaii/Guam/China service. The Company is subject to risks associated with conducting business in a foreign shipping market, which include:

- challenges in operating in a foreign country and doing business and developing relationships with foreign companies;
- difficulties in staffing and managing foreign operations;
- legal and regulatory restrictions, including compliance with Foreign Corrupt Practices Act;
- decreases in shipping rates;
- competition with established and new shippers;
- currency exchange rate fluctuations;
- political and economic instability; and
- challenges caused by cultural differences.

Any of these risks has the potential to adversely affect the Company's operating results.

Acquisitions may have an adverse effect on the Company's business.

The Company's growth strategy includes expansion through acquisitions. Acquisitions may result in difficulties in assimilating acquired companies, and may result in the diversion of the Company's capital and its management's attention from other business issues and opportunities. The Company may not be able to integrate companies that it acquires successfully, including their personnel, financial systems, distribution, operations and general operating procedures. The Company may also encounter challenges in achieving appropriate internal control over financial reporting in connection with the integration of an acquired company.

The Company's logistics services are dependent upon third parties for equipment, capacity and services essential to operate their business, and if they fail to secure sufficient third party services, their business could be adversely affected.

The Company's logistics services are dependent upon rail, truck and ocean transportation services provided by independent third parties. If they cannot secure sufficient transportation equipment, capacity or services from these third parties at a reasonable rate to meet their customers' needs and schedules, customers may seek to have their transportation and logistics needs met by other third parties on a temporary or permanent basis. As a result, the Company's business, consolidated results of operations and financial condition could be adversely affected.

Housing Policy, which requires developers of residential developments of five or more units to sell or rent 40% to 50% of the total number of units at below market rates, or pay significant fees or contribute property to the County for low-income housing. These requirements could make the cost of developing new projects prohibitive. It is possible that increasingly stringent requirements will be imposed on developers in the future that could adversely affect the Company's ability to develop projects in the affected markets or could require that the Company satisfy additional administrative and regulatory requirements, which could delay development progress or increase the development costs of the Company. Any such delays or costs could have an adverse effect on the Company's revenues and earnings.

AGRIBUSINESS

The unavailability of water for agricultural irrigation could adversely affect the Company.

It is crucial for the Company's agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane and coffee. As further described in "Legal Proceedings" below, there are administrative hearing processes challenging the Company's ability to divert water from streams in Maui. If the Company is not permitted to divert stream waters for its use, it would have an adverse effect on the Company's sugar operations.

A decline in raw sugar or coffee prices will adversely affect the Company's business.

The business and results of operations of the Company's agribusiness segment are substantially affected by market factors, principally the domestic and international prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops, weather conditions, and United States farm and trade policies. If the price for sugar or coffee were to decline, the Company's agribusiness segment would be adversely affected. See also discussion under "Business and Properties - Agribusiness - Competition and Sugar Legislation" above.

The Company is subject to risks associated with raw sugar and coffee production.

The Company's raw sugar and coffee production are subject to risks, which include:

- weather and natural disasters;
- disease;
- weed control;
- uncontrolled fires, including arson;
- poor farming practices;
- government restrictions on farming practices due to cane burning;
- increases in costs, including, but not limited to fertilizer, fuel, and drip tubing;
- water availability (see risk factor above regarding unavailability of water);
- equipment failures in factory or power plant; and
- labor, including labor availability (see risk factor above regarding labor disruptions).

Any of these risks has the potential to adversely affect the Company's future agribusiness operating results.

OTHER

Earnings on pension assets, or a change in pension law and on key assumptions, may adversely affect the Company's financial performance.

The amount of the Company's employee retirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, or lower returns on plan assets, may adversely affect the Company's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect the Company's single-employer and multiemployer pension plans and plan funding.

The Company may have exposure under its multiemployer plans in which it participates that extends beyond its funding obligation with respect to the Company's employees.

The Company contributes to various multiemployer pension plans. In the event of a partial or complete withdrawal by the Company from any plan that is underfunded, the Company would be liable for a proportionate share of such plan's unfunded vested benefits. Based on the limited information available from plan administrators, which the Company cannot independently validate, the Company believes that its portion of the contingent liability in the case of a full withdrawal or termination may be material to its financial position and results of operations. In the event that any other contributing employer withdraws from any plan that is underfunded, and such employer (or any member in its controlled group) cannot satisfy its obligations under the plan at the time of withdrawal, then the Company, along with the other remaining contributing employers, would be liable for its proportionate share of such plan's unfunded vested benefits. In addition, if a multiemployer plan fails to satisfy the minimum funding requirements, the Internal Revenue Service will impose certain penalties and taxes.

The Company is required to evaluate its internal controls over financial reporting under Section 404 of the Sarbanes-Oxley Act of 2002, and any adverse results from such evaluation could result in a loss of investor confidence in the Company's financial reports and have an adverse effect on the Company's stock price.

Section 404 of the Sarbanes-Oxley Act requires that publicly reporting companies cause their managements to perform annual assessments of the effectiveness of their internal controls over financial reporting. Although the Company has concluded that its internal controls over financial reporting were effective as of December 31, 2007, there can be no assurances that the Company will reach the same conclusion at the end of future years. If the Company is unable to assert that its internal control over financial reporting is effective, or if the Company's auditors are unable to express an opinion on the effectiveness of the Company's internal controls, the Company could lose investor confidence in the accuracy and completeness of its financial reports, which would have an adverse effect on the Company's stock price.

The foregoing should not be construed as an exhaustive list of all factors that could cause actual results to differ materially from those expressed in forward-looking statements made by the Company or on its behalf.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 3. LEGAL PROCEEDINGS

See "Business and Properties - Transportation - Rate Regulation" above for a discussion of rate and other regulatory matters in which Matson is routinely involved.

On September 14, 1998, Matson was served with a complaint filed by the Government of Guam with the Surface Transportation Board (the "Board"), alleging that Sea-Land Services, Inc., APL and Matson had charged unreasonable rates in the Guam trade since January 1991. Matson did not begin its Guam Service until February 1996. On February 2, 2007, the Board issued a decision, setting a briefing schedule to determine whether there is effective competition in the Guam trade, as requested by Matson. On August 30, 2007, the Board denied the petitions for reconsideration of its February 2, 2007 decision filed by the Government of Guam and intervenor Caribbean Shippers Association. In light of this decision, the Government of Guam filed a motion to dismiss its complaint on September 18, 2007. On October 12, 2007, the Board dismissed the complaint and discontinued the proceeding.

A&B owns 16,000 acres of watershed lands in East Maui that supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years has supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a

ITEM 6. SELECTED FINANCIAL DATA

The following financial data should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except per-share amounts):

	2007	2006	2005	2004	2003
Revenue:					
Transportation:					
Ocean transportation	**$1,006.9**	$ 945.8	$ 878.3	$ 850.1	$ 776.3
Logistics services	**433.5**	444.2	431.6	376.9	237.7
Real Estate:					
Leasing	**108.5**	100.6	89.7	83.8	80.3
Sales	**117.8**	97.3	148.9	82.3	63.8
Less amounts reported in discontinued operations[1]	**(100.6)**	(101.2)	(66.6)	(16.3)	(51.8)
Agribusiness	**123.7**	127.4	123.2	112.8	112.9
Reconciling Items[2]	**(9.2)**	(14.2)	(8.4)	(6.5)	--
Total revenue	**$1,680.6**	$1,599.9	$1,596.7	$1,483.1	$1,219.2
Operating Profit:					
Transportation:					
Ocean transportation	**$ 126.5**	$ 105.6	$ 128.0	$ 108.3	$ 93.2
Logistics services	**21.8**	20.8	14.4	8.9	4.3
Real Estate:					
Leasing	**51.6**	50.3	43.7	38.8	37.0
Sales	**74.4**	49.7	44.1	34.6	23.9
Less amounts reported in discontinued operations[1]	**(54.4)**	(46.7)	(22.2)	(7.2)	(23.7)
Agribusiness	**0.2**	6.9	11.2	4.8	5.1
Total operating profit	**220.1**	186.6	219.2	188.2	139.8
Write-down of long-lived assets[3]	--	--	(2.3)	--	(7.7)
Interest expense, net[4]	**(18.8)**	(15.0)	(13.3)	(12.7)	(11.6)
General corporate expenses	**(27.3)**	(22.3)	(24.1)	(20.3)	(15.2)
Income from continuing operations before income taxes	**174.0**	149.3	179.5	155.2	105.3
Income taxes	**(65.5)**	(55.8)	(67.2)	(58.9)	(38.7)
Income from continuing operations	**$ 108.5**	$ 93.5	$ 112.3	$ 96.3	$ 66.6

1 Prior year amounts restated for amounts treated as discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes. Amounts for 2003 were not material.

3 The 2005 and 2003 write-downs were for an "other-than-temporary" impairment in the Company's investment in C&H. The Company's investment in C&H was sold on August 9, 2005 at the then approximate carrying value.

4 Includes Ocean Transportation interest expense of $13.9 million for 2007, $13.3 million for 2006, $9.6 million for 2005, $5.7 million for 2004, and $2.6 million for 2003. Substantially all other interest expense was at the parent company.

	2007	2006	2005	2004	2003
Identifiable Assets:					
Transportation:					
Matson Ocean Transportation	**$1,215.0**	$ 1,185.3	$ 1,113.0	$ 896.9	$ 936.5
Logistics services	**58.6**	56.4	70.3	56.5	45.4
Real Estate:					
Leasing	**595.4**	525.5	478.6	436.5	451.2
Sales	**408.9**	295.0	227.3	224.5	161.6
Agribusiness	**174.6**	168.7	159.0	152.8	154.4
Other	**26.6**	20.3	22.7	11.0	10.5
Total assets	**$2,479.1**	$2,251.2	$2,070.9	$1,778.2	$1,759.6
Capital Additions:					
Transportation:					
Matson Ocean Transportation	**$ 65.8**	$ 217.1	$ 173.9	$ 128.6	$ 133.2
Logistics services[5]	**2.0**	1.7	1.3	0.1	0.2
Real Estate:					
Leasing[6]	**124.5**	93.0	78.8	10.2	49.7
Sales[7, 8]	**0.3**	1.3	0.2	0.7	58.0
Agribusiness	**20.5**	15.0	13.0	10.2	12.6
Other	**0.3**	1.5	1.4	1.4	1.7
Total capital additions	**$ 213.4**	$ 329.6	$ 268.6	$ 151.2	$ 255.4
Depreciation and Amortization:					
Ocean Transportation:					
Matson Ocean Transportation	**$ 63.2**	$ 58.1	$ 59.5	$ 56.8	$ 51.0
Logistics services	**1.5**	1.5	1.4	1.2	0.9
Real Estate:					
Leasing[1]	**15.7**	14.1	12.4	12.2	11.2
Sales	**0.2**	0.1	0.1	0.1	0.1
Agribusiness	**10.7**	10.1	9.4	9.0	8.2
Other	**1.3**	0.9	0.5	0.4	0.3
Total depreciation and amortization	**$ 92.6**	$ 84.8	$ 83.3	$ 79.7	$ 71.7

5 Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

6 Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

7 Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $110 million, $69 million, $34 million, $30 million, and $35 million for the years ended December 31, 2007, 2006, 2005, 2004, and 2003, respectively.

8 Capital expenditures for the real estate sales segment in 2003 primarily represents expenditures related to the acquisition of the Wailea resort development lands, which consisted of 270 undeveloped acres comprised of 17 individual development parcels entitled for residential and commercial uses.

	2007	2006	2005	2004	2003
Earnings per share:					
From continuing operations:					
Basic	**$ 2.55**	$ 2.16	$ 2.57	$ 2.26	$ 1.60
Diluted	**$ 2.52**	$ 2.14	$ 2.55	$ 2.23	$ 1.59
Net Income:					
Basic	**$ 3.34**	$ 2.84	$ 2.89	$ 2.37	$ 1.95
Diluted	**$ 3.30**	$ 2.81	$ 2.86	$ 2.33	$ 1.94
Return on beginning equity	**13.8%**	12.1%	13.9%	12.4%	11.2%
Cash dividends per share	**$ 1.12**	$ 0.975	$ 0.90	$ 0.90	$ 0.90
At Year End					
Shareholders of record	**3,381**	3,506	3,628	3,792	3,959
Shares outstanding	**42.4**	42.6	44.0	43.3	42.2
Long-term debt – non-current	**$ 452**	$ 401	$ 296	$ 214	$ 330

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

The Company, from time to time, may make or may have made certain forward-looking statements, whether orally or in writing, such as forecasts and projections of the Company's future performance or statements of management's plans and objectives. These statements are "forward-looking" statements as that term is defined in the Private Securities Litigation Reform Act of 1995. Such forward-looking statements may be contained in, among other things, SEC filings, such as the Forms 10-K, 10-Q and 8-K, the Annual Report to Shareholders, press releases made by the Company, the Company's Internet Web sites (including Web sites of its subsidiaries), and oral statements made by the officers of the Company. Except for historical information contained in these written or oral communications, such communications contain forward-looking statements. These include, for example, all references to 2008 or future years. New risk factors emerge from time to time and it is not possible for the Company to predict all such risk factors, nor can it assess the impact of all such risk factors on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. Accordingly, forward-looking statements cannot be relied upon as a guarantee of future results and involve a number of risks and uncertainties that could cause actual results to differ materially from those projected in the statements, including, but not limited to the factors that are described in Part I, Item 1A under the caption of "Risk Factors" of this Form 10-K, which section is incorporated herein by reference. The Company is not required, and undertakes no obligation, to revise or update forward-looking statements or any factors that may affect actual results, whether as a result of new information, future events, or circumstances occurring after the date of this report.

OVERVIEW

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is designed to provide a discussion of the Company's financial condition, results of operations, liquidity and certain other factors that may affect its future results from the perspective of management. The discussion that follows is intended to provide information that will assist in understanding the changes in the Company's financial statements from year to year, the primary factors that accounted for those changes, and how certain accounting principles, policies and estimates affect the Company's financial statements. MD&A is provided as a supplement to, and should be read in conjunction with, the consolidated financial statements and the accompanying notes to the financial statements. MD&A is presented in the following sections:

- Business Overview
- Critical Accounting Estimates
- Consolidated Results of Operations
- Analysis of Operating Revenue and Profit by Segment
- Liquidity and Capital Resources
- Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements
- Business Outlook
- Other Matters

BUSINESS OVERVIEW

Alexander & Baldwin, Inc. ("A&B"), founded in 1870, is a multi-industry corporation headquartered in Honolulu that operates in five segments in three industries—Transportation, Real Estate, and Agribusiness.

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. The Ocean Transportation segment also has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities to Matson and numerous international carriers.

The Logistics Services segment is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services (collectively "Highway"). As a non-asset based business, the Logistics Services segment does not own transportation assets. Rather, the Logistics Services segment generates its revenues by purchasing transportation services from direct (asset-based) carriers and reselling those services to its customers. By concentrating its buying power and/or consolidating shipments from multiple customers, the Logistics Services segment is able to negotiate favorable rates from the direct carriers, while at the same time offering lower rates than customers would otherwise be able to negotiate themselves.

The Transportation Industry accounted for 80 percent, 54 percent, and 52 percent of the revenue, operating profit, and identifiable assets, respectively, in 2007 on a consolidated basis before discontinued operations.

Real Estate: The Real Estate Industry is comprised of two segments. The Real Estate Sales segment generates its revenues through the development and sale of commercial, residential, and other properties. The Real Estate Sales segment seeks to diversify its investments and create value by entering into long-term, large projects as well as shorter-term development projects, partnering with other developers, developing newly purchased landholdings in Hawaii and on the U.S. mainland, and entitling and developing the Company's core landholdings in Hawaii.

The Real Estate Leasing segment owns, operates, and manages commercial properties. The Real Estate Leasing segment focuses on acquiring high-quality retail, office, and industrial properties in good locations, primarily with tax-deferred 1031 proceeds, and on effectively managing those properties to increase margins through higher occupancies and cost management. The Real Estate Leasing segment's assets are well-diversified by geography and product-type. Real Estate Leasing income also includes revenue from a variety of land leases, licenses, and other agreements related to real estate in Hawaii.

The Real Estate Industry accounted for 13 percent, 46 percent, and 41 percent of the revenue, operating profit, and identifiable assets, respectively, in 2007 on a consolidated basis before discontinued operations.

Agribusiness: Agribusiness, which contains one segment, is the largest grower of sugar cane and coffee in the State of Hawaii. The segment produces bulk raw sugar, specialty food-grade sugars, molasses and green coffee; markets and distributes roasted coffee and green coffee; provides sugar, petroleum and molasses hauling, general trucking services, mobile equipment maintenance and repair services, and self-service storage in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

The Agribusiness Industry accounted for 7 percent of the revenue and 7 percent of the identifiable assets in 2007 on a consolidated basis before discontinued operations.

CRITICAL ACCOUNTING ESTIMATES

The Company's significant accounting policies are described in Note 1 to the Consolidated Financial Statements. The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America, upon which the Management's Discussion and Analysis is based, requires that management exercise judgment when making estimates and assumptions about future events that may affect the amounts reported in the financial statements and accompanying notes. Future events and their effects cannot be determined with absolute certainty and actual results will, inevitably, differ from those critical accounting estimates. These differences could be material.

The Company considers an accounting estimate to be critical if: (i) the accounting estimate requires the Company to make assumptions that are difficult or subjective about matters that were highly uncertain at the time that the accounting estimate was made, and (ii) changes in the estimate that are reasonably likely to occur in periods subsequent to the period in which the estimate was made, or use of different estimates that the Company could have

CONSOLIDATED RESULTS OF OPERATIONS

The following analysis of the consolidated financial condition and results of operations of Alexander & Baldwin, Inc. and its subsidiaries (collectively, the "Company") should be read in conjunction with the consolidated financial statements and related notes thereto. Amounts in this narrative are rounded to millions, but per-share calculations and percentages were calculated based on thousands. Accordingly, a recalculation of some per-share amounts and percentages, if based on the reported data, may be slightly different than the more accurate amounts included herein.

(dollars in millions, except per-share amounts)	2007	Chg.	2006	Chg.	2005
Operating Revenue	$ 1,681	5%	$ 1,600	--	$ 1,597
Operating Costs and Expenses	1,515	4%	1,456	3%	1,418
Operating Income	166	15%	144	-20%	179
Other Income and (Expense)	8	60%	5	NM	--
Income Taxes	(66)	17%	(56)	-16%	(67)
Discontinued Operations (net of taxes)	34	17%	29	107%	14
Net Income	$ 142	16%	$ 122	-3%	$ 126
Basic Earnings Per Share	$ 3.34	18%	$ 2.84	-2%	$ 2.89
Diluted Earnings Per Share	$ 3.30	17%	$ 2.81	-2%	$ 2.86

Operating Revenue for 2007 increased more than 5 percent, or $81 million, to $1,681 million. Ocean transportation revenue increased 7 percent in 2007, principally due to higher China service container volumes, improved yields and cargo mix, and higher fuel surcharge revenues, partially offset by lower Hawaii service container volumes. Logistics services revenue decreased 2 percent in 2007, primarily due to lower volumes. Real estate leasing revenue increased 16 percent in 2007 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to additions to the leased portfolio and higher lease rates. Real estate sales revenue almost tripled in 2007 (after subtracting revenue from discontinued operations) due principally to residential sales at the Company's Port Allen development and a commercial parcel on Maui. Because of the episodic nature of property sales, the Company views changes in real estate sales revenues on a year-over-year basis before the reclassification of revenue to discontinued operations to be more meaningful in assessing segment performance. Additionally, due to the timing of sales for development properties and the mix of properties sold, management believes performance is more appropriately assessed over a multi-year period. Furthermore, year-over-year comparisons of revenue are not complete without the consideration of results from the Company's investment in its real estate joint ventures, which are not included in operating revenues, but are included in operating profit. The Analysis of Operating Revenue and Profit by Segment that follows, provides additional information on changes in real estate sales revenue and operating profit.

Operating Revenue for 2006 increased by less than 1 percent, or $3 million, to $1,600 million. Real estate leasing revenue increased 21 percent in 2006 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to higher occupancies, higher lease rates, and additions to the leased portfolio. Ocean transportation revenue increased 7 percent in 2006, principally due to higher fuel surcharge revenues as a result of higher direct and indirect energy costs, initiation of the new China service, and improved yields and cargo mix. Logistics services revenue increased 3 percent in 2006, primarily due to higher yields and mix, partially offset by a decline in volumes for freight transported by rail. Real estate sales revenue decreased by 92 percent in 2006 (after subtracting revenue from discontinued operations) due to the timing and mix of properties sold.

The reasons for business- and segment-specific year-to-year fluctuations in revenue growth are further described below in the Analysis of Operating Revenue and Profit by Segment.

Operating Costs and Expenses for 2007 increased by 4 percent, or $59 million, to $1,515 million. Ocean transportation costs increased 5 percent in 2007, primarily due to higher vessel costs, terminal handling, and equipment repositioning costs. Real estate sales and leasing costs increased 40 percent, primarily due to the timing and mix of development sales. Selling, General and Administrative costs ("SG&A") increased by 13 percent in 2007 due to higher personnel and benefit costs, including performance-based compensation. Agribusiness costs increased 2 percent in 2007, principally due to higher crop production costs.

Operating Costs and Expenses for 2006 increased by 3 percent, or $38 million, to $1,456 million. Ocean transportation costs increased 12 percent in 2006, primarily due to higher fuel costs, terminal handling, and equipment costs. Agribusiness costs increased 7 percent in 2006, principally due to higher crop production costs and repairs to irrigation reservoirs. Real estate sales and leasing costs decreased 58 percent in 2006, primarily due to the timing and mix of development sales. Selling, General and Administrative costs ("SG&A") increased by 3 percent, or $4 million, to $146 million in 2006 due to higher personnel and benefit costs that included $2.8 million in non-cash stock option expense as a result of the adoption of SFAS No. 123R.

The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Other Income and Expense in 2007 is comprised of equity in earnings of real estate joint ventures, interest revenue and interest expense. Equity in income of real estate affiliates was $9 million higher in 2007 due principally to earnings from the Company's Kai Malu joint venture project. Interest expense of $19 million in 2007 was $4 million higher than 2006 due to higher average debt balances.

Other Income and Expense in 2006 is comprised of equity in earnings of real estate joint ventures, interest revenue and interest expense. Equity in income of real estate affiliates was $11 million higher in 2006 compared to 2005 due principally to the Company's share of earnings from its Hokua joint venture, which completed sales of all 247 luxury residential units in the first quarter of 2006. Interest expense of $15 million in 2006 was $2 million higher than 2005 due to higher average debt balances.

Income Taxes were higher in 2007 compared with 2006 on an absolute and percentage basis due to higher income and a change in the effective income tax rate. The higher effective income tax rate in 2007 was principally due to higher state income taxes, higher tax-deductible appreciated land donations in 2006, an increase in certain non-deductible expenses, and lower non-taxable Medicare-D benefits in 2007. Income Taxes were lower in 2006 compared with 2005 due primarily to lower pre-tax income. The effective tax rates in 2006 and 2005 were comparable.

ANALYSIS OF OPERATING REVENUE AND PROFIT BY SEGMENT

Additional detailed information related to the operations and financial performance of the Company's Industry Segments is included in Part II Item 6 and Note 13 to the Consolidated Financial Statements. The following information should be read in relation to the information contained in those sections.

Transportation Industry

***Ocean Transportation**; 2007 compared with 2006*

(dollars in millions)	2007	2006	Change
Revenue	$ 1,006.9	$ 945.8	6%
Operating profit	$ 126.5	$ 105.6	20%
Operating profit margin	12.6%	11.2%	
Volume (units):			
Hawaii containers	167,500	173,200	-3%
Hawaii automobiles	110,100	118,700	-7%
China containers	51,200	32,700	57%
Guam containers*	14,600	13,500	8%

* Container volumes related to the Federated States of Micronesia (FSM) have been excluded for comparative purposes due to the Company's new deployment in the Guam and Micronesia trades.

Ocean Transportation revenue increased $61.1 million, or 6 percent, in 2007 compared to 2006. The increase reflected a number of factors, including $36.2 million related to improved yields and cargo mix, $44.3 million due principally to higher China, Guam and Micronesia service volumes, partially offset by $16.3 in lower Hawaii volumes, and $18.1 million related to an increase in fuel surcharge revenues. These increases were partially offset by $6.4 million of lower vessel charter revenue resulting from the expiration of the APL Alliance in the first quarter of 2006 and $2.1 million in lower government charter service revenue.

Total Hawaii container volume was down 3 percent from 2006, due to the reduction of volumes in certain segments, including construction materials, despite continued moderate growth in the Hawaii economy. Matson's Hawaii automobile volume for 2007 was 7 percent lower than the same period of last year, due primarily to lower rental fleet turnover and slower retail auto sales. China volume increased 57 percent in 2007 as a result of the ramp-up of the China service during 2006 as compared to relatively full ships throughout 2007. Guam container volume increased 8 percent from year-earlier levels due to general market growth.

Operating profit increased $20.9 million, or 20 percent, in 2007 compared to 2006. This increase was primarily the result of revenue increases described above, partially offset by the following operating expense changes. Vessel costs increased by $15.8 million due principally to higher direct and indirect fuel costs, higher vessel wages, higher insurance and claims costs, and higher dry-dock expenses, partially offset by fleet optimization initiatives, resulting in fewer operating vessel days in line with the lower volumes in the Hawaii service, as well as lower charter costs as a result of the off-hire of the M.V. Greatland late in the first quarter of 2007. Terminal handling costs increased by $9.2 million, principally the result of higher terminal handling fees. Depreciation expenses increased $5.5 million due primarily to the acquisition of a new vessel late in the third quarter of 2006. Operations overhead increased $4.0 million, primarily due to higher container repositioning costs arising as a result of increased China volumes destined for inland U.S. locations. General and administrative costs increased $3.8 million due to higher payroll, professional fees, and legal expenses. The year-over-year variance was also negatively impacted by a $3.3 million gain in 2006 on the sale of two surplus and obsolete vessels, a $2.6 million decrease in Matson's share of SSAT joint venture earnings, principally the result of lower terminal volumes, and a $2.3 million decrease in interest income primarily due to lower cash balances.

***Discontinued Operations**; Real-estate*-- The revenue, operating profit, and after-tax effects of discontinued operations for 2007, 2006 and 2005 were as follows (in millions, except per-share amounts):

	2007	2006	2005
Sales Revenue	$ 94.7	$ 89.7	$ 50.1
Leasing Revenue	$ 5.9	$ 11.5	$ 16.5
Sales Operating Profit	$ 50.8	$ 40.1	$ 13.9
Leasing Operating Profit	$ 3.6	$ 6.6	$ 8.3
After-tax Earnings	$ 33.7	$ 29.0	$ 13.7
Basic Earnings Per Share	$ 0.79	$ 0.68	$ 0.32
Diluted Earnings Per Share	$ 0.78	$ 0.67	$ 0.31

2007: The revenue and expenses of land leased to a retail tenant on Oahu, several commercial properties on Maui, and a commercial property in California have been classified as discontinued operations. Additionally, the revenue and expenses of leased fee parcel on Maui was classified as discontinued operations even though the Company had not sold the property by the end of 2007.

2006: The revenue and operating profit from the sale of two retail centers in Arizona, an office building on Maui, a commercial property on the island of Hawaii, and several commercial parcels in Hawaii were included in discontinued operations.

2005: The sales of two office buildings in Honolulu, one warehouse/distribution complex in Ontario, California, one service center/warehouse complex, consisting of three buildings in San Antonio, Texas, and the fee interest in a parcel in Maui were considered discontinued operations. Additionally, the revenue and expenses of an office building in Wailuku, Maui and three parcels on Maui were classified as discontinued operations even though the Company had not sold the properties by the end of 2005. The three parcels were sold in 2006.

Agribusiness

Agribusiness; 2007 compared with 2006

(dollars in millions)	2007	2006	Change
Revenue	$ 123.7	$ 127.4	-3%
Operating profit	$ 0.2	$ 6.9	-97%
Operating profit margin	0.2%	5.4%	
Tons sugar produced	164,500	173,600	-5%

Agribusiness revenue decreased $3.7 million, or 3 percent, in 2007 compared with 2006. The decrease was principally due to $6.3 million in lower raw sugar revenue as a result of lower sales volumes and prices, and $1.6 million in lower power revenue due principally to lower volumes sold. The decrease was partially offset by $4.3 million in higher revenue from coffee sales, specialty sugar sales, land and quarry rent, and trucking and shop services.

Operating profit for 2007 decreased $6.7 million, or 97 percent, compared with 2006. The decrease in operating profit was primarily due to lower sugar production, higher operating costs, and lower sugar prices. The decrease in operating profit was also due to $1.6 million in lower power revenue due principally to lower volumes sold.

Compared with 2006, sugar production in 2007 was 5 percent, or 9,100 tons, lower due primarily to lower yields. Lower sugar yields were principally the result of dry-weather conditions over the past two years and to certain agronomic practices. The average revenue per ton of sugar for 2007 was $342, or 2 percent lower than the average revenue per ton of $350 in 2006.

Approximately 87 percent of the Company's sugar production was sold to Hawaiian Sugar & Transportation Cooperative ("HS&TC") during 2007 under a marketing contract. The remainder was sold as specialty sugar. HS&TC sells its raw sugar to C&H at a price equal to the New York No. 14 Contract settlement price, less a discount and less costs for sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Company.

Agribusiness: 2006 compared with 2005

(dollars in millions)	2006	2005	Change
Revenue	$ **127.4**	$ 123.2	3%
Operating profit	$ **6.9**	$ 11.2	-38%
Operating profit margin	**5.4%**	9.1%	
Tons sugar produced	**173,600**	192,700	-10%

Agribusiness revenue increased $4.2 million, or 3 percent, in 2006 compared to 2005. Excluding the $5.5 million disaster relief payment received in 2005, revenue increased 8 percent due mainly to $4.3 million in higher repair services and trucking revenue, $4.1 million from higher power sales, $2.6 million in higher equipment rentals and soil sales, and $2.2 million in higher specialty sugar and molasses sales. Lower revenue of $5.4 million from lower bulk raw sugar sales volumes partially offset the previously noted increases. Operating profit decreased $4.3 million, or 38 percent, in 2006 compared with 2005. However, excluding the $5.5 million disaster relief payment received in 2005, operating profit increased 21 percent due mainly to the same factors noted above. This 21 percent increase in operating profit reflected the effect of the factors mentioned above as well as higher 2006 crop production costs and repair costs for irrigation reservoirs. Production costs were higher due to increases in personnel, materials and supplies, fertilizer, and chemicals expenses. Also, 2006 included one additional week compared to 2005 (53 weeks in 2006 vs. 52 weeks in 2005).

Compared with 2005, sugar production in 2006 was 10 percent, or 19,100 tons, lower due primarily to dry-weather conditions during critical growing months, less-than-optimal fertilizer applications last year, and a lower crop age. The average revenue per ton of sugar for 2006 was $350, or 2 percent higher than in 2005.

LIQUIDITY AND CAPITAL RESOURCES

Overview: Cash flows provided by operating activities continue to be the Company's most significant source of liquidity. Additional sources of liquidity were provided by available cash and cash equivalent balances as well as borrowings on available credit facilities.

Cash Flows: Cash Flows from Operating Activities totaled $124 million for 2007, $106 million for 2006, and $278 million for 2005. The increase in 2007 over 2006 was due principally to higher ocean transportation earnings, including higher distributions from Matson's investment in SSAT, and higher residential development sales proceeds, partially offset by higher expenditures for real estate developments held-for-sale and higher income tax payments. The decrease in 2006 over 2005 was principally the result of higher 2005 proceeds from the sale of units in the Company's Lanikea residential high-rise project in Waikiki, higher year-to-date income tax payments, higher development expenditures for real estate inventory, and lower Matson earnings in 2006, partially offset by proceeds received from the Company's Hokua joint venture in 2006.

Cash Flows used in Investing Activities were $145 million for 2007, $124 million for 2006, and $305 million in 2005. Of the 2007 amount, $122 million was for capital expenditures that included $68 million for the purchase of ocean transportation-related assets, principally related to the modification of the *MV Mokihana*, $34 million for real estate leasing and property improvements (excluding non-cash 1031 transactions and real estate development activity), and $20 million related to agricultural operations, primarily for the expansion of specialty sugar facilities. The $122 million for 2007 excludes $91 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period. In 2006, the Company's capital expenditures, excluding purchases of property using tax-deferred proceeds, totaled $281million. This was comprised principally

(e) Non-qualified benefit obligations includes estimated payments to executives and directors under the Company's four non-qualified plans. The $13 million noted in the column labeled "Thereafter" comprises estimated benefit payments for 2013 through 2017. Additional information about the Company's non-qualified plans is included in Note 9 to the Consolidated Financial Statements.

(f) Operating lease obligations include principally land, office and terminal facilities, containers and equipment using long-term lease arrangements that do not transfer the rights and risks of ownership to the Company. These amounts are further described in Note 8 to the Consolidated Financial Statements.

The Company adopted FIN 48 on January 1, 2007. The Company has not provided a detailed estimate of the timing of payments due to the uncertainty of when the related tax settlements are due.

Off Balance Sheet Arrangements: See Note 12 of the Consolidated Financial Statements, which is incorporated herein by reference, for a description of contingent commitments that totaled approximately $117 million at December 31, 2007.

BUSINESS OUTLOOK

In 2007, the pace of growth in the Hawaii economy slowed, especially in the second half of the year. This moderation paralleled the general economic contraction that characterized much of the U.S. domestic economy and is expected to continue in the near-term. Economic and market uncertainty arising from the credit crisis and housing market downturn is high in early 2008, and this business outlook section must be qualified as a result.

The Company's long-term strategic intent is to grow its asset base, earnings streams and cash flow generation prospects from within its core competencies. To achieve its goals, the Company will continue its active real estate program, including development of new and current projects, expansion of joint ventures, effective operation of income-producing properties and opportunistic and targeted investments in special situations. In the transportation business, growth will be influenced by various initiatives, which include the expansion of Matson Integrated Logistics ("MIL") into new service lines and geographies through acquisitions and growth, extension of cross-selling opportunities to MIL and Matson customer bases, development of third-party logistics services at Matson Global Distribution Services, and continuing margin growth in Matson's expedited service from China. In the Agribusiness segment, near-term growth opportunities primarily are a function of improving production levels achieved in the Company's sugar operations, but in the future may include an expansion of specialty sugar products or investments in alternative energy initiatives.

Real Estate – Leasing: The Company's leasing, or commercial, portfolio consists of high-quality properties in attractive locations and generates approximately 41 percent of the Company's real estate operating profit in 2007, before discontinued operations, and comprises 24 percent of consolidated identifiable assets. These properties are well diversified by geography, asset class, and tenancy, which provides protection against location-specific downturns. The stability of the earnings and cash flow streams generated by the portfolio mitigates the economic impact that may be caused by reduced sales activity in the Company's development activities. Year-end occupancy for the commercial portfolio averaged 97 percent for U.S. mainland properties and 98 percent for Hawaii properties. These near-record occupancies cannot be sustained indefinitely, and the Company expects a slight decrease in its overall portfolio occupancy in line with recent market trends. Financial results, however, are expected to remain strong as the Company expands its lease portfolio footprint and improves the performance of its properties through re-tenanting and property repositioning. Hawaii market strength is expected to be sustained in 2008. As of year-end, market vacancy rates were at or near historic lows of 3.0 percent, 7.3 percent and 3.3 percent for industrial, office, and retail properties, respectively.

Real Estate – Sales: The Company's development activities, which are primarily concentrated in Hawaii, consist of a diversified "pipeline" of projects including, but not limited to, primary residential and resort residential single-family, multi-family, and condominium units; commercial (industrial, office, and retail) subdivisions, building, and condominiums; and raw and improved land. To mitigate risk in its real estate portfolio, the Company adheres to disciplined underwriting, which may include self-imposed pre-sale or pre-leasing requirements, phased development, and joint ventures with third-parties.

In the Hawaii primary residential market, which includes single family homes and condominiums, sales prices generally leveled off in 2007, although year-over-year decreases in prices occurred in certain categories and sales volumes generally declined. Median year-over-year sales prices for single family homes and condominiums on the island of Oahu, Hawaii's largest market, were up 2.1 percent and 4.8 percent in 2007, respectively.

In 2008, the Company expects continued growth in its real estate sales activity, driven primarily by the completion of the Company's Keola La'i urban condominium project. The project is expected to be completed in the first quarter of the year, with the majority of these sales expected to close in the first half of 2008.

One of the Company's largest long-term projects is Kukui'ula, a 1,000-acre resort residential joint venture project on the island of Kauai, which is a premier lifestyle destination development being built in partnership with an affiliate of DMB Associates, Inc. While 2007 sales activity did not meet original expectations due to softening real estate markets, the prospects for the development remain favorable. The contribution to profit from this development in the near-term will be limited due to the percentage-of-completion method of accounting for revenue recognition. It is also expected that in 2008 the Company will make additional capital contributions to the joint venture. Based on construction and operating costs to be incurred and revenue from lot sales over the next three years, A&B's additional contribution of capital to the joint venture could range from $70 million to $90 million over the next three years, a portion of which could be financed by construction financing obtained by the venture.

Sales are expected to continue at other, smaller development projects in Hawaii in 2008. In addition to development sales, the Company regularly makes dispositions of properties from its commercial portfolio when it believes the value of an asset has been maximized and the full fair market value for that asset can be realized. This allows the Company to capture embedded value created by its property and asset management efforts and provides investment capital for redeployment through tax-deferred 1031 exchanges. In 2008, several dispositions are expected.

Transportation: In 2007, Matson Navigation posted exceptionally strong earnings results, primarily due to the maturation of its Guam China service. While the Guam China service was effectively full for the entire 2007 year, which will limit 2008 volume growth, the Company believes that this service will continue to perform at a high level. Improvements in the rate structure of its highly-regarded China service, coupled with an increasingly positive volume forecast for container service in Guam related to the commencement of infrastructure development preceding the future redeployment of 8,000 Marines during the 2012-2014 timeframe, are expected to provide the catalysts for modest growth in 2008.

Performance in the Hawaii Service will continue to be influenced by the strength of Hawaii's economy. It is expected that container volumes will be steady to slightly down in 2008, and Matson will focus on cost containment efforts to protect operating profit margins. In late 2007, Matson modified one of its C-9 class ships, the *M.V. Mokihana*, to add bi-weekly roll-on roll-off auto carriage capacity for more than 1,200 cars. The modification improves the efficiency of Matson's auto carriage and is expected to positively impact earnings in 2008. In addition, Matson will benefit from a reduction in the number of scheduled dry dockings (from seven in 2007 to three in 2008) and to the full, year-long service of its interisland barge operations.

Matson Integrated Logistics ("MIL") is expected take advantage of opportunistic acquisitions in the highly fragmented intermodal, truck brokerage, and third party logistics warehousing sectors to propel earnings expansion in 2008. In addition to acquisitions, MIL expects to capture new business opportunities as the result of an extension of its product offerings and its national footprint. In 2007, MIL created a subsidiary, Matson Global Distribution Services, that deepens the company's presence in its customers' supply chains by offering integrated services in the movement of goods. While Matson Global is in its formative stages, it is expected that additional opportunities will surface in this area and be realized in 2008.

Agribusiness: A&B, through its Hawaiian Commercial & Sugar ("HC&S") operations on Maui, produces approximately 75 to 80 percent of the sugar grown in Hawaii. This commodity-based industry poses specific challenges as margins decline. Revenue enhancement and cost containment are areas of constant focus. In 2007, HC&S had its lowest production of sugar in over four decades, primarily as a result of drought conditions during critical growing months in the past two years, as well as substandard agronomic practices. And while agriculture remains the best and highest use for much of the Company's land, declining margins in this segment impacted the Company's profitability in 2007. It is expected that HC&S will not reach profitability in 2008. However, in addition to the operations of HC&S, the Agribusiness segment includes power generation operations on Kauai and Maui, coffee operations on Kauai, and trucking service companies and related business service companies on Maui, Kauai, and the island of Hawaii. These companies, in aggregate, are expected to offset the negative impact of HC&S results and provide minimal profitability for the segment in total. In 2007, the Company continued construction of new facilities to expand its specialty sugar production, distribution and marketing capabilities. The Company expects these investments to produce favorable results, and it is encouraged by the growing market demand in this higher-margin segment of the food processing industry. In addition, the Company continues to evaluate the expansion of its energy production capacity, including the production of ethanol from raw sugar, sugar juices, and molasses.

In addition to the economic and market information presented above, there are two primary sources of periodic economic forecasts for the state of Hawaii; the University of Hawaii Economic Research Organization (UHERO) and the state's Department of Business, Economic Development & Tourism (DBEDT).

OTHER MATTERS

Management Changes: The following management changes occurred during 2007 and through February 15, 2008.

Son-Jai Paik was named vice president, human resources of A&B, effective January 1, 2007.

Paul K. Ito was promoted to vice president and named assistant treasurer of A&B, effective April 1, 2007, and continues in the position of controller of A&B.

Kevin L. Halloran was promoted to vice president, corporate development and investor relations, effective April 26, 2007.

Meredith J. Ching was promoted to senior vice president, government and community relations, effective June 28, 2007.

Frank E. Kiger was promoted to general manager, Hawaiian Commercial & Sugar Company (HC&S), effective January 1, 2008.

ITEM 7A. QUANTITATIVE AND QUALITATIVE DISCLOSURES ABOUT MARKET RISK

A&B, in the normal course of doing business, is exposed to the risks associated with fluctuations in the market value of certain financial instruments. A&B maintains a portfolio of investments, pension fund investments and, through its Capital Construction Fund, an investment in mortgage-backed securities. Details regarding these financial instruments are described in Notes 1, 3, 4, 6 and 9 to the Consolidated Financial Statements.

The Company periodically uses derivative financial instruments such as interest rate and foreign currency hedging products to mitigate risks. The Company's use of derivative instruments is limited to reducing its risk exposure by utilizing interest rate or currency agreements that are accounted for as hedges. The Company does not hold or issue derivative instruments for trading or other speculative purposes nor does it use leveraged financial instruments.

In February 2005, Matson entered into a right-of-first-refusal agreement with Aker Philadelphia Shipyard, which provides that, subsequent to the delivery of the MV Maunalei, Matson has the right of first refusal to purchase each of the next four containerships of similar design built by Aker that are deliverable before June 30, 2010. Matson may either exercise its right of first refusal and purchase the ship at an 8 percent discount from a third party's proposed contract price, or decline to exercise its right of first refusal and be paid by Aker 8 percent of such price. Notwithstanding the above, if Matson and Aker agree to a construction contract for a vessel to be delivered before June 30, 2010, Matson shall receive an 8 percent discount. The right of first refusal was accounted for as a derivative under FASB Statement No. 133, "Accounting for Derivative Instruments and Hedging Activities." The amount recorded was not material. Other than the right-of-first-refusal agreement, the Company had no other derivative financial instruments outstanding as of December 31, 2007 or 2006.

A&B is exposed to changes in interest rates, primarily as a result of its borrowing and investing activities used to maintain liquidity and to fund business operations. In order to manage its exposure to changes in interest rates, A&B utilizes a balanced mix of debt maturities, along with both fixed-rate and variable-rate debt. The nature and amount of A&B's long-term and short-term debt can be expected to fluctuate as a result of future business requirements, market conditions, and other factors.

The Company's fixed rate debt consists of $390 million in principal term notes. The Company's variable rate debt consists of $119 million in principal term notes. Other than in default, the Company does not have an obligation to prepay its fixed-rate debt prior to maturity and, as a result, interest rate risk and the resulting changes in fair value would not have a significant impact on its fixed rate borrowings unless the Company was required to refinance such debt.

The following table summarizes A&B's debt obligations at December 31, 2007, presenting principal cash flows and related interest rates by the expected fiscal year of repayment.

	Expected Fiscal Year of Repayment as of December 31, 2007 (dollars in millions)							
	2008	2009	2010	2011	2012	Thereafter	Total	Fair Value at December 31, 2007
Fixed rate	$ 32	$ 32	$ 31	$ 27	$ 29	$ 239	$ 390	$ 383
Average interest rate	5.33%	5.28%	5.25%	5.29%	5.32%	5.27%	5.29%	
Variable rate	$ 25	$ --	$ --	$ 42	$ 11	$ 41	$ 119	$ 119
Average interest rate	5.35%	--	--	5.37%	5.44%	5.44%	5.38%	

A&B's sugar plantation, HC&S, has a contract to sell its raw sugar production through 2008 to Hawaiian Sugar & Transportation Cooperative ("HS&TC"), an unconsolidated sugar and marketing cooperative, in which A&B has an ownership interest. Under that contract, the price paid will fluctuate with the New York No. 14 Contract settlement price for domestic raw sugar, less a fixed discount. A&B also has an agreement with C&H Sugar Company, Inc., the primary purchaser of sugar from HS&TC, which allows A&B to forward price, with

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31,		
	2007	2006	2005
Operating Revenue:			
Ocean transportation	$ 1,003	$ 936	$ 873
Logistics services	433	444	432
Property leasing	102	88	73
Property sales	23	8	98
Agribusiness	120	124	121
Total operating revenue	1,681	1,600	1,597
Operating Costs and Expenses:			
Cost of ocean transportation services	789	754	673
Cost of logistics services	381	395	390
Cost of property sales and leasing services	60	43	103
Cost of agricultural goods and services	120	118	110
Selling, general and administrative	165	146	142
Total operating costs and expenses	1,515	1,456	1,418
Operating Income	166	144	179
Other Income and (Expense)			
Gain on insurance settlement and other	1	--	5
Equity in income of real estate affiliates	23	14	3
Interest income	3	6	5
Interest expense, net of amounts capitalized	(19)	(15)	(13)
Income From Continuing Operations Before Income Taxes	174	149	179
Income taxes	66	56	67
Income From Continuing Operations	108	93	112
Income from discontinued operations, net of income taxes (see Note 2)	34	29	14
Net Income	$ 142	$ 122	$ 126
Basic Earnings per Share of Common Stock:			
Continuing operations	$ 2.55	$ 2.16	$ 2.57
Discontinued operations	0.79	0.68	0.32
Net income	$ 3.34	$ 2.84	$ 2.89
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ 2.52	$ 2.14	$ 2.55
Discontinued operations	0.78	0.67	0.31
Net income	$ 3.30	$ 2.81	$ 2.86
Weighted Average Number of Basic Shares Outstanding	42.5	43.2	43.6
Weighted Average Number of Dilutive Shares Outstanding	43.1	43.6	44.0

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31,		
	2007	2006	2005
Cash Flow from Operating Activities:			
Net income	$ 142	$ 122	$ 126
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	93	85	84
Deferred income taxes	26	40	68
Gains on disposal of assets	(64)	(49)	(28)
Share-based expense	17	10	--
Equity in income of affiliates, net of distributions	1	1	(17)
Changes in assets and liabilities:			
Accounts and notes receivable	(9)	5	5
Inventories	(3)	(1)	(4)
Prepaid expenses and other assets	12	(35)	(8)
Deferred dry-docking costs	(22)	(6)	(1)
Liability for benefit plans	(3)	6	(1)
Accounts and income taxes payable	19	(28)	39
Other liabilities	14	21	4
Real Estate Developments Held for Sale:			
Real estate inventory sales	11	4	45
Expenditures for new real estate inventory	(110)	(69)	(34)
Net cash provided by operations	124	106	278
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	(122)	(281)	(231)
Receipts from disposal of income-producing property, investments and other assets	18	61	25
Deposits into Capital Construction Fund	(30)	(66)	(219)
Withdrawals from Capital Construction Fund	30	159	150
Payments for purchases of investments	(43)	(40)	(32)
Proceeds from sale and maturity of investments	2	43	2
Net cash used in investing activities	(145)	(124)	(305)
Cash Flows from Financing Activities:			
Proceeds from issuance of long-term debt	139	217	104
Payments of long-term debt and deferred financing costs	(88)	(102)	(27)
Proceeds from (payments on) short-term borrowings – net	15	--	(7)
Repurchases of capital stock	(33)	(72)	--
Proceeds from issuance of capital stock, including excess tax benefit	8	5	11
Dividends paid	(48)	(42)	(39)
Net cash provided by (used in) financing activities	(7)	6	42
Cash and Cash Equivalents:			
Net (decrease) increase for the year	(28)	(12)	15
Balance, beginning of year	45	57	42
Balance, end of year	$ 17	$ 45	$ 57
Other Cash Flow Information:			
Interest paid	$ (25)	$ (20)	$ (17)
Income taxes refunded (paid), net	$ (55)	$ (49)	$ 3
Non-cash Activities:			
Debt assumed in real estate purchase	$ –	$ --	$ 11
Tax-deferred property sales	$ 83	$ 60	$ 55
Tax-deferred property purchases	$ (91)	$ (49)	$ (28)

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2007	December 31, 2006
ASSETS		
Current Assets		
Cash and cash equivalents	$ 17	$ 45
Accounts and notes receivable, less allowances of $12 for 2007 and $14 for 2006	185	178
Inventories	21	19
Real estate held for sale	150	--
Income taxes receivable	1	5
Deferred income taxes	11	10
Prepaid expenses and other assets	36	28
Total current assets	421	285
Investments in Affiliates	184	149
Real Estate Developments	99	147
Property – net	1,582	1,499
Capital Construction Fund	1	1
Benefit Plan Assets	80	56
Other Assets	112	114
Total	$ 2,479	$ 2,251
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	$ 57	$ 41
Accounts payable	156	136
Payrolls and vacation due	19	18
Uninsured claims	12	12
Accrued and other liabilities	78	50
Total current liabilities	322	257
Long-term Liabilities		
Long-term debt	452	401
Deferred income taxes	468	442
Liability for benefit plans	50	52
Uninsured claims and other liabilities	57	72
Total long-term liabilities	1,027	967
Commitments and Contingencies		
Shareholders' Equity		
Capital stock – common stock without par value; authorized, 150 million shares ($0.75 stated value per share); outstanding, 42.4 million shares in 2007 and 42.6 million shares in 2006	34	35
Additional capital	200	179
Accumulated other comprehensive loss	(4)	(19)
Retained earnings	911	843
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,130	1,027
Total	$ 2,479	$ 2,251

See notes to consolidated financial statements.

However, if the Company is not permitted to operate its vessels in coastwise trade or unable to participate in the CCF and cargo preference program, it may have a material adverse effect on the Company's ocean transportation operations.

The Company and certain subsidiaries are parties to other various legal actions and are contingently liable in connection with claims and contracts arising in the normal course of business, the outcome of which, in the opinion of management after consultation with legal counsel, will not have a material adverse effect on the Company's financial position or results of operations.

13. INDUSTRY SEGMENTS

Operating segments are components of an enterprise that engage in business activities from which it may earn revenues and incur expenses, whose operating results are regularly reviewed by the chief operating decision maker to make decisions about resources to be allocated to the segment and assess its performance, and for which discrete financial information is available. The Company's chief operating decision maker is its Chief Executive Officer. Based on the foregoing, the Company has five segments that operate in three industries: Transportation, Real Estate and Agribusiness.

The Transportation Industry consists of two segments. Ocean Transportation carries freight between various U.S. Pacific Coast, major Hawaii ports, Guam, China and other Pacific ports and provides terminal, stevedoring and container equipment management services in Hawaii. Logistics Services arranges domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited freight services, and warehousing and distribution services.

The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. mainland. The Real Estate Sales segment generates its revenues through the development and sale of land, commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties, as well as leases vacant land and improved lands to third parties. When property that was previously leased is sold, the revenue and operating profit are included with the Real Estate Sales segment.

Agribusiness, which consists of one segment, grows sugar cane and coffee; produces bulk raw sugar, specialty food-grade sugars, molasses and green coffee; markets and distributes roasted coffee and green coffee; provides sugar, petroleum and molasses hauling, general trucking services, mobile equipment maintenance and repair services, and self-service storage; and generates and sells, to the extent not used in the Company's operations, electricity.

The accounting policies of the operating segments are the same as those described in the summary of significant accounting policies. Reportable segments are measured based on operating profit, exclusive of non-operating or unusual transactions, interest expense, general corporate expenses, and income taxes.

Industry segment information for each of the three years ended December 31, 2007 is summarized below (in millions):

For the Year	2007	2006	2005
Revenue:			
Transportation:			
Ocean transportation	$ 1,006.9	$ 945.8	$ 878.3
Logistics services	433.5	444.2	431.6
Real Estate:			
Leasing	108.5	100.6	89.7
Sales	117.8	97.3	148.9
Less amounts reported in discontinued operations[1]	(100.6)	(101.2)	(66.6)
Agribusiness	123.7	127.4	123.2
Reconciling Items [2]	(9.2)	(14.2)	(8.4)
Total revenue	$ 1,680.6	$ 1,599.9	$ 1,596.7
Operating Profit:			
Transportation:			
Ocean transportation	$ 126.5	$ 105.6	$ 128.0
Logistics services	21.8	20.8	14.4
Real Estate:			
Leasing	51.6	50.3	43.7
Sales	74.4	49.7	44.1
Less amounts reported in discontinued operations[1]	(54.4)	(46.7)	(22.2)
Agribusiness	0.2	6.9	11.2
Total operating profit	220.1	186.6	219.2
Write-down of long-lived assets[3]	--	--	(2.3)
Interest expense, net[4]	(18.8)	(15.0)	(13.3)
General corporate expenses	(27.3)	(22.3)	(24.1)
Income from continuing operations before income taxes	$ 174.0	$ 149.3	$ 179.5
Identifiable Assets:			
Ocean transportation	$ 1,215.0	$ 1,185.3	$ 1,113.0
Logistics services	58.6	56.4	70.3
Real estate leasing	595.4	525.5	478.6
Real estate sales	408.9	295.0	227.3
Agribusiness	174.6	168.7	159.0
Other	26.6	20.3	22.7
Total assets	$ 2,479.1	$ 2,251.2	$ 2,070.9
Capital Additions:			
Ocean transportation	$ 65.8	$ 217.1	$ 173.9
Logistics services[5]	2.0	1.7	1.3
Real estate leasing[6]	124.5	93.0	78.8
Real estate sales[7]	0.3	1.3	0.2
Agribusiness	20.5	15.0	13.0
Other	0.3	1.5	1.4
Total capital additions	$ 213.4	$ 329.6	$ 268.6
Depreciation and Amortization:			
Ocean transportation	$ 63.2	$ 58.1	$ 59.5
Logistics services	1.5	1.5	1.4
Real estate leasing[1]	15.7	14.1	12.4
Real estate sales	0.2	0.1	0.1
Agribusiness	10.7	10.1	9.4
Other	1.3	0.9	0.5
Total depreciation and amortization	$ 92.6	$ 84.8	$ 83.3

1 Prior year amounts restated for amounts treated as discontinued operations. See Notes 1 and 2 for additional information.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

3 The 2005 write-down was for an "other than temporary" impairment in the Company's investment in C&H. The Company's investment in C&H was sold on August 9, 2005 at the then approximate carrying value.

4 Includes Ocean Transportation interest expense of $13.9 million for 2007, $13.3 million for 2006, and $9.6 million for 2005. Substantially all other interest expense was at the parent company.

5 Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

6 Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

7 Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $110 million, $69 million, and $34 million, for the years ended December 31, 2007, 2006, and 2005, respectively.

14. QUARTERLY INFORMATION (Unaudited)

Segment results by quarter for 2007 are listed below (in millions, except per-share amounts):

	2007			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 231.6	$ 253.1	$ 259.9	$ 262.3
Logistics services	102.9	112.4	110.4	107.8
Real Estate:				
Leasing	28.8	26.4	26.3	27.0
Sales	6.5	0.4	78.5	32.4
Less amounts reported in discontinued operations [1]	(1.9)	(2.0)	(75.4)	(21.3)
Agribusiness	17.2	38.5	37.3	30.7
Reconciling Items [2]	(2.0)	(1.8)	(2.4)	(3.0)
Total revenue	$ 383.1	$ 427.0	$ 434.6	$ 435.9
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 18.8	$ 39.1	$ 38.5	$ 30.1
Logistics services	5.6	5.5	6.0	4.7
Real Estate:				
Leasing	15.0	12.3	12.2	12.1
Sales	8.8	4.5	37.9	23.2
Less amounts reported in discontinued operations [1]	(1.2)	(1.4)	(36.1)	(15.7)
Agribusiness	3.6	0.5	(3.2)	(0.7)
Total operating profit	50.6	60.5	55.3	53.7
Interest Expense	(4.3)	(4.1)	(4.8)	(5.6)
General Corporate Expenses	(6.9)	(6.6)	(6.0)	(7.8)
Income From Continuing Operations before Income Taxes	39.4	49.8	44.5	40.3
Income taxes	(15.4)	(18.6)	(17.9)	(13.6)
Income From Continuing Operations	24.0	31.2	26.6	26.7
Discontinued Operations [1]	0.7	0.8	22.5	9.7
Net Income	$ 24.7	$ 32.0	$ 49.1	$ 36.4
Earnings Per Share:				
Basic	$ 0.58	$ 0.75	$ 1.15	$ 0.86
Diluted	$ 0.58	$ 0.74	$ 1.14	$ 0.85

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

Segment results by quarter for 2006 are listed below (in millions, except per-share amounts):

	2006			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 219.3	$ 243.6	$ 243.2	$ 239.7
Logistics services	108.4	116.4	113.1	106.3
Real Estate:				
Leasing	24.6	24.4	25.5	26.1
Sales	23.8	36.8	5.0	31.7
Less amounts reported in discontinued operations [1]	(26.6)	(39.9)	(4.8)	(29.9)
Agribusiness	15.5	37.8	41.8	32.3
Reconciling Items [2]	(6.1)	(3.3)	(2.7)	(2.1)
Total revenue	$ 358.9	$ 415.8	$ 421.1	$ 404.1
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 18.3	$ 24.4	$ 34.2	$ 28.7
Logistics services	4.7	5.3	5.1	5.7
Real Estate:				
Leasing	12.1	12.2	12.5	13.5
Sales	27.1	10.9	1.2	10.5
Less amounts reported in discontinued operations [1]	(17.1)	(17.0)	(3.8)	(8.8)
Agribusiness	6.5	3.1	0.6	(3.3)
Total operating profit	51.6	38.9	49.8	46.3
Interest Expense	(3.2)	(3.0)	(4.0)	(4.8)
General Corporate Expenses	(5.2)	(5.1)	(5.0)	(7.0)
Income From Continuing Operations before Income Taxes	43.2	30.8	40.8	34.5
Income taxes	(16.5)	(11.2)	(15.3)	(12.8)
Income From Continuing Operations	26.7	19.6	25.5	21.7
Discontinued Operations [1]	10.7	10.6	2.4	5.3
Net Income	$ 37.4	$ 30.2	$ 27.9	$ 27.0
Earnings Per Share:				
Basic	$ 0.85	$ 0.69	$ 0.66	$ 0.64
Diluted	$ 0.84	$ 0.68	$ 0.65	$ 0.63

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

15. PARENT COMPANY CONDENSED FINANCIAL INFORMATION

Set forth below are the unconsolidated condensed financial statements of Alexander & Baldwin, Inc. ("Parent Company"). The significant accounting policies used in preparing these financial statements are substantially the same as those used in the preparation of the consolidated financial statements as described in Note 1, except that, for purposes of the tables presented in this footnote, subsidiaries are carried under the equity method.

The following table presents the Parent Company's condensed Balance Sheets as of December 31, 2007 and 2006 (in millions):

	2007	2006
ASSETS		
Current Assets:		
Cash and cash equivalents	$ 3	$ 2
Accounts and notes receivable, net	3	20
Prepaid expenses and other	19	14
Total current assets	25	36
Investments:		
Subsidiaries consolidated, at equity	1,097	939
Property, at Cost	451	428
Less accumulated depreciation and amortization	212	199
Property -- net	239	229
Due from Subsidiaries	87	68
Other Assets	47	34
Total	$ 1,495	$ 1,306
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 32	$ 18
Accounts payable	5	6
Income taxes payable	10	12
Other	19	22
Total current liabilities	66	58
Long-term Debt	212	141
Other Long-term Liabilities	31	31
Deferred Income Taxes	56	49
Commitments and Contingencies		
Shareholders' Equity:		
Capital stock	34	35
Additional capital	200	179
Accumulated other comprehensive loss	(4)	(19)
Retained earnings	911	843
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,130	1,027
Total	$ 1,495	$ 1,306

The following table presents the Parent Company's condensed Statements of Income for the years ended December 31, 2007, 2006 and 2005 (in millions):

	2007	2006	2005
Revenue:			
Agribusiness	$ 92	$ 97	$ 89
Property leasing	28	24	21
Property sales	6	1	3
Interest and other	8	9	14
Total revenue	134	131	127
Costs and Expenses:			
Cost of agricultural goods and services	97	96	90
Cost of property sales and leasing services	14	11	10
Selling, general and administrative	28	24	24
Interest and other	12	7	9
Income taxes	(5)	1	(8)
Total costs and expenses	146	139	125
Income (Loss) from Continuing Operations	(12)	(8)	2
Discontinued Operations, net of income taxes	-	10	1
Income Before Equity in Income of Subsidiaries Consolidated	(12)	2	3
Equity in Income from Continuing Operations of Subsidiaries Consolidated	120	104	112
Equity in Income from Discontinued Operations of Subsidiaries Consolidated	34	16	11
Net Income	142	122	126
Other Comprehensive Income (Loss), net of income taxes	15	--	2
Comprehensive Income	$ 157	$ 122	$ 128

The following table presents the Parent Company's condensed Statements of Cash Flows for the years ended December 31, 2007, 2006 and 2005 (in millions):

	2007	2006	2005
Cash Flows from Operations (including dividends received from subsidiaries)	$ 17	$ 65	$ 89
Cash Flows from Investing Activities:			
Capital expenditures	(18)	(35)	(13)
Proceeds from disposal of property and investments	5	22	1
Net cash used by investing activities	(13)	(13)	(12)
Cash Flows from Financing Activities:			
Change in intercompany payables/receivables	(15)	(6)	(19)
Proceeds from (repayments of) long-term debt, net	85	58	(24)
Proceeds from issuance of capital stock, including tax benefit	8	5	11
Repurchases of capital stock	(33)	(72)	--
Dividends paid	(48)	(42)	(39)
Net cash used in financing activities	(3)	(57)	(71)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	1	(5)	6
Balance, beginning of year	2	7	1
Balance, end of year	$ 3	$ 2	$ 7
Other Cash Flow Information:			
Interest paid, net of amounts capitalized	$ (12)	$ (7)	$ (7)
Income taxes paid, net of refunds	$ (55)	$ (49)	$ 3
Other Non-cash Information:			
Depreciation expense	$ (15)	$ (13)	$ (12)
Tax-deferred property sales	$ –	$ 13	$ 3
Tax-deferred property purchases	$ –	$ (13)	$ (3)

General Information: The Parent Company is headquartered in Honolulu, Hawaii and is engaged in the operations that are generally described in Note 13, "Industry Segments." Additional information related to the Parent Company is described in the foregoing notes to the consolidated financial statements.

Long-term Debt: At December 31, 2007 and 2006, long-term debt consisted of the following (in millions):

	2007	2006
Revolving Credit loans, 5.28%	$ 54	$ 27
Term Loans:		
5.53%, payable through 2016	50	50
5.56%, payable through 2016	25	--
5.55%, payable through 2017	50	--
4.10%, payable through 2012	35	35
7.55%, payable through 2009	15	15
7.42%, payable through 2010	9	11
6.20%, payable through 2013	2	3
7.44%, payable through 2007	--	7
7.57%, payable through 2009	4	6
7.43%, payable through 2007	--	5
Total	244	159
Less current portion	32	18
Long-term debt	$ 212	$ 141

Long-term Debt Maturities: At December 31, 2007, maturities of all long-term debt during the next five years are $32 million annually in 2008, $18 million in 2009, $16 million in 2010, $55 million in 2011, $17 million in 2012, and $106 million thereafter.

Revolving Credit Facilities: The Company has a revolving senior credit facility with six commercial banks that expires in December 2011. The revolving credit facility provides for a commitment of $225 million. Amounts drawn under the facility bear interest at London Interbank Offered Rate ("LIBOR") plus 0.225 percent, provided the Company maintains an S&P/Moody's rating of A-/A3 or better. The agreement contains certain restrictive covenants, the most significant of which require the maintenance of minimum shareholders' equity levels, minimum property investment values, and a maximum ratio of total debt to earnings before interest, depreciation, amortization, and taxes. At December 31, 2007, $54 million was outstanding, $2 million in letters of credit had been issued against the facility, and $169 million remained available for borrowing. As of December 31, 2007, $39 million drawn on this facility was classified as non-current because the Company had the ability and intent to refinance the balance on a long-term basis.

Real Estate Secured Term Debt: In June 2005, the Company, together with its real-estate subsidiaries, purchased an office building in Phoenix, Arizona, and assumed $11 million of mortgage-secured debt. A&B owns approximately 24 percent of the Phoenix office building. At December 31, 2007, approximately $2 million of the $11 million was recorded on the parent company's books, consistent with ownership of the property. The property is jointly and severally owned by three Company entities.

Other Long-term Liabilities: Other Long-term Liabilities at December 31, 2007 and 2006 consisted principally of deferred compensation, executive benefit plans, additional minimum pension liability, and self-insurance liabilities.

16. RELATED PARTY TRANSACTIONS

Related Party Transactions: Notes 3 and 4 includes additional information about transactions with unconsolidated affiliates, which affiliates are/were also related parties, due to the Company's minority interest investments.

Hawaiian Sugar & Transportation Cooperative ("HS&TC") is a raw sugar marketing and transportation cooperative that the Company uses to market and transport its sugar to C&H. Under the terms of a supply contract between HS&TC and C&H, which expires with the 2008 crop, C&H is obligated to purchase, and HS&TC is obligated to sell, all of the raw sugar delivered to HS&TC by the Hawaii sugar growers, at prices determined by the quoted domestic sugar market. The price that the Hawaii sugar growers receive for the sale of raw sugar is the C&H contract price, reduced for the operating, transportation and interest costs incurred by HS&TC, net of revenue generated by HS&TC for charter voyages. Revenue from raw sugar and molasses sold to HS&TC was $53 million, $59 million, and $62 million, during 2007, 2006, and 2005, respectively. At December 31, 2007, 2006 and 2005, the Company had amounts receivable from HS&TC of $15 million, $11 million and $7 million, respectively.

17. SUBSEQUENT EVENTS

On January 31, 2008, the Board of Directors authorized A&B to repurchase up to 2 million additional shares of its common stock. The new authorization will expire on December 31, 2009.

From January 1, 2008 through February 15, 2008, the Company repurchased 1,124,449 shares of its common stock at an average price of $44.24 per share. The repurchases were made under a October 2006 share authorization that expires December 31, 2008. As of February 15, 2008, 2,203,823 shares remain available for repurchase, including 203,823 shares subject to an authorization that expires December 31, 2008 and 2 million shares subject to an authorization that expires December 31, 2009.

In October 2007, A&B entered into an agreement to purchase a 1.0 million-square-foot industrial facility consisting of two warehouse buildings located on 63 acres in Savannah, Georgia, approximately 12 miles from the Port of Savannah the second largest U.S. container port on the east coast. A&B closed the acquisition of both buildings in February 2008 for approximately $48 million. The property will be treated as a development property until the completion of tenant improvements by A&B and the delivery of the space to one or more tenants.

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2008

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _______ to _______

Commission file number 000-00565

ALEXANDER & BALDWIN, INC.
(Exact name of registrant as specified in its charter)

Hawaii (State or other jurisdiction of incorporation or organization)	**99-0032630** (I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	NYSE

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 13, 2009:
41,025,935

Aggregate market value of Common Stock held by non-affiliates at June 30, 2008:
$1,840,694,745

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☒

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒	Accelerated filer ☐
Non-accelerated filer ☐ (Do not check if a smaller reporting company)	Smaller reporting company ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement dated March 12, 2009 (Part III of Form 10-K)

Exhibit E-R2

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PART I

PART II

ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2008

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Alexander & Baldwin, Inc. ("A&B") is a multi-industry corporation with its primary operations centered in Hawaii. It was founded in 1870 and incorporated in 1900. Ocean transportation operations, related shoreside operations in Hawaii, and intermodal, truck brokerage and logistics services are conducted by a wholly-owned subsidiary, Matson Navigation Company, Inc. ("Matson"), and two Matson subsidiaries. Property development and agribusiness operations are conducted by A&B and certain other subsidiaries of A&B.

The business industries of A&B are generally as follows:

A. *Transportation* - carrying freight, primarily between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports; arranging domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services; and providing terminal, stevedoring and container equipment maintenance services in Hawaii.

B. *Real Estate* - engaging in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property.

C. *Agribusiness* - growing sugar cane and coffee in Hawaii; producing bulk raw sugar, specialty food-grade sugars, molasses and green coffee; marketing and distributing roasted coffee and green coffee; providing sugar, petroleum and molasses hauling, general trucking services, mobile equipment maintenance and repair services, and self-service storage in Hawaii; and generating and selling, to the extent not used in A&B's operations, electricity.

For information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2008, see Note 13 ("Industry Segments") to A&B's financial statements in Item 8 of Part II below.

DESCRIPTION OF BUSINESS AND PROPERTIES

A. Transportation

Property	Location	Type	(sq. ft.)
Heritage Business Park	Dallas, TX	Industrial	1,316,400
Ontario Distribution Center	Ontario, CA	Industrial	898,400
Midstate 99 Distribution Center	Visalia, CA	Industrial	790,400
Savannah Logistics Park (Bldg. A)	Savannah, GA	Industrial	710,800
Sparks Business Center	Sparks, NV	Industrial	396,100
Republic Distribution Center	Pasadena, TX	Industrial	312,500
Centennial Plaza	Salt Lake City, UT	Industrial	244,000
Valley Freeway Corporate Park	Kent, WA	Industrial	228,200
1800 and 1820 Preston Park	Plano, TX	Office	198,600
Ninigret Office Park X and XI	Salt Lake City, UT	Office	185,200
San Pedro Plaza	San Antonio, TX	Office/Retail	171,900
2868 Prospect Park	Sacramento, CA	Office	162,900
Concorde Commerce Center	Phoenix, AZ	Office	140,700
Arbor Park Shopping Center	San Antonio, TX	Retail	139,500
Deer Valley Financial Center	Phoenix, AZ	Office	126,600
San Jose Avenue Warehouse	City of Industry, CA	Industrial	126,000
Southbank II	Phoenix, AZ	Office	120,800
Village at Indian Wells	Indian Wells, CA	Retail	104,600
Broadlands Marketplace	Broomfield, CO	Retail	103,900
2890 Gateway Oaks	Sacramento, CA	Office	58,700
Wilshire Center	Greeley, CO	Retail	46,500
Royal MacArthur Center	Dallas, TX	Retail	44,000

A&B's mainland commercial properties maintained an average occupancy rate of 95 percent in 2008, compared to 97 percent in 2007.

A&B's mainland joint venture commercial developments are summarized below:

(i) *Crossroads Plaza.* In June 2004, A&B entered into a joint venture with Intertex Hasley, LLC, for the development of a 56,000-square-foot mixed-use neighborhood retail center on 6.5 acres in Valencia, California. The property was acquired in August 2004. The sale of a pad site building closed in 2007, and construction of the center was substantially completed in 2008. Current occupancy is 56 percent.

(ii) *Centre Pointe Marketplace.* In April 2005, A&B entered into a joint venture with Intertex Centre Pointe Marketplace, LLC for the development of a 105,700-square-foot retail center on a 10.2-acre parcel in Valencia, California. The sale of several pad site buildings closed in 2007. Vertical construction was substantially completed in 2008, with five of seven buildings closed in 2008 and the two remaining buildings expected to be sold in 2010.

(iii) *Bridgeport Marketplace.* In July 2005, A&B entered into a joint venture with Intertex Bridgeport Marketplace, LLC for the development of a 27.8-acre parcel in Valencia, California. The parcel was subdivided into a 5-acre parcel for a public park, a 7.3-acre parcel sold to a church in 2007, and a 15.5-acre parcel for the development of a 130,000-square-foot retail center. Vertical construction of the center commenced in 2007 and is nearing completion with 98 percent of the retail and office space under binding leases.

(iv) *Bakersfield - Panama Grove.* In November 2006, A&B entered into a joint venture with Intertex P&G Retail, LLC, for the planned development of a 575,000-square-foot retail center on a 57.3-acre commercial parcel in Bakersfield, California. The parcel was acquired in November 2006. Development plans currently are on hold due to current economic conditions.

(v) *Palmdale Trade & Commerce Center.* In December 2007, A&B entered into a joint venture with Intertex Palmdale Trade & Commerce Center LLC, for the planned development of a 315,000-square-foot mixed-use commercial office and light industrial condominium complex on 18.2 acres in Palmdale, California, located 60 miles northeast of Los Angeles and 25 miles northeast of Valencia. The parcel was contributed to the venture in 2008. Due to current market conditions, the venture is reevaluating the product design and timing of development.

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870, and the production of coffee in Hawaii since 1987. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) a coffee farm on the island of Kauai, operated by its Kauai Coffee Company, Inc. ("Kauai Coffee") subsidiary, and (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide all types of trucking services, including sugar and molasses hauling on Maui and Kauai, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai.

HC&S is Hawaii's largest producer of raw sugar, producing approximately 145,200 tons of raw sugar in 2008, or about 75 percent of the raw sugar produced in Hawaii for the year (compared with 164,500 tons, or about 80 percent, in 2007). The primary reason for the decline in sugar production has been the unprecedented continuing drought conditions affecting the island of Maui. In 2008, HC&S had the lowest East Maui water deliveries on record since the Company first began recording deliveries in 1925. Moreover, the two-year period beginning in 2007, and extending through 2008, marked two consecutive years of the lowest rainfall recorded. A chronic lack of water that has extended throughout the crop's lifecycle has had serious adverse impacts on crop yields. HC&S harvested 16,961 acres of sugar cane in 2008 (compared with 16,895 in 2007). Yields averaged 8.6 tons of sugar per acre in 2008 (compared with 9.7 in 2007). As a by-product of sugar production, HC&S also produced approximately 52,200 tons of molasses in 2008 (compared with 51,700 in 2007).

In 2008, approximately 27,500 tons of sugar (compared with 21,200 tons in 2007) were processed by HC&S into specialty food-grade sugars under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. A multi-phase expansion of the production facilities for these sugars was completed in early 2008.

During 2008, Kauai Coffee had approximately 3,000 acres of coffee trees under cultivation. The 2008 harvest yielded approximately 3.0 million pounds of green coffee, compared with 2.5 million pounds in 2007. The preliminary mix of green coffee has resulted in a slightly higher percentage of specialty and commodity green beans and a lower percentage of mid-grade green beans than in 2007.

HC&S and McBryde Sugar Company, Limited ("McBryde"), a subsidiary of A&B and the parent company of Kauai Coffee, produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels, whereas McBryde produces power solely by hydroelectric generation. The price for the power sold by HC&S and McBryde is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. See "Energy" below for power production and sales data.

(2) **Marketing of Sugar and Coffee**

Approximately 81 percent of the bulk raw sugar produced by HC&S in 2008 was purchased by C&H Sugar Company, Inc. ("C&H"). C&H processes the raw cane sugar at its refinery at Crockett, California, and markets the refined products primarily in the western and central United States.

The remaining 19 percent of the raw sugar was used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" products.

Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative consisting of two sugar cane growers in Hawaii (including HC&S), has a supply contract with C&H, ending in December 2009. HS&TC has the option to extend this supply contract by an additional year. Pursuant to the supply contract, the growers sell their raw sugar to C&H at a price equal to the New York No. 14 Contract settlement price, less a discount and less costs of sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Hawaii sugar growers, including HC&S. Notwithstanding the supply contract, HC&S arranged directly with C&H for the forward pricing of a portion of its 2008 harvest, as described in Item 7A ("Quantitative and Qualitative Disclosures About Market Risk") of Part II below. The other member of HS&TC has announced that it plans to withdraw from the sugar-growing business later this year. HC&S and the withdrawing member will need to resolve issues relating to such withdrawal from HS&TC.

At Kauai Coffee, coffee marketing efforts are directed toward developing a market for premium-priced, estate-grown Kauai green bean (unroasted) coffee. Most of the coffee crop is being marketed on the U.S. Mainland as green bean coffee. In addition to the sale of green bean coffee, Kauai Coffee produces and sells roasted, packaged coffee under the Kauai Coffee® trademark. Kauai Coffee's customers include specialty and commodity brokers, hotels, and large regional roasters.

(3) **Sugar Competition and Legislation**

Hawaii sugar growers produce more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the U.S. Mainland market. Hawaiian refined sugar is marketed primarily west of Chicago. This is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

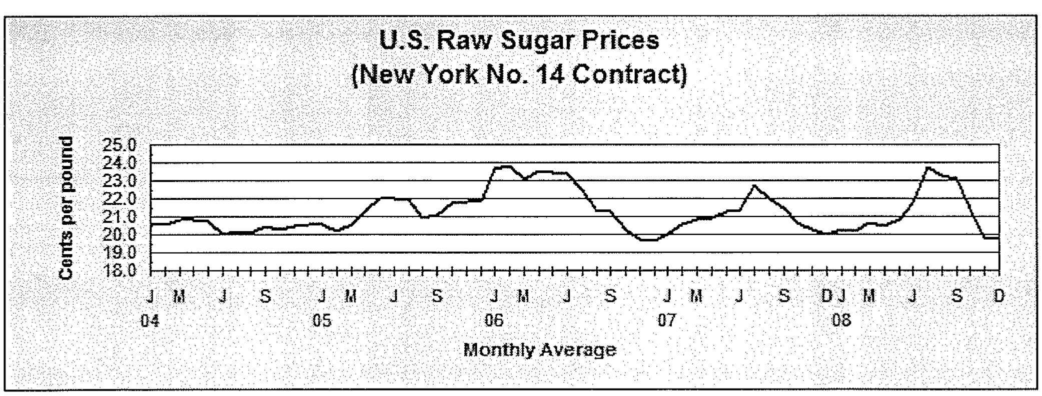
The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current legislation is the Food Conservation and Energy Act of 2008, which expires on December 31, 2012 ("2008 Farm Bill"). The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports from countries other than Canada and Mexico by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount. Also, a new but limited sucrose ethanol program was added in 2008, which allows sugar to be diverted into ethanol when the market is deemed to be oversupplied.

The 2008 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18 cents per pound ("c/lb") for raw cane sugar is in effect for the 2008 crop. The loan rate increases by .25 c/lb each year up to 18.75 c/lb for 2011 and 2012 (the last year of the bill). The supply agreement between HS&TC and C&H provides for a floor minimum price that is based on the loan rate.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement. In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately, while others were phased out over periods of 5 to 15 years with full elimination having begun January 1, 2008. Starting in 2008, Mexico can ship an unlimited quantity of sugar duty-free to the U.S. each year, even though the U.S. sugar market is already oversupplied.

U.S. domestic raw sugar prices remain suppressed. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 14 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



Liberalized international trade agreements, such as the General Agreement on Tariffs and Trade, or GATT, include provisions relating to agriculture that can affect the

U.S. sugar or sweetener industries materially. Negotiations under the U.S.-Central America Free Trade Agreement, or CAFTA, as well as other trade discussions, have resulted in lower U.S. sugar prices.

(4) **Coffee Competition and Prices**

Kauai Coffee competes with coffee growers located worldwide, including in Hawaii. Coffee commodity prices have been strong for the past several years. The market for specialty coffee in the United States is very competitive. Because of its quality and branding, Kauai Coffee has been successful at selling most of its coffee at a premium, above commodity market prices. Kauai Coffee has long-term, repeat customers that account for the bulk of its sales, though there is strong competition and the contracts are subject to renegotiation each year.

Approximately one-fifth of Kauai Coffee's production is off-grade coffees, which are loosely tied to world commodity market prices. Kauai Coffee engages in short-term contracts with established customers to ensure that it receives the best price possible for these coffees. These prices are subject to price adjustments on an annual basis.

Kauai Coffee's green bean coffee production volume and unit costs vary each year depending upon growing and harvesting conditions. The unit cost per pound impacts the cost of goods for Kauai Coffee's wholesale roasted and retail programs.

(5) **Properties and Water**

The HC&S sugar plantation, the largest in Hawaii, consists of approximately 43,300 acres, including a small portion of leased lands. Approximately 34,700 acres are under cultivation, and the balance is leased to third parties, is not suitable for cane cultivation, or is used for plantation purposes such as roads, reservoirs, ditches and plant sites.

On Kauai, approximately 3,000 acres are cultivated by Kauai Coffee.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to fulfill the State constitutional mandate to protect agricultural lands, promote diversified agriculture, increase the State's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. In 2008, the Legislature passed a package of incentives, which is necessary to trigger the IAL system of land designation. The Company is now in the process of filing voluntary petitions to designate lands on Maui and Kauai as IAL.

It is crucial for HC&S and Kauai Coffee to have access to reliable sources of water supply and efficient irrigation systems. A&B's plantations conserve water by using a "drip" irrigation system that distributes water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated. All of Kauai Coffee's fields are drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years has supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provides approximately one-tenth of the irrigation water used by HC&S. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

D. **Employees and Labor Relations**

As of December 31, 2008, A&B and its subsidiaries had approximately 2,160 regular full-time employees. About 969 regular full-time employees were engaged in the agribusiness segment, 1,069 were engaged in the transportation segment, 51 were engaged in the real estate segment, and the remaining were in administration. Approximately 49 percent were covered by collective bargaining agreements with unions.

At December 31, 2008, the active Matson fleet employed seagoing personnel in 223 billets. Each billet corresponds to a position on a ship that typically is filled by two or more employees because seagoing personnel rotate between active sea duty and time ashore. Approximately 22 percent of Matson's regular full-time employees and all of the seagoing employees were covered by collective bargaining agreements.

Historically, collective bargaining with longshore and seagoing unions has been complex and difficult. However, Matson and Matson Terminals consider their relations with those unions, other unions and their non-union employees generally to be satisfactory.

Matson's seagoing employees are represented by six unions, three representing unlicensed crew members and three representing licensed crew members. Matson negotiates directly with these unions. Matson's agreements with the Seafarer's International Union, the Sailors Union of the Pacific and the Marine Firemen's Union were renewed in mid-2008 through June 2013 without service interruption. Contracts that Matson has with the American Radio Association expire on June 15, 2009. Contracts that Matson has with the Masters, Mates & Pilots ("MM&P") and the Marine Engineers Beneficial Association ("MEBA") for ships built prior to 2003 expire on June 15, 2009. Negotiations will commence in May 2009 for the contracts expiring in June 2009. Contracts that Matson has with MM&P and the MEBA for ships built after 2003 include provisions for a wage reopener with negotiations completed by August 15, 2009.

SSAT, the previously-described joint venture of Matson and SSA, provides stevedoring and terminal services for Matson vessels calling at U.S. Pacific Coast ports. Matson, SSA and SSAT are members of the Pacific Maritime Association ("PMA") which, on behalf of its members, negotiates collective bargaining agreements with the ILWU on the U.S. Pacific Coast. A new six-year PMA/ILWU Master Contract, which covers all Pacific Coast longshore labor, was negotiated in 2008 without significant disruption and will expire on July 1, 2014. Matson Terminals provides stevedoring and terminal services to Matson and other vessel operators calling at Honolulu and on the islands of Hawaii, Maui and Kauai. Matson Terminals is a member of the Hawaii Stevedore Industry Committee, which negotiates with the ILWU in Hawaii on behalf of its members. The ILWU contract in Hawaii expired on June 30, 2008. Negotiations commenced in the spring of 2008 and recently concluded. Matson has signed six-year agreements with each of the ILWU units. The current contracts will expire on June 30, 2014.

During 2008, Matson renewed its collective bargaining agreement with ILWU clerical workers at Honolulu and Oakland through June 2014 without service interruption.

During 2008, Matson contributed to multiemployer pension plans for vessel crews. If Matson were to withdraw from or significantly reduce its obligation to contribute to one of the plans, Matson would review and evaluate data, actuarial assumptions, calculations and other factors used in determining its withdrawal liability, if any. In the event that any third parties materially disagree with Matson's determination, Matson would pursue the various means available to it under federal law for the adjustment or removal of its withdrawal liability. Matson Terminals participates in a multiemployer pension plan for its Hawaii ILWU non-clerical employees. For a discussion of withdrawal liabilities under the Hawaii longshore and seagoing plans, see Note 9 ("Employee Benefit Plans") to A&B's financial statements in Item 8 of Part II below.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the ILWU. The agreements with the HC&S production unit employees and clerical bargaining unit employees covering approximately 640 workers, expired on January 31, 2009, and are being renegotiated. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. Both agreements were renegotiated. The bulk sugar employees agreement expires on June 30, 2014, and the agreement with all other employees expires on March 31, 2009, with renegotiations expected to begin in spring of 2009. There are two collective bargaining agreements with KCC employees represented by the ILWU. These agreements were also renegotiated and expire on April 30, 2010. There is a collective bargaining agreement with the ILWU for the production unit employees of Kauai Coffee. This contract was renegotiated in 2007 and will expire on January 31, 2010.

E. Energy

Matson and Matson Terminals purchase residual fuel oil, lubricants, gasoline and diesel fuel for their operations. Residual fuel oil is by far Matson's largest energy-related expense. In 2008, Matson vessels purchased approximately 2.0 million barrels of residual fuel oil (compared with 2.3 million barrels in 2007).

Residual fuel oil prices paid by Matson in 2008 started at $77.67 per barrel and ended the year at $43.06. The low for the year was $34.48 per barrel in November and the high was $126.57 in August. Sufficient fuel for Matson's requirements is expected to be available in 2009.

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory operations, HC&S sells electricity. In 2008, HC&S produced and sold, respectively, approximately 211,000 MWH and 91,300 MWH of electric power (compared with 218,000 MWH produced and 94,000 MWH sold in 2007). The decrease in power sold was due to drought conditions, which hindered hydro power produced and increased the use of power for irrigation pumping. HC&S's use of oil in 2008 of 26,600 barrels was 14 percent less than the 31,100 barrels used in 2007. The decrease was due to a supply shortage of low-cost, recycled motor oil. Coal used for power generation was 96,400 short tons, about 28,300 tons more than that used in 2007. More coal was required because less bagasse was produced due to a smaller crop, and some of the coal had a lower heat value, requiring more tons to produce the same level of heat.

In 2008, McBryde produced approximately 32,000 MWH of hydroelectric power (compared with approximately 31,800 MWH in 2007). To the extent it is not used in A&B's coffee operations, McBryde sells electricity to Kauai Island Utility Cooperative. Power sales in 2008 amounted to approximately 23,700 MWH (compared with 21,200 MWH in 2007).

In the third quarter of 2008, HC&S was notified that the Hawaii Public Utilities Commission ("PUC") had issued a decision that provides for a new methodology of calculating avoided energy costs, which resulted in a reduction in the avoided energy cost payable to energy producers, beginning in August 2008. The decision affects the Company's power sales on Maui, but not on Kauai. If no changes were to occur to the decision or the terms of HC&S's power sales contract with Maui Electric Company ("MECO"), this decision could result in an approximately $6 million annual reduction in HC&S's power revenue and profitability. The Company is currently evaluating its options for a reconsideration or reversal of the PUC's decision or for negotiating a new power contract with MECO, and the final outcome of these actions cannot yet be determined.

F. Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

The business of A&B and its subsidiaries (collectively, the "Company") faces numerous risks, including those set forth below or those described elsewhere in this Form 10-K or in the Company's filings with the SEC. The risks described below are not the only risks that the Company faces, nor are they necessarily listed in order of significance. Other risks and uncertainties may also impair its business operations. Any of these risks may have a material adverse effect on the Company's business, liquidity, financial condition, results of operations and cash flows. All forward-looking statements made by the Company or on the Company's behalf are qualified by the risks described below.

Changes in U.S., global, or regional economic conditions that result in a further decrease in consumer confidence or market demand for the Company's services and products in Hawaii, the U.S. Mainland, Guam or Asia may adversely affect the Company's financial position, results of operations, liquidity, or cash flows.

A continuation or further weakening of the U.S., Guam, Asian or global economies may adversely impact the level of freight volumes, freight rates, and real estate leasing and development activity. Within the U.S., a continuation or further weakening of economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, and/or the further weakening of consumer confidence, market demand or the economy in the U.S. Mainland, may further reduce the demand for goods to and from Hawaii and Asia, travel to Hawaii and domestic transportation of goods, adversely affecting inland and ocean transportation volumes and/or rates, the sale of Hawaii real estate to mainland buyers, and the real estate leasing and development markets. In addition, continued overcapacity in the global ocean transportation market may adversely affect freight volumes and/or rates in the Company's China service. Additionally, a change in the cost of goods or currency exchange rates may cause these adverse effects as well.

The Company may face new or increased competition.

The Company's transportation segment may face new competition by established or start-up shipping operators that enter the Company's markets. The entry of a new competitor or the addition of ships or capacity by existing competition on any of the Company's routes could result in a significant increase in available shipping capacity that could have an adverse effect on volumes and/or rates. See also discussion under "Business and Properties - Transportation - Competition" above.

For the Company's real estate segment, there are numerous other developers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with the Company for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Increased vacancies or lack of development opportunities may lead to a deterioration in results from the Company's real estate business.

The Company's significant operating agreements and leases could be replaced.

The significant operating agreements and leases of the Company in its various businesses expire at various points in the future and may not be replaced or could be replaced on less favorable terms, thereby adversely affecting future revenue generation. For example, the Company's agribusiness segment sells substantially all of its bulk raw sugar through the cooperative HS&TC, which has a supply contract with C&H Sugar Company, Inc., ending in December 2009. Replacement of this supply contract on less favorable terms to the Company may adversely affect the Company's sugar business.

The reduction in availability of mortgage financing and the volatility and reduction in liquidity in the financial markets may adversely affect the Company's real estate business.

During 2008, the financial industry continued to experience significant instability due to, among other things, declining property values and increasing defaults on loans. This has led to tightened credit requirements, reduced liquidity and increased credit risk premiums for virtually all borrowers. Fewer loan products and tighter loan qualifications will make it more difficult for borrowers to finance the purchase of units in the Company's residential projects. The tightening of credit in the commercial markets may adversely affect the Company's ability to secure construction and/or other financing for the Company's residential and commercial projects, working capital requirements, and/or investment needs. The absence of financing for buyers of commercial properties will make it significantly more difficult for the Company to sell commercial properties and will negatively impact the sales prices and other terms of such sales. Additionally, continuation or worsening of the liquidity crisis may impact the Company in other ways, including the credit or solvency of customers, vendors, or joint venture partners, and the ability of partners to fund their equity obligations to the joint venture.

A downgrade in the Company's credit rating or disruptions on the credit markets could restrict its ability to access the debt capital markets and/or increase the cost of debt.

Changes in the Company's credit ratings may ultimately impact the Company's ability to access debt in the private or public market and may also increase its borrowing costs. If the Company's credit ratings fall below investment grade, its access to the debt capital markets may become restricted. Furthermore, the tightening in the credit markets and the low level of liquidity in the financial markets resulting from the current turmoil in the financial industry may adversely affect the Company's ability to access the debt capital markets or to renew its committed lines of credit in the future and/or increase the Company's cost of capital. Because the Company relies on its ability to draw on its revolving credit facilities to support its operations, when required, continued volatility in the credit and financial markets that prevents the Company from accessing funds (for example, a lender that does not fulfill its lending obligation), could have an adverse effect on the Company's financial condition and cash flows. Additionally, the Company's credit agreements generally include an increase in interest rates if the Company's ratings are downgraded.

Failure to comply with certain restrictive financial covenants contained in the Company's credit facilities could preclude the payment of dividends, impose restrictions on the Company's business segments, capital resources or other activities or otherwise adversely affect the Company.

The Company's credit facilities contain certain restrictive financial covenants, the most restrictive of which include the maintenance of minimum shareholders' equity levels, a maximum ratio of debt to earnings before interest, depreciation, amortization, and taxes, and the maintenance of a minimum unencumbered property investment value. If the Company does not maintain the required covenants, and that breach of covenants is not cured timely or waived by the lenders, resulting in default, the Company's access to credit may be limited or terminated, and the lenders could declare any outstanding amounts due and payable.

The Company is subject to potential insolvency of insurance carriers.

The Company purchases a variety of insurance products to transfer financial risk. Accordingly, the Company is subject to the risk that one or more of the insurers may become insolvent and would be unable to pay one or more claims that may be made in the future.

An increase in fuel prices, or changes in the Company's ability to collect fuel surcharges, may adversely affect the Company's profits.

Fuel is a significant operating expense for the Company's shipping and agribusiness operations. The price and supply of fuel is unpredictable and fluctuates based on events beyond the Company's control. Increases in the price of fuel may adversely affect the Company's results of operations based on market and competitive conditions. Increases in fuel costs also can lead to other expense increases, through, for example, increased costs of energy, petroleum-based raw materials and purchased transportation services. In the Company's ocean transportation and logistics segments, the Company is able to utilize fuel surcharges to partially recover increases in fuel expense, although increases in the fuel surcharge may adversely affect the Company's competitive position and may not correspond exactly with the timing of increases in fuel expense. Changes in the Company's ability to collect fuel surcharges may adversely affect its results of operations. Increases in energy costs for the Company's leased real estate portfolio are typically recovered from lessees, although higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices may also increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting the Company's development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Noncompliance with, or changes to, federal, state or local law or regulations may adversely affect the Company's business.

The Company is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, government administration of the U.S. sugar program, environmental regulations including those relating to air quality initiatives at port locations, and cabotage laws. Noncompliance with, or changes to, the laws and regulations governing the Company's business could impose significant additional costs on the Company and adversely affect the Company's financial condition. For example, if the Jones Act and the regulations promulgated thereunder were repealed, amended, or otherwise modified, non-U.S. competitors with significantly lower costs may consequently enter any of the Jones Act routes or the Company's business may be significantly altered, all of which may have an adverse effect on the Company's shipping business. In addition, changes in federal, state and local environmental laws impacting the shipping business, including passage of climate change legislation or other regulatory initiatives in the United States that restrict emissions of greenhouse gasses, may require costly vessel modifications, the use of higher-priced fuel and changes in operating practices that may not all be able to be recovered through increased payments from customers. The real estate segment is subject to numerous federal, state and local laws and regulations, which, if changed, may adversely affect the Company's business. The agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the 2008 Farm Bill, and the Hawaii Public Utilities Commission's regulation of avoided energy cost rates paid to the Company in connection with it sale of electric power, and the Company may be adversely affected by any changes.

Work stoppages or other labor disruptions by the unionized employees of the Company or other companies in related industries may adversely affect the Company's operations.

As of December 31, 2008, the Company had approximately 2,160 regular full-time employees, of which approximately 49 percent were covered by collective bargaining agreements with unions. The Company's transportation, real estate and agribusiness segments may be adversely affected by actions taken by employees of the Company or other companies in related industries against efforts by management to control labor costs, restrain wage increases or modify work practices. Strikes and disruptions may occur as a result of the failure of the Company or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its real estate segment, the Company may be unable to complete construction of its projects if building materials or labor is unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor and customer relationships may adversely affect the Company's business.

The Company's business is dependent on its relationships with key vendors, customers and tenants. The ocean transportation business relies on its relationships with freight forwarders, large retailers and consumer goods and automobile manufacturers, as well as other larger customers. Relationships with railroads and shipping companies are important in the Company's intermodal business. For agribusiness, HC&S's relationship with C&H Sugar Company, Inc. is critical. The loss of or damage to any of these key relationships may affect the Company's business adversely.

Interruption or failure of the Company's information technology and communications systems could impair the Company's ability to operate and adversely affect its business.

The Company is highly dependent on information technology systems. For example, in the transportation segment, these dependencies include accounting, billing, disbursement, cargo booking and tracking, vessel scheduling and stowage, equipment tracking, customer service, banking, payroll and employee communication systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. The Company may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at the Company's facilities. Any failure of the Company's systems could result in interruptions in its service or production, reductions in its revenue and profits and damage to its reputation.

The Company is susceptible to weather and natural disasters.

The Company's transportation operations are vulnerable to disruption as a result of weather and natural disasters such as bad weather at sea, hurricanes, typhoons, tsunamis, floods and earthquakes. Such events will interfere with the Company's ability to provide on-time scheduled service, resulting in increased expenses and potential loss of business associated with such events. In addition, severe weather and natural disasters can result in interference with the Company's terminal operations, and may cause serious damage to its vessels, loss or damage to containers, cargo and other equipment, and loss of life or physical injury to its employees, all of which could have an adverse effect on the Company's business.

For the real estate segment, the occurrence of natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, could damage its real estate holdings, resulting in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, the Company's properties.

For the agribusiness segment, drought, greater than normal rainfall, hurricanes, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar and coffee planting, harvesting and production, and the agribusiness segment's facilities, including dams and reservoirs.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact the Company's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability or willingness of tourists to travel to Hawaii, thereby adversely affecting Hawaii's economy and the Company. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets. Acts of war or terrorism may be directed at the Company's shipping operations or real estate holdings, or may cause the U.S. government to take control of Matson's vessels for military operation. Heightened security measures are likely to slow the movement and increase the cost of freight through U.S. or foreign ports, across borders or on U.S. or foreign railroads or highways and could adversely affect the Company's business and results of operations.

Loss of the Company's key personnel could adversely affect its business.

The Company's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, the Company may have to incur significant costs to replace them, and the Company's ability to execute its business model could be impaired if it cannot replace them in a timely manner. The Company does not expect to maintain key person insurance on any of its key personnel.

The Company is involved in joint ventures and is subject to risks associated with joint venture relationships.

The Company is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as:

- the Company may not have voting control over the joint venture;
- the Company may not be able to maintain good relationships with its venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with the Company's;
- the venture partner may fail to fund its share of capital for operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to the Company;
- the joint venture or venture partner could lose key personnel; and
- the venture partner could become insolvent, requiring the Company to assume all risks and capital requirements related to the joint venture project.

In connection with its real estate joint ventures, the Company is sometimes asked to guarantee completion of a joint venture's construction and development of a project, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If the Company were to become obligated under such arrangement, the Company may be adversely affected.

For information regarding certain recent developments involving the Kukui'ula project, see "Business Outlook" in "Management's Discussion and Analysis of Financial Condition and Results of Operations" in Item 7 of Part II of this Form 10-K.

The Company is subject to, and may in the future be subject to, disputes, legal or other proceedings, or government inquiries or investigations, that could have an adverse effect on the Company.

The nature of the Company's business exposes it to the potential for disputes, legal or other proceedings, or government inquiries or investigations, relating to antitrust matters, labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section or in other Company filings with the SEC. For example, Matson is a common carrier, whose tariffs, rates, rules and practices in dealing with its customers are governed by extensive and complex foreign, federal, state and local regulations, which may be the subject of disputes or administrative and/or judicial proceedings. These disputes, individually or collectively, could harm the Company's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by the Company, or result in significant changes to Matson's tariffs, rates, rules and practices in dealing with its customers, all of which could have an adverse effect on the Company's future operating results, including profitability, cash flows, and financial condition. As a real estate developer, the Company may face warranty and construction defect claims, as described below in the "Real Estate" section of this "Risk Factors" item. For a description of significant legal proceedings involving the Company, including proceedings involving the Company's irrigation systems on Maui, and a grand jury subpoena served on Matson on April 21, 2008 and subsequently filed civil lawsuits purporting to be class actions in which the Company and Matson are named as defendants, and which allege violations of the antitrust laws and seek treble damages and injunctive relief, see "Legal Proceedings" below.

TRANSPORTATION

The Company is subject to risks associated with conducting business in a foreign shipping market.

The Company, through Matson's Hawaii/Guam/China service, is subject to risks associated with conducting business in a foreign shipping market, which include:

- challenges in operating in a foreign country and doing business and developing relationships with foreign companies;
- difficulties in staffing and managing foreign operations;
- legal and regulatory restrictions, including compliance with Foreign Corrupt Practices Act;
- global vessel overcapacity that may lead to decreases in volumes and/or shipping rates;
- competition with established and new shippers;
- currency exchange rate fluctuations;
- political and economic instability;
- protectionist measures that may affect the Company's operation of its wholly-owned foreign enterprise; and
- challenges caused by cultural differences.

Any of these risks has the potential to adversely affect the Company's operating results.

Compliance with environmental laws and regulations may adversely affect the Company's business.

The Company's vessel operations are subject to various federal, state and local environmental laws and regulations, including, but not limited to, the Oil Pollution Act of 1990, the Comprehensive Environmental Response Compensation & Liability Act of 1980, the Clean Water Act, the Invasive Species Act and the Clean Air Act. Continued compliance with these laws and regulations may result in additional costs and changes in operating procedures that may adversely affect the Company's business.

Acquisitions may have an adverse effect on the Company's business.

The Company's growth strategy includes expansion through acquisitions. Acquisitions may result in difficulties in assimilating acquired companies, and may result in the diversion of the Company's capital and its management's attention from other business issues and opportunities. The Company may not be able to integrate companies that it acquires successfully, including their personnel, financial systems, distribution, operations and general operating procedures. The Company may also encounter challenges in achieving appropriate internal control over financial reporting in connection with the integration of an acquired company. The Company may pay a premium for an acquisition, resulting in goodwill that may later be determined to be impaired, adversely affecting the Company's financial condition and results of operations.

The Company's logistics services are dependent upon third parties for equipment, capacity and services essential to operate the Company's logistics business, and if the Company fails to secure sufficient third party services, its business could be adversely affected.

The Company's logistics services are dependent upon rail, truck and ocean transportation services provided by independent third parties. If the Company cannot secure sufficient transportation equipment, capacity or services from these third parties at a reasonable rate to meet its customers' needs and schedules, customers may seek to have their transportation and logistics needs met by other third parties on a temporary or permanent basis. As a result, the Company's business, consolidated results of operations and financial condition could be adversely affected.

The loss of several of the Company's major customers could have an adverse effect on the revenue and business of the Company's logistics business.

The Company's logistics business derives a significant portion of its revenues from its largest customers. For 2008, the Company's logistics business's largest ten customers accounted for approximately 28 percent of the business's revenue. A reduction in or termination of the Company's logistics services by several of the logistics business's largest customers could have an adverse effect on the Company's revenue and business.

REAL ESTATE

The Company is subject to risks associated with real estate construction and development.

The Company's development projects are subject to risks relating to the Company's ability to complete its projects on time and on budget. Factors that may result in a development project exceeding budget or being prevented from completion include:

- an inability of the Company or buyers to secure sufficient financing or insurance on favorable terms, or at all;
- construction delays, defects, or cost overruns, which may increase project development costs;
- an increase in commodity or construction costs, including labor costs;
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues;
- an inability to obtain zoning, occupancy and other required governmental permits and authorizations;
- difficulty in complying with local, city, county and state rules and regulations regarding permitting, zoning, subdivision, utilities, affordable housing, and water quality as well as federal rules and regulations regarding air and water quality and protection of endangered species and their habitats;
- an inability to have access to reliable sources of water or to secure water service or meters for its projects;
- an inability to secure tenants necessary to support the project;

- failure to achieve or sustain anticipated occupancy or sales levels;
- buyer defaults, including defaults under executed or binding contracts; and
- an inability to sell the Company's constructed inventory.

Any of these risks has the potential to adversely affect the Company's operating results.

A decline in leasing rental income could adversely affect the Company.

The Company owns a portfolio of commercial income properties. Factors that may adversely affect the portfolio's profitability include:

- a significant number of the Company's tenants are unable to meet their obligations;
- increases in non-recoverable operating and ownership costs;
- the Company is unable to lease space at its properties when the space becomes available;
- the rental rates upon a renewal or a new lease are significantly lower than prior rents or do not increase sufficiently to cover increases in operating and ownership costs;
- the providing of lease concessions, such as free or discounted rents and tenant improvement allowances; and
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues at the property.

Governmental entities have adopted or may adopt regulatory requirements that may restrict the Company's development activity.

The Company is subject to extensive and complex laws and regulations that affect the land development process, including laws and regulations related to zoning and permitted land uses. Government entities have adopted or may approve regulations or laws that could negatively impact the availability of land and development opportunities within those areas. For example, in December 2007, Maui County adopted an ordinance requiring verification of water source availability and sustainability for all developments prior to submission of subdivision construction plans. This requirement adds further process delays and burdens the developer with identifying and developing new water sources. It is possible that increasingly stringent requirements will be imposed on developers in the future that could adversely affect the Company's ability to develop projects in the affected markets or could require that the Company satisfy additional administrative and regulatory requirements, which could delay development progress or increase the development costs of the Company. Any such delays or costs could have an adverse effect on the Company's revenues and earnings.

Real estate development projects are subject to warranty and construction defect claims in the ordinary course of business that can be significant.

As a developer, the Company is subject to warranty and construction defect claims arising in the ordinary course of business. The amounts payable under these claims, both in legal fees and remedying any construction defects, can be significant and exceed the profits made from the project. As a consequence, the Company may maintain liability insurance, obtain indemnities and certificates of insurance from contractors generally covering claims related to workmanship and materials, and create warranty and other reserves for projects based on historical experience and qualitative risks associated with the type of project built. Because of the uncertainties inherent to these matters, the Company cannot provide any assurance that its insurance coverage, contractor arrangements and reserves will be adequate to address some or all of the Company's warranty and construction defect claims in the future. For example, contractual indemnities may be difficult to enforce, the Company may be responsible for applicable self-insured retentions, and certain claims may not be covered by insurance or may exceed applicable coverage limits. Additionally, the coverage offered and the availability of liability insurance for construction defects could be limited and/or costly. Accordingly, the Company cannot provide any assurance that such coverage will be adequate or available at all, or available at an acceptable cost.

AGRIBUSINESS

The lack of water for agricultural irrigation could adversely affect the Company.

It is crucial for the Company's agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane and coffee. As further described in "Legal Proceedings" below, there are administrative hearing processes challenging the Company's ability to divert water from streams in Maui. In addition, the Company's access to water is subject to weather patterns that cannot be reliably predicted. If the Company is not permitted to divert stream waters for its use or there is insufficient rainfall, it would have an adverse effect on the Company's sugar operations.

A decline in raw sugar or coffee prices will adversely affect the Company's business.

The business and results of operations of the Company's agribusiness segment are substantially affected by market factors, particularly the domestic prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops and suppliers, weather conditions, and United States farm and trade policies. If the price for sugar or coffee were to decline, the Company's agribusiness segment would be adversely affected. See also discussion under "Business and Properties - Agribusiness - Competition and Sugar Legislation" above.

The Company is subject to risks associated with raw sugar and coffee production.

The Company's production of raw sugar and coffee is subject to numerous risks that could adversely affect the volume and quality of sugar or coffee produced, including:

- weather and natural disasters;
- disease;
- weed control;
- uncontrolled fires, including arson;
- poor farming practices;
- government restrictions on farming practices due to cane burning;
- increases in costs, including, but not limited to fuel, fertilizer, herbicide, and drip tubing;
- water availability (see risk factor above regarding lack of water);
- equipment failures in factory or power plant;
- labor, including labor availability (see risk factor above regarding labor disruptions); and
- lack of demand for the Company's production.

Any of these risks has the potential to adversely affect the Company's future agribusiness operating results.

Continued operating losses or negative cash flows of the Agribusiness segment will adversely affect the Company's financial performance.

If the Company's Agribusiness segment continues to generate operating losses or negative cash flows, the Company's financial performance will be adversely affected and will result in additional actions taken by the Company to reduce or eliminate these operating losses or negative cash flows. Such actions may result in an impairment loss and restructuring costs that would adversely affect the Company's financial performance.

The Company's power sales contract may not be favorably modified and may adversely affect the Company's Agribusiness segment.

As mentioned under "Business and Properties - Energy" above, HC&S was notified that the PUC had issued a decision that provides for a new methodology of calculating avoided energy cost, which resulted in a reduction in the avoided energy cost payable to energy producers, beginning in August 2008. If no changes were to occur to the decision or the terms of HC&S's power sales contract with MECO, this decision could result in an approximately $6 million annual reduction in HC&S's power revenue and profitability. The Company is currently evaluating its options for a reconsideration or reversal of the PUC's decision or for negotiating a new power contract with MECO. The inability to favorably address this matter may adversely affect the Company's agribusiness operations.

The other member of the HS&TC cooperative is expected to withdraw from HS&TC this year.

HC&S sells substantially all of its bulk raw sugar through HS&TC, a cooperative consisting of HC&S and one other member. The other member of HS&TC has announced that it plans to withdraw from the sugar-growing business later this year. The Company intends to negotiate with the departing member to resolve certain issues relating to such withdrawal from HS&TC, but the Company is unable to predict, at this time, the outcome of such negotiations or the impact, if any, on the Company's business.

OTHER

Earnings on pension assets, or a change in pension law or key assumptions, may adversely affect the Company's financial performance.

The amount of the Company's employee pension and postretirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, changes in discount rates, higher health care costs, or lower actual or expected returns on plan assets, may adversely affect the Company's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect the Company's single-employer and multiemployer pension plans and plan funding. These factors, as well as a continued decline in the fair value of pension plan assets, may put upward pressure on the cost of providing pension and medical benefits and may increase future pension expense and required funding contributions. For example, in 2008, the Company's pension assets declined approximately 33 percent. As a result, the Company expects net periodic pension expense to increase to approximately $20 million in 2009 and expects to make contributions totaling $0.4 million to certain of its defined benefit pension plans in 2009. If additional unfavorable changes to plan asset levels occur or there are further increases in the projected benefit obligation, these changes may result in significant future expense or additional required contributions. Although the Company has actively sought to control increases in these costs, there can be no assurance that it will be successful in limiting future cost and expense increases, and continued upward pressure in costs and expenses could further reduce the profitability of the Company's businesses.

The Company may have exposure under its multiemployer plans in which it participates that extends beyond its funding obligation with respect to the Company's employees.

The Company contributes to various multiemployer pension plans. In the event of a partial or complete withdrawal by the Company from any plan that is underfunded, the Company would be liable for a proportionate share of such plan's unfunded vested benefits. Based on the limited information available from plan administrators, which the Company cannot independently validate, the Company believes that its portion of the contingent liability in the case of a full withdrawal or termination may be material to its financial position and results of operations. In the event that any other contributing employer withdraws from any plan that is underfunded, and such employer (or any member in its controlled group) cannot satisfy its obligations under the plan at the time of withdrawal, then the Company, along with the other remaining contributing employers, would be liable for its proportionate share of such plan's unfunded vested benefits. In addition, if a multiemployer plan fails to satisfy the minimum funding requirements, the Internal Revenue Service will impose certain penalties and taxes.

The Company is required to evaluate its internal controls over financial reporting under Section 404 of the Sarbanes-Oxley Act of 2002, and any adverse results from such evaluation could result in a loss of investor confidence in the Company's financial reports and have an adverse effect on the Company's stock price.

Section 404 of the Sarbanes-Oxley Act requires that publicly reporting companies cause their managements to perform annual assessments of the effectiveness of their internal controls over financial reporting. Although the Company has concluded that its internal controls over financial reporting were effective as of December 31, 2008, there can be no assurances that the Company will reach the same conclusion at the end of future years. If the Company is unable to assert that its internal control over financial reporting is effective, or if the Company's auditors are unable to express an opinion on the effectiveness of the Company's internal controls, the Company could lose investor confidence in the accuracy and completeness of its financial reports, which would have an adverse effect on the Company's stock price.

The foregoing should not be construed as an exhaustive list of all factors that could cause actual results to differ materially from those expressed in forward-looking statements made by the Company or on its behalf.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 3. LEGAL PROCEEDINGS

See "Business and Properties - Transportation - Rate Regulation" above for a discussion of rate and other regulatory matters in which Matson is routinely involved.

A&B owns 16,000 acres of watershed lands in East Maui that supply a significant portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years has supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. If the Company is not permitted to divert stream waters from State lands in East Maui for its use, it would have a material adverse effect on the Company's sugar-growing operations.

In addition, on May 24, 2001, petitions were filed by a third party, requesting that the Commission on Water Resource Management of the State of Hawaii ("Water

Period	Total Number of Shares Purchased	Average Price Paid per Share	or Programs	or Programs (1)
Oct 1 – 31, 2008	42,000	28.93	42,000	2,161,823
Nov 1 – 30, 2008	310,000	27.67	310,000	1,851,823
Dec 1 – 31, 2008	--	--	--	--

(1) In January 2008, A&B's Board of Directors authorized A&B to repurchase up to two million additional shares of its common stock. The authorization will expire on December 31, 2009.

During 2008, the Company repurchased 1,476,449 shares of its common stock for approximately $59 million, or an average of $40.33 per share. During 2007, the Company repurchased 671,728 shares of its common stock for $33 million, or an average price of $48.62 per share. During 2006, the Company repurchased 1,653,795 shares of its stock for $72 million, or an average price of $43.34 per share. In January 2008, A&B's Board of Directors authorized A&B to repurchase up to two million additional shares of its common stock. The authorization expires on December 31, 2009. A portion of the shares repurchased in 2008 were made under a previous share repurchase authorization that expired on December 31, 2008. As of December 31, 2008, 1,851,823 shares remain available for repurchase under the January 2008 authorization.

During the first quarter of 2008, 10,244 shares were returned to the Company in connection with the exercise of options to purchase shares of the Company's stock. The fair value of these shares averaged $43.93 per share.

ITEM 6. SELECTED FINANCIAL DATA

The following financial data should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except per-share amounts):

	2008	2007	2006	2005	2004
Revenue:					
Transportation:					
Ocean transportation	$ 1,023.7	$ 1,006.9	$ 945.8	$ 878.3	$ 850.1
Logistics services	436.0	433.5	444.2	431.6	376.9
Real Estate:					
Leasing	107.8	108.5	100.6	89.7	83.8
Sales	350.2	117.8	97.3	148.9	82.3
Less amounts reported in discontinued operations [1]	(133.0)	(112.0)	(111.7)	(76.4)	(26.0)
Agribusiness	124.3	123.7	127.4	123.2	112.8
Reconciling Items[2]	(10.7)	(9.2)	(14.2)	(8.4)	(6.5)
Total revenue	$ 1,898.3	$ 1,669.2	$ 1,589.4	$ 1,586.9	$ 1,473.4
Operating Profit:					
Transportation:					
Ocean transportation[3]	$ 105.8	$ 126.5	$ 105.6	$ 128.0	$ 108.3
Logistics services	18.5	21.8	20.8	14.4	8.9
Real Estate:					
Leasing	47.8	51.6	50.3	43.7	38.8
Sales[3]	95.6	74.4	49.7	44.1	34.6
Less amounts reported in discontinued operations [1]	(59.1)	(61.0)	(52.3)	(27.7)	(12.6)
Agribusiness	(12.9)	0.2	6.9	11.2	4.8
Total operating profit	195.7	213.5	181.0	213.7	182.8
Write-down of long-lived assets[4]	--	--	--	(2.3)	--
Interest expense, net[5]	(23.7)	(18.8)	(15.0)	(13.3)	(12.7)
General corporate expenses	(21.0)	(27.3)	(22.3)	(24.1)	(20.3)
Income from continuing operations before income taxes	151.0	167.4	143.7	174.0	149.8
Income taxes	(55.1)	(63.2)	(53.7)	(65.1)	(56.9)
Income from continuing operations	95.9	104.2	90.0	108.9	92.9
Income from discontinued operations	36.5	38.0	32.5	17.1	7.8
Net Income	$ 132.4	$ 142.2	$ 122.5	$ 126.0	$ 100.7

1 Prior year amounts restated for amounts treated as discontinued operations.
2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.
3 The Ocean Transportation segment includes approximately $5.2 million, $10.7 million, $13.3 million, $17.1 million and $4.7 million of equity in earnings from its investment in SSAT for 2008, 2007, 2006, 2005 and 2004, respectively. The Real Estate Sales segment includes approximately $9.0 million, $22.6 million, $14.4 million, $3.3 million and $3.3 million in equity in earnings from its various real estate joint ventures for 2008, 2007, 2006, 2005, and 2004, respectively.
4 The 2005 write-down was for an "other-than-temporary" impairment in the Company's investment in C&H Sugar Company, Inc. ("C&H"). The Company's investment in C&H was sold on August 9, 2005 at the then approximate carrying value.
5 Includes Ocean Transportation interest expense of $11.6 million for 2008, $13.9 million for 2007, $13.3 million for 2006, $9.6 million for 2005, and $5.7 million for 2004. Substantially all other interest expense was at the parent company.

SELECTED FINANCIAL DATA (CONTINUED)

	2008	2007	2006	2005	2004
Identifiable Assets:					
Transportation:					
Ocean Transportation[6]	$ 1,153.9	$ 1,215.0	$ 1,185.3	$ 1,113.0	$ 896.9
Logistics services	74.2	58.6	56.4	70.3	56.5
Real Estate:					
Leasing	590.2	595.4	525.5	478.6	436.5

Sales[6]	344.6	408.9	295.0	227.3	224.5
Agribusiness	172.2	174.6	168.7	159.0	152.8
Other	15.1	26.6	20.3	22.7	11.0
Total assets	$ 2,350.2	$ 2,479.1	$ 2,251.2	$ 2,070.9	$ 1,778.2
Capital Expenditures:					
Transportation:					
Ocean Transportation	$ 35.5	$ 65.8	$ 217.1	$ 173.9	$ 128.6
Logistics services[7]	2.4	2.0	1.7	1.3	0.1
Real Estate:					
Leasing[8]	100.2	124.5	93.0	78.8	10.2
Sales[9]	0.6	0.3	1.3	0.2	0.7
Agribusiness	15.2	20.5	15.0	13.0	10.2
Other	0.8	0.3	1.5	1.4	1.4
Total capital expenditures	$ 154.7	$ 213.4	$ 329.6	$ 268.6	$ 151.2
Depreciation and Amortization:					
Transportation:					
Ocean Transportation	$ 66.1	$ 63.2	$ 58.1	$ 59.5	$ 56.8
Logistics services	2.3	1.5	1.5	1.4	1.2
Real Estate:					
Leasing[1]	17.9	15.7	14.1	12.4	12.2
Sales	0.2	0.2	0.1	0.1	0.1
Agribusiness	11.5	10.7	10.1	9.4	9.0
Other	2.7	1.3	0.9	0.5	0.4
Total depreciation and amortization	$ 100.7	$ 92.6	$ 84.8	$ 83.3	$ 79.7

6 The Ocean Transportation segment includes approximately $44.6 million, $48.6 million, $49.8 million, $39.8 million and $23.0 million related to its investment in SSAT as of December 31, 2008, 2007, 2006, 2005 and 2004, respectively. The Real Estate Sales segment includes approximately $162.1 million, $134.1 million, $98.4 million, $114.1 million, and $83.9 million related to its investment in various real estate joint ventures as of December 31, 2008, 2007, 2006, 2005, and 2004, respectively.

7 Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

8 Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

9 Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $39 million, $110 million, $69 million, $34 million, and $30 million for 2008, 2007, 2006, 2005, and 2004, respectively.

SELECTED FINANCIAL DATA (CONTINUED)

	2008	2007	2006	2005	2004
Earnings per share:					
From continuing operations:					
Basic	$ 2.32	$ 2.45	$ 2.08	$ 2.50	$ 2.18
Diluted	$ 2.31	$ 2.42	$ 2.06	$ 2.47	$ 2.15
Net income:					
Basic	$ 3.21	$ 3.34	$ 2.84	$ 2.89	$ 2.37
Diluted	$ 3.19	$ 3.30	$ 2.81	$ 2.86	$ 2.33
Return on beginning equity	11.7%	13.8%	12.1%	13.9%	12.4%
Cash dividends per share	$ 1.235	$ 1.12	$ 0.975	$ 0.90	$ 0.90
At Year End					
Shareholders of record	3,269	3,381	3,506	3,628	3,792
Shares outstanding	41.0	42.4	42.6	44.0	43.3
Long-term debt – non-current	$ 452	$ 452	$ 401	$ 296	$ 214

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

The Company, from time to time, may make or may have made certain forward-looking statements, whether orally or in writing, such as forecasts and projections of the Company's future performance or statements of management's plans and objectives. These statements are "forward-looking" statements as that term is defined in the Private Securities Litigation Reform Act of 1995. Such forward-looking statements may be contained in, among other things, SEC filings, such as the Forms 10-K, 10-Q and 8-K, the Annual Report to Shareholders, press releases made by the Company, the Company's Internet Web sites (including Web sites of its subsidiaries), and oral statements made by the officers of the Company. Except for historical information contained in these written or oral communications, such communications contain forward-looking statements. These include, for example, all references to 2009 or future years. New risk factors emerge from time to time and it is not possible for the Company to predict all such risk factors, nor can it assess the impact of all such risk factors on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. Accordingly, forward-looking statements cannot be relied upon as a guarantee of future results and involve a number of risks and uncertainties that could cause actual results to differ materially from those projected in the statements, including, but not limited to the factors that are described in Part I, Item 1A under the caption of "Risk Factors" of this Form 10-K, which section is incorporated herein by reference. The Company is not required, and undertakes no obligation, to revise or update forward-looking statements or any factors that may affect actual results, whether as a result of new information, future events, or circumstances occurring after the date of this report.

OVERVIEW

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is designed to provide a discussion of the Company's financial condition, results of operations, liquidity and certain other factors that may affect its future results from the perspective of management. The discussion that follows is intended to provide information that will assist in understanding the changes in the Company's financial statements from year to year, the primary factors that accounted for those changes, and how certain accounting principles, policies and estimates affect the Company's financial statements. MD&A is provided as a supplement to, and should be read in conjunction with, the consolidated financial statements and the accompanying notes to the financial statements. MD&A is presented in the following sections:

- Business Overview
- Critical Accounting Estimates
- Consolidated Results of Operations
- Analysis of Operating Revenue and Profit by Segment
- Liquidity and Capital Resources
- Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements
- Business Outlook
- Other Matters

BUSINESS OVERVIEW

Alexander & Baldwin, Inc. ("A&B"), founded in 1870, is a multi-industry corporation headquartered in Honolulu that operates in five segments in three industries —Transportation, Real Estate, and Agribusiness.

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment, which is conducted through Matson Navigation Company, Inc. ("Matson"), a wholly-owned subsidiary of A&B, is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities.

The Logistics Services segment, which is conducted through Matson Integrated Logistics, Inc. ("MIL"), a wholly-owned subsidiary of Matson, is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services (collectively "Highway"). Warehousing and distribution services are provided by Matson Global Distribution Services, Inc. ("MGDS"), a wholly-owned subsidiary of MIL. MGDS's operations also include Pacific American Services, LLC ("PACAM"), a San Francisco bay-area regional warehousing, packaging, and distribution company acquired in the third quarter of 2008.

The Transportation Industry accounted for 72 percent, 49 percent, and 52 percent of the revenue, operating profit, and identifiable assets, respectively, in 2008 on a consolidated basis before discontinued operations.

Real Estate: The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. Mainland. The Real Estate Sales segment generates its revenues through the development and sale of land, and commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. Real estate activities are conducted through A&B Properties, Inc. and various other wholly-owned subsidiaries of A&B.

The Real Estate Industry accounted for 22 percent, 56 percent, and 40 percent of the revenue, operating profit, and identifiable assets, respectively, in 2008 on a consolidated basis before discontinued operations.

Agribusiness: Agribusiness, a division of A&B, contains one segment and produces bulk raw sugar, specialty food grade sugars, and molasses; produces, markets, and distributes roasted coffee and green coffee; provides general trucking services, mobile equipment maintenance, and repair services; and generates and sells, to the extent not used in the Company's operations, electricity.

The Agribusiness Industry accounted for 6 percent of the revenue and 8 percent of the identifiable assets in 2008 on a consolidated basis before discontinued operations.

CRITICAL ACCOUNTING ESTIMATES

The Company's significant accounting policies are described in Note 1 to the Consolidated Financial Statements. The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America, upon which the Management's Discussion and Analysis is based, requires that management exercise judgment when making estimates and assumptions about future events that may affect the amounts reported in the financial statements and accompanying notes. Future events and their effects cannot be determined with absolute certainty and actual results will, inevitably, differ from those critical accounting estimates. These differences could be material.

The Company considers an accounting estimate to be critical if: (i) the accounting estimate requires the Company to make assumptions that are difficult or subjective about matters that were highly uncertain at the time that the accounting estimate was made, and (ii) changes in the estimate that are reasonably likely to occur in periods subsequent to the period in which the estimate was made, or use of different estimates that the Company could have used in the current period, would have a material impact on the financial condition or results of operations. The most significant accounting estimates inherent in the preparation of the Company's financial statements are described below.

Impairment of Long-Lived Assets: The Company's long-lived assets are reviewed for impairment if events or circumstances indicate that the carrying amount of the long-lived asset may not be recoverable. The Company has evaluated certain long-lived assets for impairment; however, no impairment charges were recorded as a result of this process. These asset impairment loss analyses contain uncertainties because they require management to make assumptions and apply considerable judgments to, among others, estimates of the timing and amount of future cash flows, expected useful lives of the assets, uncertainty about future events, including changes in economic conditions, changes in operating performance, changes in the use of the assets, and ongoing costs of maintenance and improvements of the assets, and thus, the accounting estimates may change from period to period. If management uses different assumptions or if different conditions occur in future periods, the Company's financial condition or its future operating results could be materially impacted.

Impairment of Investments: The Company's investments in unconsolidated affiliates are reviewed for impairment whenever there is evidence of a loss in value. An investment is written down to fair value if the impairment is other-than-temporary. In evaluating the fair value of an investment, the Company reviews the discounted projected cash flows associated with the investment and other relevant information. In evaluating whether an impairment is other-than-temporary, the Company considers all available information,

Mainland improved	81.8	6.8	35.6
Hawaii development sales	217.4	14.9	4.5
Hawaii unimproved/other	29.2	12.7	13.5
Total Revenue	$ 350.2	$ 117.8	$ 97.3
Operating profit before joint ventures	$ 86.6	$ 51.8	$ 35.3
Earnings from joint ventures	9.0	22.6	14.4
Total Operating Profit	$ 95.6	$ 74.4	$ 49.7
Operating profit margin	27.3%	63.2%	51.1%

The higher revenue and higher operating profit results were due to the mix and timing of real estate sales in 2008 compared with 2007, as well as the treatment of income earned from the Company's joint ventures. The composition of these sales is described below.

2008: Real Estate Sales revenue included the sale of 330 residential units and two commercial units at the Company's Keola La'i high-rise development in Honolulu, two mainland shopping centers, one mainland office property, the Kahului Town Terrace rental project, three improved Maui properties, a 130-acre agricultural parcel on Maui, several leased fee parcels and other land parcels on Maui, and 30 Keala'ula single-family homes on Kauai. Operating profit included joint venture income of $9.0 million, principally related to sales at the Company's Kai Malu residential development on Maui and the sale of several buildings at the Company's Centre Pointe retail/office development in Valencia, California, partially offset by the Company's share of marketing and other operating expenses of its Kukui'ula projects. Real Estate Sales operating profit for 2008 included $7.7 million, representing a final insurance settlement for the 2005 fire at Kahului Shopping Center that was received in the first quarter of 2008. Finally, the Company recorded a $3 million impairment loss related to its investment in its Santa Barbara joint venture project, $1.5 million of which was recognized at the joint venture level and recorded by the Company as earnings in loss of joint venture, and $1.5 million of which was recognized by the Company as a reduction in operating profit from an other-than-temporary impairment of its investment in the joint venture.

2007: Real Estate Sales revenue included the sale of a four-acre land parcel ground leased to a retail tenant in Honolulu, two retail centers on Maui, two small commercial buildings on a four-acre land parcel on Maui sold to the State of Hawaii, a commercial property in California, the final payment on an installment sale of an agricultural parcel on Kauai, and a commercial parcel on Maui. Closings also commenced on a single-family residential development on Kauai. Operating profit included the margin on the sales referenced above as well as $22.6 million of joint venture earnings, principally representing the results from the Company's Kai Malu and Valencia joint venture projects, partially offset by the Company's share of marketing and other operating expenses of its Kukui'ula joint venture project.

2006: Real Estate Sales revenue included the sale of two retail centers in Arizona, a commercial property on the island of Hawaii, a Maui office building, several commercial parcels on Maui, a commercial property on Oahu, and a 19-percent installment payment for an agricultural parcel on Kauai. Operating profit for 2006 was significantly higher as a percentage of real estate sales revenue compared to 2005 because operating profit also included $14.4 million for the Company's earnings from its real estate joint ventures. The joint venture earnings principally relate to a portion of the Company's earnings from its Hokua joint venture, which completed sales of all 247 residential condominium units in January 2006, and joint venture earnings from the Company's Kai Malu project, partially offset by higher marketing expenses related to the Company's Kukui'ula project.

Discontinued Operations; Real-Estate – The revenue, operating profit, and after-tax effects of discontinued operations for 2008, 2007 and 2006 were as follows (in millions, except per-share amounts):

	2008	2007	2006
Sales Revenue	$ 125.4	$ 94.8	$ 89.8
Leasing Revenue	$ 7.6	$ 17.2	$ 21.9
Sales Operating Profit	$ 55.0	$ 50.8	$ 40.1
Leasing Operating Profit	$ 4.1	$ 10.2	$ 12.2
After-tax Earnings	$ 36.5	$ 38.0	$ 32.5
Basic Earnings Per Share	$ 0.89	$ 0.89	$ 0.76
Diluted Earnings Per Share	$ 0.88	$ 0.88	$ 0.75

2008: The revenue and expenses of two retail properties on the mainland, one mainland office property, a multi-tenant residential rental property, three commercial properties on Maui, land previously leased to a telecommunications tenant on Maui, and several land parcels on Maui, and have been classified as discontinued operations.

2007: The revenue and expenses of land leased to a retail tenant on Oahu, several commercial properties on Maui, a leased fee parcel on Maui, and a commercial property in California have been classified as discontinued operations.

2006: The revenue and expenses from the sale of two retail centers in Arizona, an office building on Maui, a commercial property on the island of Hawaii, and several commercial parcels in Hawaii were included in discontinued operations.

Agribusiness

Agribusiness; 2008 compared with 2007

(dollars in millions)	2008	2007	Change
Revenue	$ 124.3	$ 123.7	--%
Operating profit (loss)	$ (12.9)	$ 0.2	NM
Operating profit (loss) margin	NM	0.2%	
Tons sugar produced	145,200	164,500	-12%

Agribusiness revenue increased $0.6 million in 2008 compared with 2007. The increase was principally due to $6.1 million in higher power prices and volumes , $4.6 million in higher specialty sugar sales volumes, and $1.5 million in higher raw sugar prices, partially offset by $8.8 million in lower raw sugar sales volumes and $2.9 million in lower revenue from soil and molasses sales.

Operating loss for 2008 was $12.9 million compared with an operating profit of $0.2 million for 2007. The operating loss was primarily due to $14.9 million in lower sugar margins that were the result of lower production volumes and higher operating costs than 2007, $1.6 million in lower soil sales, $1.5 million in lower profits from other operations and $1.2 million in lower molasses sales prices. This unfavorable variance was partially offset by $6.1 million in higher power revenue from higher prices.

Compared with 2007, sugar production in 2008 was 12 percent, or 19,300 tons, lower due to lower yields. Lower sugar yields were principally the result of extended drought conditions. The average revenue per ton of sugar for 2008 was $355, or 4 percent higher than the average revenue per ton of $342 in 2007.

Approximately 81 percent of the Company's sugar production was sold to Hawaiian Sugar & Transportation Cooperative ("HS&TC") during 2008 under a marketing contract. The remainder was sold as specialty sugar. HS&TC sells its raw sugar to C&H Sugar Company, Inc. at a price equal to the New York No. 14 Contract settlement price, less a discount and less costs for sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Company. The Agreement for Delivery and Sale of Raw Sugar with C&H Sugar Company, Inc. and HS&TC was amended in December 2008. The agreement was extended for one year, with an option to extend it for one additional year.

Agribusiness: 2007 compared with 2006

(dollars in millions)	2007	2006	Change
Revenue	$ 123.7	$ 127.4	-3%
Operating profit	$ 0.2	$ 6.9	-97%
Operating profit margin	0.2%	5.4%	
Tons sugar produced	164,500	173,600	-5%

Agribusiness revenue decreased $3.7 million, or 3 percent, in 2007 compared with 2006. The decrease was principally due to $6.3 million in lower raw sugar revenue as a result of lower sales volumes and prices, and $1.6 million in lower power revenue due principally to lower volumes sold. The decrease was partially offset by $4.3 million in higher revenue from coffee sales, specialty sugar sales, land and quarry rent, and trucking and shop services.

Operating profit for 2007 decreased $6.7 million, or 97 percent, compared with 2006. The decrease in operating profit was primarily due to lower sugar production, higher operating costs, and lower sugar prices. The decrease in operating profit was also due to $1.6 million in lower power revenue due principally to lower volumes sold.

Compared with 2006, sugar production in 2007 was 5 percent, or 9,100 tons, lower due primarily to lower yields. Lower sugar yields were principally the result of dry-weather conditions over the past two years and to certain agronomic practices. The average revenue per ton of sugar for 2007 was $342, or 2 percent lower than the average revenue per ton of $350 in 2006.

LIQUIDITY AND CAPITAL RESOURCES

Overview: During 2008, significant turmoil in the credit markets resulted in liquidity constraints across the market in general. However, the Company has not been materially impacted by the liquidity crisis because of its significant cash flows from operations and its ability to borrow under its debt facilities. The Company has a $325 million revolving credit facility, which does not expire until December 2011. As of December 31, 2008, the Company had approximately $249 million of available capacity under the facility. Additionally, as of December 31, 2008, the Company had access to approximately $143 million of remaining capacity on a $400 million term facility, under which the ability to draw additional amounts under the facility expires in April 2012, and $14 million of remaining capacity on a facility that expires in June 2015. The Company has discussed credit availability with its lenders and currently believes that its lenders are willing and able to lend pursuant to the terms of the respective credit facilities. Additionally, the Company is currently in compliance with all of its covenants under its debt agreements. As a result, the Company believes its ability to generate cash and access capital under its facilities will be adequate to meet anticipated future cash requirements to fund working capital, capital expenditures, dividends, potential acquisitions, stock repurchases, and other cash needs for the foreseeable future. There can be no assurance, however, that the Company will continue to generate cash flows at or above current levels or that it will be able to maintain its ability to borrow under its available credit facilities.

While Matson is subject to restrictions on the transfer of net assets to A&B under certain debt agreements, these restrictions have not had any effect on the Company's shareholder dividend policy, and the Company does not anticipate that these restrictions will have any impact in the future. At December 31, 2008, the amount of net assets of Matson that may not be transferred to the Company was approximately $298 million.

On January 29, 2009, the Company committed to a fourth series of senior promissory notes, Series D notes, totaling $100 million under its Prudential facility more fully described in Note 7 to the Consolidated Financial Statements. The Company intends to use the proceeds for general corporate purposes. The funding date of the draw under the facility will be at the Company's discretion, but must occur by March 9, 2009. The notes carry interest at an annual fixed-rate of 6.9 percent with a final maturity on March 9, 2020. Interest will be paid semi-annually, commencing in September 2009, and the principal under the note will be repaid in annual installments commencing in March 2012.

Cash Flows: Cash flows provided by operating activities continue to be the Company's most significant source of liquidity. Cash flows from operating activities totaled $275 million for 2008, $124 million for 2007, and $106 million for 2006. The increase in 2008 over 2007 was due principally to proceeds from the sale of 330 residential units and two commercial units at the Company's Keola La'i condominium project and to lower spending on real estate development inventory, partially offset by lower Agribusiness and Matson earnings and higher income tax payments. The increase in 2007 over 2006 was due principally to higher Ocean Transportation segment earnings, including higher distributions from Matson's investment in SSAT, and higher residential development sales proceeds, partially offset by higher expenditures for real estate developments held-for-sale and higher income tax payments.

Cash flows used in investing activities were $149 million for 2008, $145 million for 2007, and $124 million for 2006. Of the 2008 amount, $109 million was for capital expenditures, including $54 million related to real estate investments, such as the reverse 1031 acquisition of Savannah Logistics Center and other leasing portfolio improvements, $38 million related to the purchase of ocean transportation-related assets, and $15 million principally related to routine replacements for agricultural operations. Other cash flows used in investing activities included $41 million related to additional investments in joint venture projects, and $24 million for the acquisition of PACAM. These cash outflows were partially offset by $27 million in cash proceeds received that were primarily related to property sales. The $149 million of cash used in investing activities for 2008 excludes $46 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period.

Of the 2007 amount, $122 million was for capital expenditures that included $68 million for the purchase of ocean transportation-related assets, $34 million for real estate leasing and property improvements (excluding non-cash 1031 transactions and real estate development activity), and $20 million related to agricultural operations, primarily for the expansion of specialty sugar facilities. The $122 million for 2007 excludes $91 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period.

In 2006, the Company's capital expenditures, excluding purchases of property using tax-deferred proceeds, totaled $281 million. This was comprised principally of $147 million for the purchase of the *MV Maunalei*, which completed the Company's four ship modernization and replacement strategy, equipment purchases for the ocean transportation segment, primarily related to the Company's new China service, $46 million in expenditures related to property development activities, and $15 million related to routine asset replacements for agricultural operations and specialty sugar expansion activities. The cash used for transportation capital expenditures was partially funded by Capital Construction Fund withdrawals. The amounts reported as capital expenditures on the statement of cash flows in 2006 exclude $49 million of tax-deferred purchases since the Company did not actually take control of the cash during the exchange period. Additionally, expenditures for real estate held-for-sale are excluded from capital expenditures and included in Cash Flows from Operating Activities because they are considered an operating activity of the Company.

A company's internal control over financial reporting is a process designed by, or under the supervision of, the company's principal executive and principal financial officers, or persons performing similar functions, and effected by the company's board of directors, management, and other personnel to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of the inherent limitations of internal control over financial reporting, including the possibility of collusion or improper management override of controls, material misstatements due to error or fraud may not be prevented or detected on a timely basis. Also, projections of any evaluation of the effectiveness of the internal control over financial reporting to future periods are subject to the risk that the controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of Alexander & Baldwin Inc. and subsidiaries as of December 31, 2008 and 2007, and the results of their operations and their cash flows for each of the three years in the period ended December 31, 2008, in conformity with accounting principles generally accepted in the United States of America. Also, in our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2008, based on the criteria established in *Internal Control — Integrated Framework* issued by the Committee of Sponsoring Organizations of the Treadway Commission.

As discussed in Note 1 to the consolidated financial statements, the Company adopted the provisions of Financial Accounting Standards Board ("FASB") Interpretation No. 48, *Accounting for Uncertainty in Income Taxes--an interpretation of FASB Statement No. 109* and FASB Staff Position FIN 48-1, *Definition of Settlement in FASB Interpretation No. 48* on January 1, 2007, and as discussed in Note 9, Statement of Financial Accounting Standards No. 158, *Employers' Accounting for Defined Benefit Pension and Other Postretirement Plans--an amendment of FASB Statements No. 87, 88, 106, and 132(R)* on December 31, 2006.

/s/ DELOITTE & TOUCHE LLP

Honolulu, Hawaii
February 27, 2009

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31, 2008	2007	2006
Operating Revenue:			
Ocean transportation	$ **1,021**	$ 1,003	$ 936
Logistics services	**436**	433	444
Real estate leasing	**97**	90	78
Real estate sales	**225**	23	8
Agribusiness	**119**	120	124
Total operating revenue	**1,898**	1,669	1,590
Operating Costs and Expenses:			
Cost of ocean transportation services	**825**	789	754
Cost of logistics services	**381**	381	395
Cost of real estate sales and leasing	**237**	55	38
Cost of agribusiness goods and services	**133**	120	118
Selling, general and administrative	**163**	165	146
Total operating costs and expenses	**1,739**	1,510	1,451
Operating Income	**159**	159	139
Other Income and (Expense):			
Gain on insurance settlement and other	**8**	1	--
Equity in income of real estate affiliates	**9**	23	14
Impairment loss on investment	**(2)**	--	--
Interest income	**1**	3	6
Interest expense	**(24)**	(19)	(15)
Income From Continuing Operations Before Income Taxes	**151**	167	144
Income taxes	**55**	63	54
Income From Continuing Operations	**96**	104	90
Income from discontinued operations, net of income taxes (see Note 2)	**36**	38	32
Net Income	$ **132**	$ 142	$ 122
Basic Earnings per Share of Common Stock:			
Continuing operations	$ **2.32**	$ 2.45	$ 2.08
Discontinued operations	**0.89**	0.89	0.76
Net income	$ **3.21**	$ 3.34	$ 2.84
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ **2.31**	$ 2.42	$ 2.06
Discontinued operations	**0.88**	0.88	0.75

Net income	$ 3.19	$ 3.30	$ 2.81
Weighted Average Number of Shares Outstanding:			
Basic	41.2	42.5	43.2
Diluted	41.5	43.1	43.6

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31,		
	2008	2007	2006
Cash Flow from Operating Activities:			
Net income	$ 132	$ 142	$ 122
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	101	93	85
Deferred income taxes	19	26	40
Gains on disposal of assets, net of impairment losses	(91)	(64)	(49)
Casualty gain from receipt of insurance proceeds	(8)	--	--
Share-based expense	11	17	10
Equity in income of affiliates, net of distributions	11	1	1
Changes in assets and liabilities:			
Accounts and notes receivable	24	(9)	5
Inventories	(6)	(3)	(1)
Prepaid expenses and other assets	3	12	(35)
Deferred dry-docking costs	(9)	(22)	(6)
Liability for employee benefit plans	(3)	(3)	6
Accounts and income taxes payable	(37)	19	(28)
Other liabilities	(17)	14	21
Real Estate Developments Held for Sale:			
Real estate inventory sales	184	11	4
Expenditures for real estate inventory	(39)	(110)	(69)
Net cash provided by operations	275	124	106
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	(109)	(122)	(281)
Proceeds from disposal of income-producing property, investments and other assets	19	18	61
Proceeds from insurance settlement related to 2005 casualty loss	8	--	--
Deposits into Capital Construction Fund	(7)	(30)	(66)
Withdrawals from Capital Construction Fund	8	30	159
Acquisition of businesses, net of cash acquired	(27)	--	--
Payments for purchases of investments	(60)	(43)	(40)
Proceeds from sale and maturity of investments	19	2	43
Net cash used in investing activities	(149)	(145)	(124)
Cash Flows from Financing Activities:			
Proceeds from issuance of long-term debt	127	139	217
Payments of long-term debt and deferred financing costs	(138)	(88)	(102)
Proceeds from (payments on) short-term borrowings, net	(5)	15	--
Repurchases of capital stock	(59)	(33)	(72)
Proceeds from issuance of capital stock, including excess tax benefit	2	8	5
Dividends paid	(51)	(48)	(42)
Net cash provided by (used in) financing activities	(124)	(7)	6
Cash and Cash Equivalents:			
Net increase (decrease) for the year	2	(28)	(12)
Balance, beginning of year	17	45	57
Balance, end of year	$ 19	$ 17	$ 45
Other Cash Flow Information:			
Interest paid	$ (25)	$ (25)	$ (20)
Income taxes paid	$ (63)	$ (55)	$ (49)
Non-cash Activities:			
Debt assumed in real estate purchase	$ 11	$ --	$ --
Tax-deferred property sales	$ 112	$ 83	$ 60
Tax-deferred property purchases	$ (46)	$ (91)	$ (49)

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2008	2007
ASSETS		
Current Assets		
Cash and cash equivalents	$ 19	$ 17
Accounts and notes receivable, less allowances of $8 for 2008 and $12 for 2007	163	185
Inventories	28	21
Real estate held for sale	20	150
Deferred income taxes	--	11
Section 1031 exchange proceeds	23	--
Prepaid expenses and other assets	31	37
Accrued withdrawal (deposit), net to Capital Construction Fund	--	--
Total current assets	284	421
Investments in Affiliates	208	184
Real Estate Developments	78	99
Property – net	1,590	1,582
Employee Benefit Plan Assets	3	80
Other Assets	187	113
Total	$ 2,350	$ 2,479
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	$ 52	$ 57
Accounts payable	105	156
Payroll and vacation benefits	18	19
Uninsured claims	10	12
Deferred income taxes	1	--
Accrued and other liabilities	52	78
Total current liabilities	238	322
Long-term Liabilities		
Long-term debt	452	452
Deferred income taxes	414	468
Employee benefit plans	122	50
Uninsured claims and other liabilities	52	57
Total long-term liabilities	1,040	1,027
Commitments and Contingencies (Note 12)		
Shareholders' Equity		
Capital stock – common stock without par value; authorized, 150 million shares ($0.75 stated value per share); outstanding, 41.0 million shares in 2008 and 42.4 million shares in 2007	33	34
Additional capital	204	200
Accumulated other comprehensive loss	(96)	(4)
Retained earnings	942	911
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,072	1,130
Total	$ 2,350	$ 2,479

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF SHAREHOLDERS' EQUITY
For the three years ended December 31, 2008
(In millions, except per-share amounts)

	Capital Stock Issued		In Treasury			Accumulated Other			
	Shares	Stated Value	Shares	Cost	Additional Capital	Comprehensive Loss	Deferred Compensation	Retained Earnings	Total
Balance, December 31, 2005	47.6	$ 36	3.6	$ (11)	$ 175	$ (7)	$ (6)	$ 827	$ 1,014
Net income and other									

comprehensive income	—	—	—	—	—	—	—	122	122
Shares repurchased	(1.7)	(1)	—	—	(7)	—	—	(64)	(72)
Stock options exercised - net	0.1	—	—	—	5	—	—	—	5
Shares issued – incentive plan	0.2	—	—	—	2	—	—	—	2
Share-based compensation	—	—	—	—	10	—	—	—	10
Adjustment to initially adopt SFAS No. 123R	—	—	—	—	(6)	—	6	—	—
Adjustment to initially adopt SFAS No. 158, net of tax	—	—	—	—	—	(12)	—	—	(12)
Dividends ($0.975 per share)	—	—	—	—	—	—	—	(42)	(42)
Balance, December 31, 2006	**46.2**	**35**	**3.6**	**(11)**	**179**	(19)	—	**843**	**1,027**
Net income	—	—	—	—	—	—	—	142	142
Other comprehensive income, net of tax:									
Defined benefit plans:									
Net gain (loss)	—	—	—	—	—	14	—	—	14
Less: Amortization of net (gain) loss	—	—	—	—	—	1	—	—	1
Total comprehensive income									157
Shares repurchased	(0.7)	(1)	—	—	(4)	—	—	(28)	(33)
Shares issued	0.5	—	—	—	8	—	—	—	8
Share-based compensation	—	—	—	—	17	—	—	—	17
Adjustment to initially adopt FIN 48	—	—	—	—	—	—	—	2	2
Dividends ($1.12 per share)	—	—	—	—	—	—	—	(48)	(48)
Balance, December 31, 2007	**46.0**	**34**	**3.6**	**(11)**	**200**	**(4)**	—	**911**	**1,130**
Net income	—	—	—	—	—	—	—	**132**	**132**
Other comprehensive income, net of tax:									
Defined benefit plans:									
Net loss/prior service cost	—	—	—	—	—	(93)	—	—	(93)
Less: Amortization of net loss/prior service cost	—	—	—	—	—	**1**	—	—	**1**
Total comprehensive income									**40**
Shares repurchased	**(1.4)**	**(1)**	—	—	**(8)**	—	—	**(50)**	**(59)**
Shares issued	—	—	—	—	**1**	—	—	—	**1**
Share-based compensation	—	—	—	—	**11**	—	—	—	**11**
Dividends ($1.23 per share)	—	—	—	—	—	—	—	(51)	(51)
Balance, December 31, 2008	**44.6**	**$ 33**	**3.6**	**$ (11)**	**$ 204**	**$ (96)**	**$ —**	**$ 942**	**$ 1,072**

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Description of Business: Founded in 1870, Alexander & Baldwin, Inc. ("A&B" or the "Company") is incorporated under the laws of the State of Hawaii. A&B operates in five segments in three industries: Transportation, Real Estate and Agribusiness. These industries are described below:

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment, which is conducted through Matson Navigation Company, Inc. ("Matson"), a wholly-owned subsidiary of A&B, is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity (SSA Terminals, LLC or "SSAT") that provides terminal and stevedoring services at U.S. Pacific Coast facilities. The Logistics Services segment is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services and warehousing and distribution services (collectively "Highway").

Real Estate: The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. Mainland. The Real Estate Sales segment generates its revenues through the development and sale of land, and commercial and residential properties. The Real Estate Leasing segment owns, operates and manages retail, office and industrial properties.

Agribusiness: Agribusiness, which contains one segment, produces bulk raw sugar, specialty food-grade sugars, and molasses; produces, markets, and distributes roasted coffee and green coffee; provides general trucking services, mobile equipment maintenance and repair services, and self-service storage in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

Principles of Consolidation: The consolidated financial statements include the accounts of Alexander & Baldwin, Inc. and all wholly-owned and controlled subsidiaries, after elimination of significant intercompany amounts. Significant investments in businesses, partnerships, and limited liability companies in which the Company does not have a controlling financial interest, but has the ability to exercise significant influence, are accounted for under the equity method. A controlling financial interest is one in which the Company has a majority voting interest or one in which the Company is the primary beneficiary that absorbs the majority of the expected losses, or receives a majority of the expected residual returns, or both, of a variable interest entity as defined in FASB Interpretation No. 46 (revised December 2003), *Consolidation of Variable Interest Entities* ("FIN 46R"), as amended.

referred to by the District Court as the Seabulk Trader case. Such case was decided in favor of the plaintiffs by another judge in the same District Court and is reported at 551 F.Supp. 2d 447. While the Seabulk Trader case involves certain issues similar in nature to the Mokihana case, the Company believes the two cases are distinguishable in various respects. A decision in the Seabulk Trader case is expected in 2009. Matson has filed an amicus brief in the support of the Coast Guard's decision in that case. The Company is unable to predict, at this time, the outcome of the appeal in the Seabulk Trader case or the possible effect of such outcome on the Mokihana case. The Company also is unable to predict, at this time, the outcome or financial impact, if any, of the Mokihana case.

In a separate but related matter, the same plaintiffs asked the United States Department of Transportation Maritime Administration ("Marad") to investigate the continued eligibility of nine of Matson's vessels, including Mokihana, to participate in the Capital Construction Fund ("CCF") and cargo preference programs as a result of modifications performed, or to be performed, in foreign shipyards. Marad issued an Opinion and Order on March 18, 2008, stating that it would be guided by prior Coast Guard rulings with respect to CCF, that all Matson vessels would retain their CCF eligibility unless the court reversed the Coast Guard's final determination with respect to Mokihana, and that all vessels would retain their cargo preference eligibility but requested further information on Mokihana and Lurline. On December 9, 2008, after reviewing information provided by Matson, Marad issued a Final Opinion and Order ordering that Lurline and Mokihana be excluded from preference for carriage of government civilian cargo, pursuant to 46 U.S.C. 55305, for three years. Matson has filed a request for reconsideration with Marad. The decision has no immediate financial effect because these vessels are currently deployed in the Hawaii trade and do not carry civilian preference cargo.

In another separate but related matter, the Coast Guard Marine Safety Center informed Matson on December 24, 2008 that the same plaintiffs had requested reconsideration of the Coast Guard's June 2006 Mokihana major conversion determination. The Coast Guard had earlier ruled that the work to be performed on Mokihana in the foreign and U.S. shipyards was minor and, therefore, would not necessitate certain safety and maintenance upgrades. The Coast Guard has asked the Shipbuilders Council and Pasha to respond to issues as to their standing to request reconsideration and the timeliness of the request. Matson believes that the Coast Guard's determination was correct and will submit comments supporting it. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this matter.

On April 21, 2008, Matson was served with a grand jury subpoena from the U.S. District Court for the Middle District of Florida for documents and information relating to water carriage in connection with the Department of Justice's investigation into the pricing and other competitive practices of carriers operating in the domestic trades. Matson understands that while the investigation currently is focused on the Puerto Rico trade, it also includes pricing and other competitive practices in connection with all domestic trades, including the Alaska, Hawaii and Guam trades. Matson does not operate vessels in the Puerto Rico and Alaska trades. It does operate vessels in the Hawaii and Guam trades. Matson has cooperated, and will continue to cooperate, fully with the Department of Justice. If the Department of Justice believes that any violations have occurred on the part of Matson or the Company, it could seek civil or criminal sanctions, including monetary fines. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this investigation.

The Company and Matson have been named as defendants in civil lawsuits purporting to be class actions alleging violations of the antitrust laws and seeking treble damages and injunctive relief. As of January 8, 2009, the Company was aware of 26 such lawsuits. All of the lawsuits have been or will be transferred and consolidated into a consolidated civil lawsuit in the U.S. District Court for the Western District of Washington in Seattle purporting to be a class action. Another domestic shipping carrier operating in the Hawaii and Guam trades, Horizon Lines, Inc., has also been named as a defendant in the consolidated civil lawsuit. The plaintiffs filed a consolidated class action complaint on February 2, 2009. The Company and Matson intend to file a motion to dismiss the complaint by March 2009. The Company and Matson will vigorously defend themselves in this lawsuit. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this lawsuit.

In June 2006, Matson and its Long Beach terminal operator, SSAT LLC, completed negotiations of an amendment to the Preferential Assignment Agreement with the City of Long Beach that includes changes requested by Matson to implement its new China Service as well as environmental covenants applicable to vessels which call at Pier C. The environmental requirements are part of programs proposed by both the ports of Los Angeles and Long Beach designed to reduce airborne emissions in the port area. Under the amendment, Matson is required to install equipment on all its motor vessels to allow them to accept a shore-based electrical power source instead of using the vessel's diesel generators while in port ("cold ironing") and to phase out calls by its steamships by 2020. In December 2008, the Office of Administrative Law approved regulations put forth by the California Air Resources Board ("CARB") which mandate cold ironing of diesel powered container ships at major ports starting in 2014. The CARB regulations put the responsibility for shoreside electrical infrastructure on the terminal operator. Our lease agreement commits the Port of Long Beach to providing the shoreside infrastructure and construction is scheduled to begin in 2009. However, the Port of Oakland has not yet made a commitment to provide the required infrastructure at the Company's Oakland terminal and therefore, SSAT may be held responsible for this cost. The cost of the required infrastructure improvements has not been estimated. The modifications to Matson's vessels to accommodate cold ironing will occur at each of their next scheduled out-of-water drydockings. One vessel commenced retrofitting in 2008 and another is scheduled for 2009. The estimated costs of the modifications are projected at $13.7 million for the eight motor vessels including design and engineering costs, and the cost for vessel stepdown transformers to accommodate the power provided at the dock. As of December 31, 2008, approximately $1.8 million has been incurred. The costs of the modifications have been recorded as capital assets because they provide future economic benefits.

The Company and certain subsidiaries are parties to other various legal actions and are contingently liable in connection with claims and contracts arising in the normal course of business, the outcome of which, in the opinion of management after consultation with legal counsel, will not have a material adverse effect on the Company's financial position or results of operations.

13. INDUSTRY SEGMENTS

Operating segments are components of an enterprise that engage in business activities from which it may earn revenues and incur expenses, whose operating results are regularly reviewed by the chief operating decision maker to make decisions about resources to be allocated to the segment and assess its performance, and for which discrete financial information is available. The Company's chief operating decision maker is its Chief Executive Officer. Based on the foregoing, the Company has five segments that operate in three industries: Transportation, Real Estate and Agribusiness.

The Transportation Industry consists of two segments. Ocean Transportation carries freight between various U.S. Pacific Coast, major Hawaii ports, Guam, China and other Pacific ports and provides terminal, stevedoring and container equipment management services in Hawaii. Logistics Services arranges domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited freight services, and warehousing and distribution services.

The Real Estate Industry consists of two segments. The Real Estate Sales segment generates its revenues through the development and sale of land, commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. When property that was previously leased is sold, the revenue and operating profit are included with the Real Estate Sales segment.

Agribusiness, which consists of one segment, grows sugar cane and coffee; produces bulk raw sugar, specialty food-grade sugars, and molasses; produces, markets, and distributes roasted coffee and green coffee; provides general trucking services, mobile equipment maintenance and repair services, and self-service storage in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

The accounting policies of the operating segments are described in the summary of significant accounting policies. Reportable segments are measured based on operating profit, exclusive of non-operating or unusual transactions, interest expense, general corporate expenses, and income taxes.

INDUSTRY SEGMENTS (CONTINUED)

Industry segment information for each of the three years ended December 31, 2008 is summarized below (in millions):

For the Year	2008	2007	2006
Revenue:			
Transportation:			
Ocean transportation	$ 1,023.7	$ 1,006.9	$ 945.8
Logistics services	436.0	433.5	444.2
Real Estate:			
Leasing	107.8	108.5	100.6
Sales	350.2	117.8	97.3
Less amounts reported in discontinued operations [1]	(133.0)	(112.0)	(111.7)
Agribusiness	124.3	123.7	127.4
Reconciling Items [2]	(10.7)	(9.2)	(14.2)
Total revenue	$ 1,898.3	$ 1,669.2	$ 1,589.4
Operating Profit:			
Transportation:			
Ocean transportation[3]	$ 105.8	$ 126.5	$ 105.6
Logistics services	18.5	21.8	20.8
Real Estate:			
Leasing	47.8	51.6	50.3
Sales[3]	95.6	74.4	49.7
Less amounts reported in discontinued operations [1]	(59.1)	(61.0)	(52.3)
Agribusiness	(12.9)	0.2	6.9
Total operating profit	195.7	213.5	181.0
Interest expense, net[4]	(23.7)	(18.8)	(15.0)
General corporate expenses	(21.0)	(27.3)	(22.3)
Income from continuing operations before income taxes	151.0	167.4	143.7
Income taxes	(55.1)	(63.2)	(53.7)
Income from continuing operations	95.9	104.2	90.0
Discontinued operations	36.5	38.0	32.5
Net income	$ 132.4	$ 142.2	$ 122.5

1 Prior year amounts restated for amounts treated as discontinued operations. See Notes 1 and 2 for additional information.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

3 The Ocean Transportation segment includes approximately $5.2 million, $10.7 million, and $13.3 million of equity in earnings from its investment in SSAT for 2008, 2007, and 2006, respectively. The Real Estate Sales segment includes approximately $9.0 million, $22.6 million, and $14.4 million in equity in earnings from its various real estate joint ventures for 2008, 2007, and 2006, respectively.

4 Includes Ocean Transportation interest expense of $11.6 million for 2008, $13.9 million for 2007, and $13.3 million for 2006. Substantially all other interest expense was at the parent company.

INDUSTRY SEGMENTS (CONTINUED)

	2008	2007	2006
Identifiable Assets:			
Ocean transportation[5]	$ 1,153.9	$ 1,215.0	$ 1,185.3
Logistics services	74.2	58.6	56.4
Real estate leasing	590.2	595.4	525.5
Real estate sales[5]	344.6	408.9	295.0
Agribusiness	172.2	174.6	168.7
Other	15.1	26.6	20.3
Total assets	$ 2,350.2	$ 2,479.1	$ 2,251.2
Capital Expenditures:			
Ocean transportation	$ 35.5	$ 65.8	$ 217.1
Logistics services[6]	2.4	2.0	1.7
Real estate leasing[7]	100.2	124.5	93.0
Real estate sales[8]	0.6	0.3	1.3
Agribusiness	15.2	20.5	15.0
Other	0.8	0.3	1.5
Total capital expenditures	$ 154.7	$ 213.4	$ 329.6
Depreciation and Amortization:			
Ocean transportation	$ 66.1	$ 63.2	$ 58.1
Logistics services	2.3	1.5	1.5
Real estate leasing[1]	17.9	15.7	14.1
Real estate sales	0.2	0.2	0.1
Agribusiness	11.5	10.7	10.1
Other	2.7	1.3	0.9

Total depreciation and amortization	$ 100.7	$ 92.6	$ 84.8

5 The Ocean Transportation segment includes approximately $44.6 million, $48.6 million, and $49.8 million related to its investment in SSAT as of December 31, 2008, 2007, and 2006, respectively. The Real Estate Sales segment includes approximately $162.1 million, $134.1 million, and $98.4 million related to its investment in various real estate joint ventures as of December 31, 2008, 2007, and 2006, respectively.

6 Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

7 Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

8 Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $39 million, $110 million, and $69 million, for 2008, 2007, and 2006, respectively.

14. QUARTERLY INFORMATION (Unaudited)

Segment results by quarter for 2008 are listed below (in millions, except per-share amounts):

	2008			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 243.0	$ 268.4	$ 272.8	$ 239.5
Logistics services	102.6	115.5	118.1	99.8
Real Estate:				
Leasing	28.8	27.3	26.2	25.5
Sales	187.4	31.2	77.2	54.4
Less amounts reported in discontinued operations [1]	(3.8)	(14.5)	(71.0)	(43.7)
Agribusiness	22.5	36.2	37.5	28.1
Reconciling Items [2]	(1.5)	(2.6)	(3.0)	(3.6)
Total revenue	$ 579.0	$ 461.5	$ 457.8	$ 400.0
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 15.9	$ 37.4	$ 31.4	$ 21.1
Logistics services	4.7	4.6	5.1	4.1
Real Estate:				
Leasing	13.9	12.6	11.1	10.2
Sales	41.4	9.1	25.8	19.3
Less amounts reported in discontinued operations [1]	(2.1)	(8.3)	(27.7)	(21.0)
Agribusiness	4.8	(4.9)	(6.7)	(6.1)
Total operating profit	78.6	50.5	39.0	27.6
Interest Expense	(6.1)	(5.6)	(5.8)	(6.2)
General Corporate Expenses	(5.7)	(5.4)	(5.3)	(4.6)
Income From Continuing Operations before Income Taxes	66.8	39.5	27.9	16.8
Income taxes	(26.1)	(15.0)	(8.1)	(5.9)
Income From Continuing Operations	40.7	24.5	19.8	10.9
Discontinued Operations [1]	1.4	5.1	17.0	13.0
Net Income	$ 42.1	$ 29.6	$ 36.8	$ 23.9
Earnings Per Share:				
Basic	$ 1.02	$ 0.72	$ 0.89	$ 0.58
Diluted	$ 1.01	$ 0.71	$ 0.89	$ 0.58

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

Segment results by quarter for 2007 are listed below (in millions, except per-share amounts):

	2007			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 231.6	$ 253.1	$ 259.9	$ 262.3
Logistics services	102.9	112.4	110.4	107.8
Real Estate:				
Leasing	28.8	26.4	26.3	27.0
Sales	6.5	0.4	78.5	32.4
Less amounts reported in discontinued operations [1]	(4.9)	(4.7)	(78.2)	(24.2)
Agribusiness	17.2	38.5	37.3	30.7
Reconciling Items [2]	(2.0)	(1.8)	(2.4)	(3.0)

Total revenue	$ 380.1	$ 424.3	$ 431.8	$ 433.0
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 18.8	$ 39.1	$ 38.5	$ 30.1
Logistics services	5.6	5.5	6.0	4.7
Real Estate:				
Leasing	15.0	12.3	12.2	12.1
Sales	8.8	4.5	37.9	23.2
Less amounts reported in discontinued operations [1]	(3.0)	(2.9)	(37.7)	(17.4)
Agribusiness	3.6	0.5	(3.2)	(0.7)
Total operating profit	48.8	59.0	53.7	52.0
Interest Expense	(4.3)	(4.1)	(4.8)	(5.6)
General Corporate Expenses	(6.9)	(6.6)	(6.0)	(7.8)
Income From Continuing Operations before Income Taxes	37.6	48.3	42.9	38.6
Income taxes	(14.8)	(18.1)	(17.3)	(13.0)
Income From Continuing Operations	22.8	30.2	25.6	25.6
Discontinued Operations [1]	1.9	1.8	23.5	10.8
Net Income	$ 24.7	$ 32.0	$ 49.1	$ 36.4
Earnings Per Share:				
Basic	$ 0.58	$ 0.75	$ 1.15	$ 0.86
Diluted	$ 0.58	$ 0.74	$ 1.14	$ 0.85

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

15. PARENT COMPANY CONDENSED FINANCIAL INFORMATION

Set forth below are the unconsolidated condensed financial statements of Alexander & Baldwin, Inc. ("Parent Company"). The significant accounting policies used in preparing these financial statements are substantially the same as those used in the preparation of the consolidated financial statements as described in Note 1, except that, for purposes of the tables presented in this footnote, subsidiaries are carried under the equity method.

The following table presents the Parent Company's condensed Balance Sheets as of December 31, 2008 and 2007 (in millions):

	2008	2007
ASSETS		
Current Assets:		
Cash and cash equivalents	$ –	$ 3
Accounts and notes receivable, net	3	3
Income tax receivable	24	–
Section 1031 exchange proceeds	23	--
Prepaid expenses and other	23	19
Total current assets	73	25
Investments:		
Subsidiaries consolidated, at equity	1,131	1,097
Property, at Cost	432	451
Less accumulated depreciation and amortization	219	212
Property -- net	213	239
Due from Subsidiaries	–	87
Other Assets	43	47
Total	$ 1,460	$ 1,495
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 28	$ 32
Accounts payable	8	5
Income taxes payable	–	10
Non-qualified benefit plans	4	4
Other	12	15
Total current liabilities	52	66
Long-term Debt	200	212
Employee benefit plans	49	8
Non-qualified benefit plans	17	16
Other Long-term Liabilities	6	7
Deferred Income Taxes	30	56
Due to Subsidiaries	34	–
Commitments and Contingencies		
Shareholders' Equity:		
Capital stock	33	34
Additional capital	204	200
Accumulated other comprehensive loss	(96)	(4)
Retained earnings	942	911

Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,072	1,130
Total	$ 1,460	$ 1,495

The following table presents the Parent Company's condensed Statements of Income for the years ended December 31, 2008, 2007 and 2006 (in millions):

	2008	2007	2006
Revenue:			
Agribusiness	$ 91	$ 92	$ 97
Real estate leasing	23	22	20
Real estate sales	6	6	1
Interest and other	3	8	9
Total revenue	123	128	127
Costs and Expenses:			
Cost of agribusiness goods and services	110	97	96
Cost of real estate sales and leasing	12	12	9
Selling, general and administrative	21	28	24
Interest and other	14	12	7
Income taxes	(14)	(7)	--
Total costs and expenses	143	142	136
Loss from Continuing Operations	(20)	(14)	(9)
Discontinued Operations, net of income taxes	16	2	11
Income (Loss) Before Equity in Income of Subsidiaries Consolidated	(4)	(12)	3
Equity in Income from Continuing Operations of Subsidiaries Consolidated	115	118	99
Equity in Income from Discontinued Operations of Subsidiaries Consolidated	21	36	21
Net Income	132	142	122
Other Comprehensive Income (Loss), net of income taxes	(91)	15	--
Comprehensive Income	$ 41	$ 157	$ 122

The following table presents the Parent Company's condensed Statements of Cash Flows for the years ended December 31, 2008, 2007 and 2006 (in millions):

	2008	2007	2006
Cash Flows from Operations (including dividends received from subsidiaries)	$ 144	$ 17	$ 65
Cash Flows from Investing Activities:			
Capital expenditures	(16)	(18)	(35)
Purchase of investments	(12)	--	--
Proceeds from disposal of property and sale of investments	9	5	22
Net cash used by investing activities	(19)	(13)	(13)
Cash Flows from Financing Activities:			
Change in intercompany payables/receivables	(4)	(15)	(6)
Proceeds from (repayments of) long-term debt, net	(16)	85	58
Proceeds from issuance of capital stock, including tax benefit	2	8	5
Repurchases of capital stock	(59)	(33)	(72)
Dividends paid	(51)	(48)	(42)
Net cash used in financing activities	(128)	(3)	(57)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	(3)	1	(5)
Balance, beginning of year	3	2	7
Balance, end of year	$ --	$ 3	$ 2
Other Cash Flow Information:			
Interest paid	$ (13)	$ (12)	$ (7)
Income taxes paid, net of refunds	$ (63)	$ (55)	$ (49)
Other Non-cash Information:			
Depreciation expense	$ 15	$ 15	$ 13
Tax-deferred property sales	$ 60	$ --	$ 13
Tax-deferred property purchases	$ (5)	$ --	$ (13)

General Information: The Parent Company is headquartered in Honolulu, Hawaii and is engaged in the operations that are generally described in Note 13, "Industry Segments." Additional information related to the Parent Company is described in the foregoing notes to the consolidated financial statements.

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2009

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _______ to _______

Commission file number 000-00565

ALEXANDER & BALDWIN, INC.

(Exact name of registrant as specified in its charter)

Hawaii (State or other jurisdiction of incorporation or organization)	**99-0032630** (I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	**NYSE**

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 11, 2010:
41,071,571

Aggregate market value of Common Stock held by non-affiliates at June 30, 2009:
$937,803,905

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically and posted on its corporate Web site, if any, every Interactive Data File required to be submitted and posted pursuant to Rule 405 of Regulation S-T during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). Yes ☐ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☐

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒ Accelerated filer ☐

Exhibit E-R3

Non-accelerated filer ☐ (Do not check if a smaller reporting company) Smaller reporting company ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement dated March 11, 2010 (Part III of Form 10-K)

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ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2009

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Alexander & Baldwin, Inc. ("A&B") is a multi-industry corporation with its primary operations centered in Hawaii. It was founded in 1870 and incorporated in 1900. Ocean transportation operations, related shoreside operations in Hawaii, and intermodal, truck brokerage and logistics services are conducted by a wholly-owned subsidiary, Matson Navigation Company, Inc. ("Matson"), and two Matson subsidiaries. Property development and agribusiness operations are conducted by A&B and certain other subsidiaries of A&B.

The business industries of A&B are generally as follows:

A. *Transportation* - carrying freight, primarily between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports; arranging domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services; and providing terminal, stevedoring and container equipment maintenance services in Hawaii.

B. *Real Estate* - engaging in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property.

C. *Agribusiness* - growing sugar cane and coffee in Hawaii; producing bulk raw sugar, specialty food-grade sugars, molasses, green coffee and roasted coffee; marketing and distributing green coffee, roasted coffee and specialty food-grade sugars; generating and selling, to the extent not used in A&B's operations, electricity; and providing general trucking services in Hawaii, including sugar and molasses hauling, and mobile equipment maintenance and repair services.

For information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2009, see Note 13 ("Industry Segments") to A&B's financial statements in Item 8 of Part II below.

DESCRIPTION OF BUSINESS AND PROPERTIES

A. Transportation

(1) Freight Services

Matson's Hawaii Service offers containership freight services between the ports of Long Beach, Oakland, Seattle, and the major ports in Hawaii on the islands of Oahu, Kauai, Maui and Hawaii. Roll-on/roll-off service is provided between California and the major ports in Hawaii. Matson is the principal carrier of ocean cargo between the U.S. Pacific Coast and Hawaii. Principal westbound cargoes carried by Matson to Hawaii include dry containers of mixed commodities, refrigerated commodities, building materials, packaged foods, household goods and automobiles. Principal eastbound cargoes carried by Matson from Hawaii include automobiles, household goods, refrigerated containers of fresh pineapple, livestock and dry containers of mixed commodities. The majority of Matson's Hawaii Service revenue is derived from the westbound carriage of containerized freight and automobiles.

Matson's Guam Service provides weekly containership freight services between the U.S. Pacific Coast and Guam. Additional freight destined to and from the Commonwealth of the Marianas Islands, the Republic of Palau and the island of Yap in the Federated States of Micronesia is transferred at Guam to and from connecting carriers for delivery to and from those locations.

Matson's Micronesia Service offers container and conventional freight service between the U.S. Pacific Coast and the islands of Kwajalein, Ebeye and Majuro in the Republic of the Marshall Islands and the islands of Pohnpei, Chuuk and Kosrae in the Federated States of Micronesia. Cargo is transferred at Guam to a Matson-operated ship that provides consistent, reliable bi-weekly service to and from those islands. Matson also carries cargo originating in Asia to these islands by receiving cargo transferred from other carriers in Guam.

Matson's China Service is part of an integrated Hawaii/Guam/China service. This service employs five Matson containerships in a weekly service that carries cargo from the U.S. Pacific Coast to Honolulu, then to Guam. The vessels continue to China, where they are loaded with cargo to be discharged in Long Beach. These ships also carry cargo destined to and originating from Guam, the Commonwealth of Northern Marianas, the Republic of Palau and the Republic of the Marshall Islands.

See "Rate Regulation" below for a discussion of Matson's freight rates.

(2) Vessels

Matson's fleet consists of 10 containerships, excluding one containership time-chartered from a third party that serves Micronesia; three combination container/roll-on/roll-off ships; one roll-on/roll-off barge and two container barges equipped with cranes that serve the neighbor islands of Hawaii; and one container barge equipped with cranes that is available for charter. The 17 Matson-owned vessels in the fleet represent an investment of approximately \$1.2 billion expended over the past 30 years. The majority of vessels in the Matson fleet have been acquired with the assistance of withdrawals from a Capital Construction Fund ("CCF") established under Section 607 of the Merchant Marine Act, 1936, as amended.

As of year-end 2009, A&B's mainland portfolio included 7.0 million square feet of leasable area, as follows:

Property	Location	Type	Leasable Area (sq. ft.)
Heritage Business Park	Dallas, TX	Industrial	1,316,400
Savannah Logistics Park	Savannah, GA	Industrial	1,035,700
Ontario Distribution Center	Ontario, CA	Industrial	898,400
Midstate 99 Distribution Center	Visalia, CA	Industrial	790,400
Sparks Business Center	Sparks, NV	Industrial	396,100
Republic Distribution Center	Pasadena, TX	Industrial	312,500
Activity Distribution Center	San Diego, CA	Industrial	252,300
Centennial Plaza	Salt Lake City, UT	Industrial	244,000
Valley Freeway Corporate Park	Kent, WA	Industrial	228,200
1800 and 1820 Preston Park	Plano, TX	Office	198,600
Ninigret Office Park X and XI	Salt Lake City, UT	Office	185,200
San Pedro Plaza	San Antonio, TX	Office/Retail	171,900
2868 Prospect Park	Sacramento, CA	Office	162,900
Concorde Commerce Center	Phoenix, AZ	Office	140,700
Arbor Park Shopping Center	San Antonio, TX	Retail	139,500
Deer Valley Financial Center	Phoenix, AZ	Office	126,600
Northpoint Properties	Fullerton, CA	Industrial	119,400
Broadlands Marketplace	Broomfield, CO	Retail	103,900
2890 Gateway Oaks	Sacramento, CA	Office	58,700
Wilshire Center	Greeley, CO	Retail	46,500
Royal MacArthur Center	Dallas, TX	Retail	44,000
Firestone Avenue Building	La Mirada, CA	Office	28,100

A&B's mainland commercial properties' occupancy rate decreased to 85 percent in 2009, compared to 95 percent in 2008, reflecting the difficult leasing environment in certain mainland markets as well as the placement of Savannah Logistics Park Building B into service in March 2009.

A&B's mainland joint venture commercial developments are summarized below:

(i) *Crossroads Plaza.* In June 2004, A&B entered into a joint venture with Intertex Hasley, LLC, for the development of a 56,000-square-foot mixed-use neighborhood retail center on 6.5 acres in Valencia, California. The property was acquired in August 2004. The sale of a pad site building closed in 2007, and construction of the center was completed in 2008. The property was 85 percent occupied as of year-end 2009.

(ii) *Centre Pointe Marketplace.* In April 2005, A&B entered into a joint venture with Intertex Centre Pointe Marketplace, LLC for the development of a 105,700-square-foot retail center on a 10.2-acre parcel in Valencia, California. The sale of several pad site buildings closed in 2007. Vertical construction was substantially completed in 2008, with five of seven buildings closed in 2008, one building closed in 2009, and the remaining building expected to be sold in 2010.

(iii) *Bridgeport Marketplace.* In July 2005, A&B entered into a joint venture with Intertex Bridgeport Marketplace, LLC for the development of a 27.8-acre parcel in Valencia, California. The parcel was subdivided into a 5-acre parcel for a public park, a 7.3-acre parcel sold to a church in 2007, and a 15.5-acre parcel for the development of a 127,000-square-foot retail center. Construction of the center was completed in 2009 and is 95 percent leased.

(iv) *Bakersfield.* In November 2006, A&B entered into a joint venture with Intertex P&G Retail, LLC, for the planned development of a 575,000-square-foot retail center on a 57.3-acre commercial parcel in Bakersfield, California. The parcel was acquired in November 2006. Development plans remain on hold due to current economic conditions.

(v) *Palmdale Trade & Commerce Center.* In December 2007, A&B entered into a joint venture with Intertex Palmdale Trade & Commerce Center LLC, for the planned development of a 315,000-square-foot mixed-use commercial office and light industrial condominium complex on 18.2 acres in Palmdale, California, located 60 miles northeast of Los Angeles and 25 miles northeast of Valencia. The parcel was contributed to the venture in 2008. Development plans remain on hold due to current market conditions.

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870, and the production of coffee in Hawaii since 1987. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) a coffee plantation on the island of Kauai, operated by its Kauai Coffee Company, Inc. ("Kauai Coffee") subsidiary, and (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide several types of trucking services, including sugar and molasses hauling on Maui, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai.

HC&S is Hawaii's largest producer of raw sugar, producing approximately 126,800 tons of raw sugar in 2009, or about 72 percent of the raw sugar produced in Hawaii for the year (compared with 145,200 tons, or about 75 percent, in 2008). The primary reason for the decline in sugar production was the unprecedented drought conditions affecting the island of Maui in 2007 and 2008. In 2008, HC&S had the lowest East Maui water deliveries on record since

A&B first began recording deliveries in 1925, and 2007-2008 marked two consecutive years of the lowest rainfall recorded. The two-year crop harvested in 2009 suffered from lack of water throughout its lifecycle, which significantly reduced crop yields. HC&S harvested 15,028 acres of sugar cane in 2009 (compared with 16,961 in 2008). This reduction in harvest acres was designed to improve future-year yields by increasing the average age of the crop. Yields averaged 8.4 tons of sugar per acre in 2009 (compared with 8.6 in 2008). As a by-product of sugar production, HC&S also produced approximately 41,700 tons of molasses in 2009 (compared with 52,200 in 2008).

In 2009, approximately 34,300 tons of sugar (compared with 27,500 tons in 2008) were processed by HC&S into specialty food-grade sugars under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. A multi-phase expansion of the production facilities for these sugars was completed in early 2008, with the ramp up of volumes continuing in 2009.

During 2009, Kauai Coffee had approximately 3,000 acres of coffee trees under cultivation. The 2009 harvest yielded approximately 2.6 million pounds of green coffee, compared with 3.0 million pounds in 2008. The preliminary mix of green coffee indicates an average quality distribution for the crop.

HC&S and McBryde Sugar Company, Limited ("McBryde"), a subsidiary of A&B and the parent company of Kauai Coffee, produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels. McBryde produces power solely by hydroelectric generation. The price for the power sold by HC&S and McBryde is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. See "Energy" below for power production and sales data.

(2) Marketing of Sugar and Coffee

Approximately 73 percent of the bulk raw sugar produced by HC&S in 2009 was purchased by C&H Sugar Company, Inc. ("C&H"). C&H processes the raw cane sugar at its refinery at Crockett, California and markets the refined products primarily in the western and central United States.

The remaining 27 percent of the raw sugar was used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" product line.

Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a sugar grower cooperative in Hawaii (of which HC&S currently is the only member), has a supply contract with C&H ending in December 2012. This supply contract, entered into in October 2009, replaced a prior contract that was due to expire on December 31, 2009. Pursuant to the supply contract, the cooperative sells raw sugar to C&H at a price equal to the New York No. 16 Contract settlement price, less a discount and less costs of sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Hawaii sugar growers, including HC&S. Throughout most of 2009, HS&TC consisted of two members, HC&S and the Gay & Robinson plantation on Kauai ("G&R"). In November 2009, G&R ceased operations and its membership in the cooperative ended concurrently. Various implications of G&R's withdrawal from the cooperative are discussed in Item 7 ("Management's Discussion and Analysis of Financial Condition and Results of Operation") of Part II below.

Most of Kauai Coffee's crop is being marketed on the U.S. Mainland as green bean coffee. In addition to the sale of green bean coffee, Kauai Coffee produces and sells roasted, packaged coffee under the Kauai Coffee® trademark. Kauai Coffee's customers include specialty and commodity brokers, hotels, and large regional roasters.

(3) Sugar Competition and Legislation

Hawaii sugar growers have traditionally produced more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the U.S. Mainland market. Hawaiian refined sugar is marketed primarily west of Chicago. This is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current legislation is the Food Conservation and Energy Act of 2008, which expires on December 31, 2012 ("2008 Farm Bill"). The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports from countries other than Canada and Mexico by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount. Also, a new but limited sucrose ethanol program was added in 2008, which allows sugar to be diverted into ethanol when the market is deemed to be oversupplied.

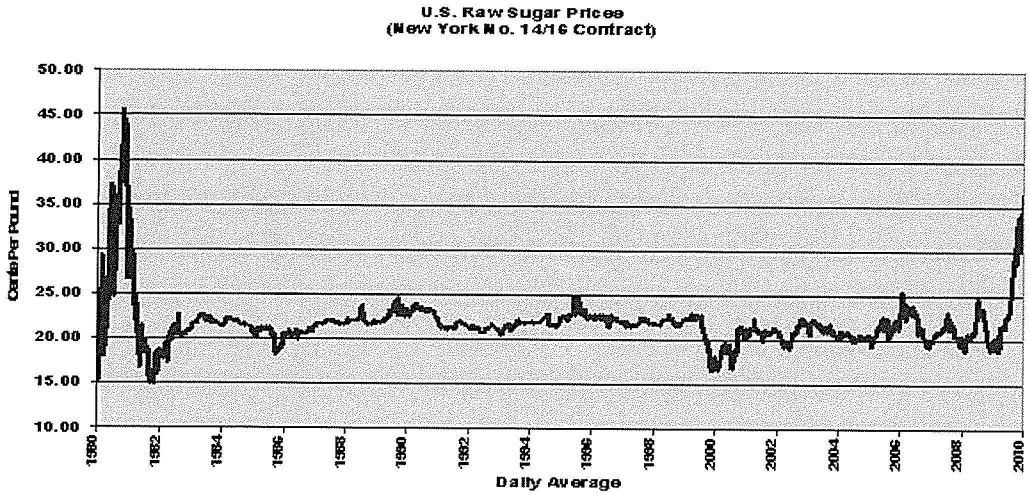
The 2008 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18.25 cents per pound ("c/lb") for raw cane sugar is in effect for the 2009 crop. The loan rate increases to 18.50 c/lb for the 2010 crop and to 18.75 c/lb for the 2012 and 2013 crops (the last year of the bill). The U.S. rates are adjusted by region to reflect the cost of transportation. The 2009 crop loan rate in Hawaii is 15.88 c/lb.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement. In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately or phased out. Starting in 2008, Mexico can ship an unlimited quantity of sugar duty-free to the U.S. each year.

U.S. raw sugar prices remained relatively stable and flat for over thirty years. The full implementation of NAFTA in 2008, which unified the U.S.

and Mexican sugar markets, increased price volatility. In 2009, a tight NAFTA supply/demand outlook and a soaring world raw sugar market combined to push U.S. raw sugar prices to 29-year highs. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 14 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



(4) Coffee Competition and Prices

Kauai Coffee competes with coffee growers located worldwide, including in Hawaii. The market for specialty coffee in the United States is highly competitive. Relative to other Hawaii growers, Kauai Coffee produces a large amount of green coffee beans each year, with its crop divided among specialty, midrange and commodity grades. It has been successful at selling its specialty and midgrade coffees at a premium to world commodity market prices. Kauai Coffee sells its specialty and midgrade green beans primarily to long-term, repeat customers, though there is strong competition and pricing and other terms are subject to annual renegotiations. These grades are also utilized in Kauai Coffee's wholesale and direct retail roasted programs. Kauai Coffee also produces commodity-grade green beans, whose prices are more closely tied to world commodity market prices.

Kauai Coffee's green bean coffee total production volume, volume by grade and unit costs vary each year depending upon growing and harvesting conditions. The unit cost per pound impacts the profitability of green bean sales as well as the cost of goods for Kauai Coffee's wholesale roasted and retail programs.

(5) Land Designations and Water

The HC&S sugar plantation, the largest in Hawaii, consists of approximately 43,300 acres, including a small portion of leased lands. Approximately 34,700 acres are under cultivation, and the balance is leased to third parties, is not suitable for cane cultivation, or is used for plantation purposes such as roads, reservoirs, ditches and plant sites.

On Kauai, approximately 3,000 acres are cultivated by Kauai Coffee.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to fulfill the State constitutional mandate to protect agricultural lands, promote diversified agriculture, increase the State's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. In 2008, the Legislature passed a package of incentives, which is necessary to trigger the IAL system of land designation. In 2009, A&B received approval from the State Land Use Commission for the designation of over 27,000 acres on Maui and over 3,700 acres on Kauai as IAL. These designations were the result of voluntary petitions filed by A&B.

It is crucial for HC&S and Kauai Coffee to have access to reliable sources of water supply and efficient irrigation systems. A&B's plantations conserve water by using "drip" irrigation systems that distribute water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated. All of Kauai Coffee's fields are drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years have supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provides approximately one-sixth of the irrigation water used by HC&S. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

D. Employees and Labor Relations

As of December 31, 2009, A&B and its subsidiaries had approximately 2,110 regular full-time employees. About 924 regular full-time employees were engaged in the agribusiness segment, 1,076 were engaged in the transportation segment, 44 were engaged in the real estate segment, and the remaining were in administration. Approximately 49 percent were covered by collective bargaining agreements with unions.

At December 31, 2009, the active Matson fleet employed seagoing personnel in 196 billets. Each billet corresponds to a position on a ship that typically is filled by two or more employees because seagoing personnel rotate between active sea duty and time ashore. Approximately 24 percent of Matson's regular full-time employees and all of the seagoing employees were covered by collective bargaining agreements.

Historically, collective bargaining with longshore and seagoing unions has been complex and difficult. However, Matson and Matson Terminals consider their relations with those unions, other unions and their non-union employees generally to be satisfactory.

Matson's seagoing employees are represented by six unions, three representing unlicensed crew members and three representing licensed crew members. Matson negotiates directly with these unions. Matson's agreements with the Seafarer's International Union, the Sailors Union of the Pacific and the Marine Firemen's Union were renewed in mid-2008 through June 2013 without service interruption. Contracts that Matson has with the American Radio Association were renewed in mid-2009 through August 15, 2013 after a one-day job action in the Port of Seattle. Contracts that Matson has with the Masters, Mates & Pilots ("MM&P") and the Marine Engineers Beneficial Association ("MEBA") for ships built prior to 2003 were renewed in mid-2009 through August 15, 2013. Contracts that Matson has with MM&P and the MEBA for ships built after 2003 expire on August 15, 2013 and include provisions for a wage reopener, which was negotiated in mid-2009 to cover the remaining contract period.

SSAT, the previously-described joint venture of Matson and SSA, provides stevedoring and terminal services for Matson vessels calling at U.S. Pacific Coast ports. Matson, SSA and SSAT are members of the Pacific Maritime Association ("PMA") which, on behalf of its members, negotiates collective bargaining agreements with the ILWU on the U.S. Pacific Coast. A new six-year PMA/ILWU Master Contract, which covers all Pacific Coast longshore labor, was negotiated in 2008 without significant disruption and will expire on July 1, 2014. Matson Terminals provides stevedoring and terminal services to Matson and other vessel operators calling at Honolulu and on the islands of Hawaii, Maui and Kauai. Matson Terminals is a member of the Hawaii Stevedore Industry Committee, which negotiates with the ILWU in Hawaii on behalf of its members. The ILWU contracts in Hawaii expired on June 30, 2008 and Matson has signed new six-year agreements with each of the ILWU units. The new contracts will expire on June 30, 2014.

During 2009, Matson maintained its collective bargaining agreement with ILWU clerical workers at Honolulu and Oakland, which are in effect through June 2014. The bargaining agreement with ILWU clerical workers in Long Beach will be negotiated during 2010 as it will expire in June 2010.

During 2009, Matson contributed to multiemployer pension plans for vessel crews. If Matson were to withdraw from or significantly reduce its obligation to contribute to one of the plans, Matson would review and evaluate data, actuarial assumptions, calculations and other factors used in determining its withdrawal liability, if any. In the event that any third parties materially disagree with Matson's determination, Matson would pursue the various means available to it under federal law for the adjustment or removal of its withdrawal liability. Matson Terminals participates in a multiemployer pension plan for its Hawaii ILWU non-clerical employees. For a discussion of withdrawal liabilities under the Hawaii longshore and seagoing plans, see Note 9 ("Employee Benefit Plans") to A&B's financial statements in Item 8 of Part II below.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the ILWU. The agreements with the HC&S production unit employees and clerical bargaining unit employees covering approximately 640 workers, expired on January 31, 2010, were extended through February 2010, and are being renegotiated. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. The bulk sugar employees agreement expires on June 30, 2014, and the agreement with all other employees expires on March 31, 2010, with renegotiations expected to begin in spring of 2010. There are two collective bargaining agreements with KCC employees represented by the ILWU. These agreements expire on April 30, 2010, with renegotiations expected to begin in spring of 2010. There is a collective bargaining agreement with the ILWU for the production unit employees of Kauai Coffee. This contract was renegotiated and will expire on January 31, 2011.

E. Energy

Matson and Matson Terminals purchase residual fuel oil, lubricants, gasoline and diesel fuel for their operations. Residual fuel oil is by far Matson's largest energy-related expense. In 2009, Matson vessels purchased approximately 1.8 million barrels of residual fuel oil (compared with 2.0 million barrels in 2008).

Residual fuel oil prices paid by Matson in 2009 started at $44.50 per barrel and ended the year at $78.62. The low for the year was the price of $35.69 per barrel in April, the high was the price of $105.55 in June. Sufficient fuel for Matson's requirements is expected to be available in 2010.

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory and farming operations, HC&S sells electricity. In 2009, HC&S produced and sold, respectively, approximately 188,000 MWH and 72,800 MWH of electric power (compared with 211,000 MWH produced and 91,300 MWH sold in 2008). The decrease in power sold was due to increased power used for irrigation pumps to improve soil moisture levels and yields, and also to a mechanical failure in the HC&S power plant that reduced production capacity. HC&S's use of oil in 2009 of 28,800 barrels was 8 percent greater than the 26,600 barrels used in 2008. The increase was due to additional supplies of low-cost, recycled motor and vegetable oils. Coal used for power generation was 89,300 short tons, about 7,100 tons less than that used in 2008. Less coal was required primarily because of the reduced volume of power production and sales, as mentioned above.

In 2009, McBryde produced approximately 30,800 MWH of hydroelectric power (compared with approximately 32,000 MWH in 2008). To the extent it is not used in A&B's coffee operations, McBryde sells electricity to Kauai Island Utility Cooperative. Power sales in 2009 amounted to approximately 22,800 MWH (compared with 23,700 MWH in 2008).

In the third quarter of 2008, HC&S was notified that the Hawaii Public Utilities Commission ("PUC") had issued a decision that provides for a new methodology of calculating avoided energy costs, which resulted in a reduction in the avoided energy cost payable to energy producers, beginning in August 2008. The decision affects A&B's power sales on Maui, but not on Kauai. Despite efforts to gain an exemption from or modification to the decision, HC&S remains subject to the new methodology and received approximately $4.0 million lower power revenue in 2009 than it would have under the former methodology. A&B is currently pursuing efforts to modify the mechanism through which its energy rate is calculated, although the final outcome of these efforts cannot yet be determined.

F. Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

The business of A&B and its subsidiaries (collectively, the "Company") faces numerous risks, including those set forth below or those described elsewhere in this Form 10-K or in the Company's filings with the SEC. The risks described below are not the only risks that the Company faces, nor are they necessarily listed in order of significance. Other risks and uncertainties may also impair its business operations. Any of these risks may have a material adverse effect on the Company's business, liquidity, financial condition, results of operations and cash flows. All forward-looking statements made by the Company or on the Company's behalf are qualified by the risks described below.

Changes in U.S., global, or regional economic conditions that result in a further decrease in consumer confidence or market demand for the Company's services and products in Hawaii, the U.S. Mainland, Guam or Asia may adversely affect the Company's financial position, results of operations, liquidity, or cash flows.

A continuation or further weakening of the U.S., Guam, Asian or global economies may adversely impact the level of freight volumes, freight rates, and real estate leasing and development activity. Within the U.S., a continuation or further weakening of economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, and/or the further weakening of consumer confidence, market demand or the economy in the U.S. Mainland, may further reduce the demand for goods to and from Hawaii and Asia, travel to Hawaii and domestic transportation of goods, adversely affecting inland and ocean transportation volumes and/or rates, the sale of Hawaii real estate to mainland buyers, and the real estate leasing and development markets. In addition, continued overcapacity in the global ocean transportation market may adversely affect freight volumes and/or rates in the Company's China service. Additionally, a change in the cost of goods or currency exchange rates may cause these adverse effects as well.

The Company may face new or increased competition.

The Company's transportation segment may face new competition by established or start-up shipping operators that enter the Company's markets. The entry of a new competitor or the addition of ships or capacity by existing competition on any of the Company's routes could result in a significant increase in available shipping capacity that could have an adverse effect on volumes and/or rates. See also discussion under "Business and Properties - Transportation - Competition" above.

For the Company's real estate segments, there are numerous other developers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with the Company for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Increased vacancies or lack of development opportunities may lead to a deterioration in results from the Company's real estate business.

The Company's significant operating agreements and leases could be replaced on less favorable terms or may not be replaced.

The significant operating agreements and leases of the Company in its various businesses expire at various points in the future and may not be replaced or could be replaced on less favorable terms, thereby adversely affecting future revenue generation.

The reduction in availability of mortgage financing and the volatility and reduction in liquidity in the financial markets may adversely affect the Company's real estate business.

During 2008 and 2009, the financial industry continued to experience significant instability due to, among other things, declining property values and increasing defaults on loans. This has led to tightened credit requirements, reduced liquidity and increased credit risk premiums for virtually all borrowers. Fewer loan products and tighter loan qualifications will make it more difficult for borrowers to finance the purchase of units in the Company's residential projects. The tightening of credit in the commercial markets may adversely affect the Company's ability to secure construction and/or other financing for the Company's residential and commercial projects, working capital requirements, and/or investment needs. The absence of financing for buyers of commercial properties will make it significantly more difficult for the Company to sell commercial properties and will negatively impact the sales prices and other terms of such sales. Additionally, continuation or worsening of the liquidity crisis may impact the Company in other ways, including the credit or solvency of customers, vendors, or joint venture partners, and the ability of partners to fund their equity obligations to the joint venture.

A future downgrade in the Company's credit rating or disruptions on the credit markets could restrict its ability to access the debt capital markets and/or increase the cost of debt.

In June 2009, the Company's Standard and Poor's credit rating was changed from A- with a Stable outlook to BBB+ with a Negative outlook. Further changes in the Company's credit ratings may ultimately have an adverse impact on the Company's ability to access debt in the private or public market and also may increase its borrowing costs. If the Company's credit ratings fall below investment grade, its access to the debt capital markets may become restricted. Furthermore, the tightening in the credit markets and the constrained liquidity in the financial markets resulting from recent turmoil in the financial industry may adversely affect the Company's ability to access the debt capital markets or to renew its committed lines of credit in the future and/or increase the Company's cost of capital. Because the Company relies on its ability to draw on its revolving credit facilities to support its operations, when required, continued volatility in the credit and financial markets that prevents the Company from accessing funds (for example, a lender that does not fulfill its lending obligation), could have an adverse effect on the Company's financial condition and cash flows. Additionally, the Company's credit agreements generally include an increase in borrowing rates if the Company's ratings are downgraded, and renegotiation of the Company's primary revolving credit line upon its expiration in 2011 could be affected negatively by ratings downgrades.

Failure to comply with certain restrictive financial covenants contained in the Company's credit facilities could preclude the payment of dividends, impose restrictions on the Company's business segments, capital resources or other activities or otherwise adversely affect the Company.

The Company's credit facilities contain certain restrictive financial covenants, the most restrictive of which include the maintenance of minimum shareholders' equity levels, a maximum ratio of debt to earnings before interest, depreciation, amortization, and taxes, and the maintenance of a minimum unencumbered property investment value. If the Company does not maintain the required covenants, and that breach of covenants is not cured timely or waived by the lenders, resulting in default, the Company's access to credit may be limited or terminated, dividends may be suspended, and the lenders could declare any outstanding amounts due and payable.

The Company is subject to potential insolvency of insurance carriers.

The Company purchases a variety of insurance products to transfer financial risk. Accordingly, the Company is subject to the risk that one or more of the insurers may become insolvent and would be unable to pay one or more claims that may be made in the future.

An increase in fuel prices, or changes in the Company's ability to collect fuel surcharges, may adversely affect the Company's profits.

Fuel is a significant operating expense for the Company's shipping and agribusiness operations. The price and supply of fuel is unpredictable and fluctuates based on events beyond the Company's control. Increases in the price of fuel may adversely affect the Company's results of operations based on market and competitive conditions. Increases in fuel costs also can lead to other expense increases, through, for example, increased costs of energy, petroleum-based raw materials and purchased transportation services. In the Company's ocean transportation and logistics services segments, the Company is able to utilize fuel surcharges to partially recover increases in fuel expense, although increases in the fuel surcharge may adversely affect the Company's competitive position and may not correspond exactly with the timing of increases in fuel expense. Changes in the Company's ability to collect fuel surcharges may adversely affect its results of operations. Increases in energy costs for the Company's leased real estate portfolio are typically recovered from lessees, although the Company's share of energy costs increases as a result of lower occupancies and higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices may also increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting the Company's development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Noncompliance with, or changes to, federal, state or local law or regulations, including passage of climate change legislation or regulation, may adversely affect the Company's business.

The Company is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, government administration of the U.S. sugar program, environmental regulations including those relating to air quality initiatives at port locations, and cabotage laws. Noncompliance with, or changes to, the laws and regulations governing the Company's business could impose significant additional costs on the Company and adversely affect the Company's financial condition and results of operations. For example, if the Jones Act and the regulations promulgated thereunder were repealed, amended, or otherwise modified, non-U.S. competitors with significantly lower costs may consequently enter any of the Jones Act routes or the Company's business may be significantly altered, all of which may have an adverse effect on the Company's shipping business. In addition, changes in environmental laws impacting the shipping business, including passage of climate change legislation or other regulatory initiatives that restrict emissions of greenhouse gasses, may require costly vessel modifications, the use of higher-priced fuel and changes in operating practices that may not all be able to be recovered through increased payments from customers. The real estate segments are subject to numerous federal, state and local laws and regulations, which, if changed, may adversely affect the Company's business. The agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the 2008 Farm Bill, and the Hawaii Public Utilities Commission's regulation of avoided energy cost rates paid to the Company in connection with it sale of electric power. Further changes to these laws and regulations could adversely affect the Company. Pending climate change legislation, such as limiting and reducing greenhouse gas emissions through a "cap and trade" system of allowances and credits, if enacted, may have an adverse effect on the Company's business.

Work stoppages or other labor disruptions by the unionized employees of the Company or other companies in related industries may adversely affect the Company's operations.

As of December 31, 2009, the Company had approximately 2,110 regular full-time employees, of which approximately 49 percent were covered by collective bargaining agreements with unions. The Company's transportation, real estate and agribusiness segments may be adversely affected by actions taken by employees of the Company or other companies in related industries against efforts by management to control labor costs, restrain wage increases or modify work practices. Strikes and disruptions may occur as a result of the failure of the Company or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its real estate sales segment, the Company may be unable to complete construction of its projects if building materials or labor is unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor and customer relationships may adversely affect the Company's business.

The Company's business is dependent on its relationships with key vendors, customers and tenants. The ocean transportation business relies on its relationships with freight forwarders, large retailers and consumer goods and automobile manufacturers, as well as other larger customers. Relationships with railroads and shipping companies are important in the Company's intermodal business. For agribusiness, HC&S's relationship with C&H Sugar Company, Inc. is critical. The loss of or damage to any of these key relationships may affect the Company's business adversely.

Interruption or failure of the Company's information technology and communications systems could impair the Company's ability to operate

and adversely affect its business.

The Company is highly dependent on information technology systems. For example, in the ocean transportation segment, these dependencies include accounting, billing, disbursement, cargo booking and tracking, vessel scheduling and stowage, equipment tracking, customer service, banking, payroll and employee communication systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. The Company may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at the Company's facilities. Any failure of the Company's systems could result in interruptions in its service or production, reductions in its revenue and profits and damage to its reputation.

The Company is susceptible to weather and natural disasters.

The Company's transportation operations are vulnerable to disruption as a result of weather and natural disasters such as bad weather at sea, hurricanes, typhoons, tsunamis, floods and earthquakes. Such events will interfere with the Company's ability to provide on-time scheduled service, resulting in increased expenses and potential loss of business associated with such events. In addition, severe weather and natural disasters can result in interference with the Company's terminal operations, and may cause serious damage to its vessels, loss or damage to containers, cargo and other equipment, and loss of life or physical injury to its employees, all of which could have an adverse effect on the Company's business.

For the real estate segments, the occurrence of natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, could damage its real estate holdings, resulting in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, the Company's properties.

For the agribusiness segment, drought, greater than normal rainfall, hurricanes, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar and coffee planting, harvesting and production, and the agribusiness segment's facilities, including dams and reservoirs.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact the Company's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability or willingness of tourists to travel to Hawaii, thereby adversely affecting Hawaii's economy and the Company. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets. Acts of war or terrorism may be directed at the Company's shipping operations or real estate holdings, or may cause the U.S. government to take control of Matson's vessels for military operation. Heightened security measures are likely to slow the movement and increase the cost of freight through U.S. or foreign ports, across borders or on U.S. or foreign railroads or highways and could adversely affect the Company's business and results of operations.

Loss of the Company's key personnel could adversely affect its business.

The Company's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, the Company may have to incur significant costs to replace them, and the Company's ability to execute its business model could be impaired if it cannot replace them in a timely manner. The Company does not expect to maintain key person insurance on any of its key personnel.

The Company is involved in joint ventures and is subject to risks associated with joint venture relationships.

The Company is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as:

- the Company may not have voting control over the joint venture;
- the Company may not be able to maintain good relationships with its venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with the Company's;
- the venture partner may fail to fund its share of capital for operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to the Company;
- the joint venture or venture partner could lose key personnel; and
- the venture partner could become insolvent, requiring the Company to assume all risks and capital requirements related to the joint venture project.

In connection with its real estate joint ventures, the Company is sometimes asked to guarantee completion of a joint venture's construction and development of a project, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If the Company were to become obligated to perform under such arrangement, the Company may be adversely affected.

The Company is subject to, and may in the future be subject to, disputes, legal or other proceedings, or government inquiries or investigations, that could have an adverse effect on the Company.

The nature of the Company's business exposes it to the potential for disputes, legal or other proceedings, or government inquiries or investigations, relating to antitrust matters, labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section or in other Company filings with the SEC. For example, Matson is a common carrier, whose tariffs, rates, rules and practices in dealing with its customers are governed by extensive and complex foreign, federal, state and local regulations, which may be the subject of disputes or administrative and/or judicial proceedings. These disputes, individually or collectively, could harm the Company's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by the Company, or result in significant changes to Matson's tariffs, rates, rules and practices in dealing with its customers, all of which could have an adverse effect on the Company's future operating results, including profitability, cash flows, and financial condition. As a real estate developer, the Company may face warranty and construction defect claims, as described below in the "Real Estate" section of this "Risk Factors" item. For a description of significant legal proceedings involving the Company, including proceedings involving the Company's irrigation systems on Maui, and a grand jury subpoena served on Matson on April 21, 2008 and the status of the subsequently filed and dismissed civil lawsuits purporting to be class actions in which the Company and Matson are named as defendants, and which allege violations of the antitrust laws and seek treble damages and injunctive relief, see "Legal Proceedings" below.

Earnings on pension assets, or a change in pension law or key assumptions, may adversely affect the Company's financial performance.

The amount of the Company's employee pension and postretirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, changes in discount rates, higher health care costs, or lower actual or expected returns on plan assets, may adversely affect the Company's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect the Company's single-employer and multiemployer pension plans and plan funding. These factors, as well as a continued decline in the fair value of pension plan assets, may put upward pressure on the cost of providing pension and medical benefits and may increase future pension expense and required funding contributions. Although the Company has actively sought to control increases in these costs, there can be no assurance that it will be successful in limiting future cost and expense increases, and continued upward pressure in costs and expenses could further reduce the profitability of the Company's businesses.

The Company may have exposure under its multiemployer plans in which it participates that extends beyond its funding obligation with respect to the Company's employees.

The Company contributes to various multiemployer pension plans. In the event of a partial or complete withdrawal by the Company from any plan that is underfunded, the Company would be liable for a proportionate share of such plan's unfunded vested benefits. Based on the limited information available from plan administrators, which the Company cannot independently validate, the Company believes that its portion of the contingent liability in the case of a full withdrawal or termination may be material to its financial position and results of operations. In the event that any other contributing employer withdraws from any plan that is underfunded, and such employer (or any member in its controlled group) cannot satisfy its obligations under the plan at the time of withdrawal, then the Company, along with the other remaining contributing employers, would be liable for its proportionate share of such plan's unfunded vested benefits. In addition, if a multiemployer plan fails to satisfy the minimum funding requirements, the Internal Revenue Service will impose certain penalties and taxes.

The Company is required to evaluate its internal controls over financial reporting under Section 404 of the Sarbanes-Oxley Act of 2002, and any adverse results from such evaluation could result in a loss of investor confidence in the Company's financial reports and have an adverse effect on the Company's stock price.

Section 404 of the Sarbanes-Oxley Act requires that publicly reporting companies cause their managements to perform annual assessments of the effectiveness of their internal controls over financial reporting. Although the Company has concluded that its internal controls over financial reporting were effective as of December 31, 2009, there can be no assurances that the Company will reach the same conclusion at the end of future years. If the Company is unable to assert that its internal control over financial reporting is effective, or if the Company's auditors are unable to express an opinion on the effectiveness of the Company's internal controls, the Company could lose investor confidence in the accuracy and completeness of its financial reports, which would have an adverse effect on the Company's stock price.

TRANSPORTATION

The Company is subject to risks associated with conducting business in a foreign shipping market.

The Company, through Matson's Hawaii/Guam/China service, is subject to risks associated with conducting business in a foreign shipping market, which include:

- challenges in operating in a foreign country and doing business and developing relationships with foreign companies;
- difficulties in staffing and managing foreign operations;
- legal and regulatory restrictions, including compliance with Foreign Corrupt Practices Act;
- global vessel overcapacity that may lead to decreases in volumes and/or shipping rates;
- competition with established and new shippers;
- currency exchange rate fluctuations;
- political and economic instability;
- protectionist measures that may affect the Company's operation of its wholly-owned foreign enterprise; and
- challenges caused by cultural differences.

Any of these risks has the potential to adversely affect the Company's operating results.

Compliance with environmental laws and regulations may adversely affect the Company's business.

The Company's vessel operations are subject to various federal, state and local environmental laws and regulations, including, but not limited to, the Oil Pollution Act of 1990, the Comprehensive Environmental Response Compensation & Liability Act of 1980, the Clean Water Act, the Invasive Species Act and the Clean Air Act. Continued compliance with these laws and regulations may result in additional costs and changes in operating procedures that may adversely affect the Company's business.

Acquisitions may have an adverse effect on the Company's business.

The Company's growth strategy includes expansion through acquisitions. Acquisitions may result in difficulties in assimilating acquired companies, and may result in the diversion of the Company's capital and its management's attention from other business issues and opportunities. The Company may not be able to integrate companies that it acquires successfully, including their personnel, financial systems, distribution, operations and general operating procedures. The Company may also encounter challenges in achieving appropriate internal control over financial reporting in connection with the integration of an acquired company. The Company may pay a premium for an acquisition, resulting in goodwill that may later be determined to be impaired, adversely affecting the Company's financial condition and results of operations.

The Company's logistics services are dependent upon third parties for equipment, capacity and services essential to operate the Company's logistics business, and if the Company fails to secure sufficient third party services, its business could be adversely affected.

The Company's logistics services are dependent upon rail, truck and ocean transportation services provided by independent third parties. If the Company cannot secure sufficient transportation equipment, capacity or services from these third parties at a reasonable rate to meet its customers' needs and schedules, customers may seek to have their transportation and logistics needs met by other third parties on a temporary or permanent basis. As a result, the Company's business, consolidated results of operations and financial condition could be adversely affected.

The loss of several of the Company's major customers could have an adverse effect on the revenue and business of the Company's logistics business.

The Company's logistics business derives a significant portion of its revenues from its largest customers. For 2009, the Company's logistics business's largest ten customers accounted for approximately 33 percent of the business's revenue. A reduction in or termination of the Company's logistics services by several of the logistics business's largest customers could have an adverse effect on the Company's revenue and business.

REAL ESTATE

The Company is subject to risks associated with real estate construction and development.

The Company's development projects are subject to risks relating to the Company's ability to complete its projects on time and on budget. Factors that may result in a development project exceeding budget or being prevented from completion include:

- an inability of the Company or buyers to secure sufficient financing or insurance on favorable terms, or at all;
- construction delays, defects, or cost overruns, which may increase project development costs;
- an increase in commodity or construction costs, including labor costs;
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues;
- an inability to obtain, or significant delay in obtaining, zoning, occupancy and other required governmental permits and authorizations;
- difficulty in complying with local, city, county and state rules and regulations regarding permitting, zoning, subdivision, utilities, affordable housing, and water quality as well as federal rules and regulations regarding air and water quality and protection of endangered species and their habitats;
- an inability to have access to sufficient and reliable sources of water or to secure water service or meters for its projects;
- an inability to secure tenants necessary to support the project or maintain compliance with debt covenants;
- failure to achieve or sustain anticipated occupancy or sales levels;
- buyer defaults, including defaults under executed or binding contracts; and

- an inability to sell the Company's constructed inventory.

Any of these risks has the potential to adversely affect the Company's operating results.

A decline in leasing rental income could adversely affect the Company.

The Company owns a portfolio of commercial income properties. Factors that may adversely affect the portfolio's profitability include:

- a significant number of the Company's tenants are unable to meet their obligations;
- increases in non-recoverable operating and ownership costs;
- the Company is unable to lease space at its properties when the space becomes available;
- the rental rates upon a renewal or a new lease are significantly lower than prior rents or do not increase sufficiently to cover increases in operating and ownership costs;
- the providing of lease concessions, such as free or discounted rents and tenant improvement allowances; and
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues at the property.

Governmental entities have adopted or may adopt regulatory requirements that may restrict the Company's development activity.

The Company is subject to extensive and complex laws and regulations that affect the land development process, including laws and regulations related to zoning and permitted land uses. Government entities have adopted or may approve regulations or laws that could negatively impact the availability of land and development opportunities within those areas. For example, in December 2007, Maui County adopted an ordinance requiring verification of water source availability and sustainability for all developments prior to submission of subdivision construction plans. This requirement adds further process delays and burdens the developer with identifying and developing new water sources. It is possible that increasingly stringent requirements will be imposed on developers in the future that could adversely affect the Company's ability to develop projects in the affected markets or could require that the Company satisfy additional administrative and regulatory requirements, which could delay development progress or increase the development costs of the Company. Any such delays or costs could have an adverse effect on the Company's revenues and earnings.

Real estate development projects are subject to warranty and construction defect claims in the ordinary course of business that can be significant.

As a developer, the Company is subject to warranty and construction defect claims arising in the ordinary course of business. The amounts payable under these claims, both in legal fees and remedying any construction defects, can be significant and exceed the profits made from the project. As a consequence, the Company may maintain liability insurance, obtain indemnities and certificates of insurance from contractors generally covering claims related to workmanship and materials, and create warranty and other reserves for projects based on historical experience and qualitative risks associated with the type of project built. Because of the uncertainties inherent to these matters, the Company cannot provide any assurance that its insurance coverage, contractor arrangements and reserves will be adequate to address some or all of the Company's warranty and construction defect claims in the future. For example, contractual indemnities may be difficult to enforce, the Company may be responsible for applicable self-insured retentions, and certain claims may not be covered by insurance or may exceed applicable coverage limits. Additionally, the coverage offered and the availability of liability insurance for construction defects could be limited and/or costly. Accordingly, the Company cannot provide any assurance that such coverage will be adequate or available at all, or available at an acceptable cost.

AGRIBUSINESS

The lack of water for agricultural irrigation could adversely affect the Company.

It is crucial for the Company's agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane and coffee. As further described in "Legal Proceedings" below, there are administrative hearing processes challenging the Company's ability to divert water from streams in Maui. In addition, the Company's access to water is subject to weather patterns that cannot be reliably predicted. If the Company is not permitted to divert stream waters for its use or there is insufficient rainfall, it would have an adverse effect on the Company's sugar operations, including possible cessation of operations.

A decline in raw sugar or coffee prices will adversely affect the Company's business.

The business and results of operations of the Company's agribusiness segment are substantially affected by market factors, particularly the domestic prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops and suppliers, weather conditions, and United States farm and trade policies. If the price for sugar or coffee were to decline, the Company's agribusiness segment would be adversely affected. See also discussion under "Business and Properties - Agribusiness - Competition and Sugar Legislation" above.

The Company is subject to risks associated with raw sugar and coffee production.

The Company's production of raw sugar and coffee is subject to numerous risks that could adversely affect the volume and quality of sugar or coffee produced, including:

- weather and natural disasters;
- disease;
- weed control;
- uncontrolled fires, including arson;
- government restrictions on farming practices due to cane burning;
- increases in costs, including, but not limited to fuel, fertilizer, herbicide, and drip tubing;
- water availability (see risk factor above regarding lack of water);
- equipment failures in factory or power plant;

- labor, including labor availability (see risk factor above regarding labor disruptions) and loss of qualified personnel; and
- lack of demand for the Company's production.

Any of these risks has the potential to adversely affect the Company's future agribusiness operating results.

A reorganization or termination of the Company's sugar business could result in impairment losses and restructuring costs.

If the Company's sugar business continues to generate operating losses or negative cash flows, the Company may reorganize or terminate its sugar operations. The reorganization or termination of sugar operations may result in an impairment loss and restructuring costs that would adversely affect the Company's financial performance.

The Company's power sales contract may not be favorably modified and may adversely affect the Company's Agribusiness segment.

As mentioned under "Business and Properties - Energy" above, HC&S was notified that the PUC had issued a decision that provides for a new methodology of calculating avoided energy cost, which resulted in a reduction in the avoided energy cost payable to energy producers, beginning in August 2008. If no changes were to occur to the decision or the terms of HC&S's power sales contract with MECO, this decision will continue to adversely affect HC&S's power revenue and profitability. The Company is currently pursuing efforts to modify the mechanism through which its energy rate is calculated, although the final outcome of these efforts cannot yet be determined. The inability to favorably address this matter may adversely affect the Company's agribusiness operations.

The foregoing should not be construed as an exhaustive list of all factors that could cause actual results to differ materially from those expressed in forward-looking statements made by the Company or on its behalf.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 3. LEGAL PROCEEDINGS

See "Business and Properties - Transportation - Rate Regulation" above for a discussion of rate and other regulatory matters in which Matson is routinely involved.

A&B owns 16,000 acres of watershed lands in East Maui that supply a significant portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the years has supplied approximately two-thirds of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. If the Company is not permitted to divert stream waters from State lands in East Maui for its use, it would have a material adverse effect on the Company's sugar-growing operations.

In addition, on May 24, 2001, petitions were filed by a third party, requesting that the Commission on Water Resource Management of the State of Hawaii ("Water Commission") amend interim instream flow standards ("IIFS") in 27 East Maui streams that feed the Company's irrigation system. On September 25, 2008, the Water Commission took action on eight of the petitions, resulting in some quantity of water being returned to the streams rather than being utilized for irrigation purposes. While the loss of the water as a result of the Water Commission's action on the eight petitions may not significantly impair the Company's sugar-growing operations, similar losses of water on the remaining 19 streams would have a material adverse effect on the Company's sugar-growing operations. In December 2009, the Water Commission conducted deliberations on the amendment of IIFS for the remaining 19 East Maui streams, deferring action for at least a three month period. The Company, at this time, is unable to determine what action the Water Commission will take with respect to all 27 streams.

On June 25, 2004, two organizations filed with the Water Commission a petition to amend IIFS for four streams in West Maui to increase the amount of water to be returned to these streams. The West Maui irrigation system provides approximately one-sixth of the irrigation water used by HC&S. The Water Commission's deliberations on whether to amend the current IIFS for the West Maui streams are currently ongoing, and an adverse decision could result in some quantity of water being returned to the streams, rather than being utilized for irrigation purposes, which may have a material adverse effect on the Company's sugar-growing operations. A decision by the Water Commission is not expected until mid-2010.

On December 10, 2007, the Shipbuilders Council of America, Inc. and Pasha Hawaii Transport Lines LLC filed a complaint against the U.S. Department of Homeland Security, the U.S. Coast Guard and the National Vessel Documentation Center in the U.S. District Court for the Eastern District of Virginia. The complaint sought review of a certificate of documentation with a coastwise endorsement issued by the National Vessel Documentation Center after concluding that Matson's C9 vessel Mokihana had not been rebuilt abroad. Matson intervened in the action. On December 4, 2009, the court granted summary judgment in favor of the government and Matson, and dismissed the plaintiffs' complaint with prejudice. The time to seek appellate review of this matter has expired.

On April 21, 2008, Matson was served with a grand jury subpoena from the U.S. District Court for the Middle District of Florida for documents and information relating to water carriage in connection with the Department of Justice's investigation into the pricing and other competitive practices of carriers operating in the domestic trades. Matson understands that while the investigation currently is focused on the Puerto Rico trade, it also includes pricing and other competitive practices in connection with all domestic trades, including the Alaska, Hawaii and Guam trades. Matson does not operate vessels in the Puerto Rico and Alaska trades. It does operate vessels in the Hawaii and Guam trades. Matson has cooperated, and will continue to cooperate, fully with the Department of Justice. If the Department of Justice believes that any violations have occurred on the part of Matson or the Company, it could seek civil or criminal sanctions, including monetary fines. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this investigation.

The Company and Matson were named as defendants in a consolidated civil lawsuit purporting to be a class action in the U.S. District Court for the

ITEM 6. SELECTED FINANCIAL DATA

The following financial data should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except per-share amounts):

	2009	2008	2007	2006	2005
Revenue:					
Transportation:					
Ocean transportation	$ 888.6	$ 1,023.7	$ 1,006.9	$ 945.8	$ 878.3
Logistics services	320.9	436.0	433.5	444.2	431.6
Real Estate:					
Leasing	103.2	107.8	108.5	100.6	89.7
Sales	125.6	350.2	117.8	97.3	148.9
Less amounts reported in discontinued operations [1]	(124.2)	(151.5)	(130.2)	(128.4)	(91.3)
Agribusiness[6]	107.0	124.3	123.7	127.4	123.2
Reconciling Items[2]	(16.3)	(10.7)	(9.2)	(14.2)	(8.4)
Total revenue	$ 1,404.8	$ 1,879.8	$ 1,651.0	$ 1,572.7	$ 1,572.0
Operating Profit:					
Transportation:					
Ocean transportation[3]	$ 58.3	$ 105.8	$ 126.5	$ 105.6	$ 128.0
Logistics services	6.7	18.5	21.8	20.8	14.4
Real Estate:					
Leasing	43.2	47.8	51.6	50.3	43.7
Sales[3]	39.1	95.6	74.4	49.7	44.1
Less amounts reported in discontinued operations [1]	(52.3)	(69.3)	(71.2)	(62.6)	(36.1)
Agribusiness[6]	(27.8)	(12.9)	0.2	6.9	11.2
Total operating profit	67.2	185.5	203.3	170.7	205.3
Write-down of long-lived assets[4]	–	–	--	--	(2.3)
Interest expense, net[5]	(25.9)	(23.7)	(18.8)	(15.0)	(13.3)
General corporate expenses	(21.8)	(21.0)	(27.3)	(22.3)	(24.1)
Income from continuing operations before income taxes	19.5	140.8	157.2	133.4	165.6
Income taxes	7.6	51.5	59.3	49.8	62.0
Income from continuing operations	11.9	89.3	97.9	83.6	103.6
Income from discontinued operations	32.3	43.1	44.3	38.9	22.4
Net Income	$ 44.2	$ 132.4	$ 142.2	$ 122.5	$ 126.0

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $6.2 million, $5.2 million, $10.7 million, $13.3 million, and $17.1 million of equity in earnings from its investment in SSAT for 2009, 2008, 2007, 2006, and 2005, respectively. The Real Estate Sales segment includes approximately $9.0 million, $22.6 million, $14.4 million, and $3.3 million in equity in earnings from its various real estate joint ventures for 2008, 2007, 2006, and 2005, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] The 2005 write-down was for an impairment in the Company's investment in C&H Sugar Company, Inc. ("C&H") which was subsequently sold.

[5] Includes Ocean Transportation interest expense of $9.0 million for 2009, $11.6 million for 2008, $13.9 million for 2007, $13.3 million for 2006, and $9.6 million for 2005. Substantially all other interest expense was incurred at the parent company.

[6] Includes a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

SELECTED FINANCIAL DATA (CONTINUED)

	2009	2008	2007	2006	2005
Identifiable Assets:					
Transportation:					
Ocean transportation[7]	$ **1,095.2**	$ 1,153.9	$ 1,215.0	$ 1,185.3	$ 1,113.0
Logistics services	**72.4**	74.2	58.6	56.4	70.3
Real Estate:					
Leasing	**627.4**	590.2	595.4	525.5	478.6
Sales[7]	**415.6**	344.6	408.9	295.0	227.3
Agribusiness	**156.8**	172.2	174.6	168.7	159.0
Other	**12.2**	15.1	26.6	20.3	22.7
Total assets	**$ 2,379.6**	$ 2,350.2	$ 2,479.1	$ 2,251.2	$ 2,070.9
Capital Expenditures:					
Transportation:					
Ocean transportation	$ **12.7**	$ 35.5	$ 65.8	$ 217.1	$ 173.9
Logistics services[8]	**0.6**	2.4	2.0	1.7	1.3
Real Estate:					
Leasing[9]	**108.8**	100.2	124.5	93.0	78.8
Sales[10]	**0.1**	0.6	0.3	1.3	0.2
Agribusiness	**3.4**	15.2	20.5	15.0	13.0
Other	**0.3**	0.8	0.3	1.5	1.4
Total capital expenditures	**$ 125.9**	$ 154.7	$ 213.4	$ 329.6	$ 268.6
Depreciation and Amortization:					
Transportation:					
Ocean transportation	$ **67.1**	$ 66.1	$ 63.2	$ 58.1	$ 59.5
Logistics services	**3.5**	2.3	1.5	1.5	1.4
Real Estate:					
Leasing[1]	**19.5**	17.9	15.7	14.1	12.4
Sales	**0.3**	0.2	0.2	0.1	0.1
Agribusiness	**11.9**	11.5	10.7	10.1	9.4
Other	**3.1**	2.7	1.3	0.9	0.5
Total depreciation and amortization	**$ 105.4**	$ 100.7	$ 92.6	$ 84.8	$ 83.3

7 The Ocean Transportation segment includes approximately $47.2 million, $44.6 million, $48.6 million, $49.8 million, and $39.8 million related to its investment in SSAT as of December 31, 2009, 2008, 2007, 2006, and 2005, respectively. The Real Estate Sales segment includes approximately $193.3 million, $162.1 million, $134.1 million, $98.4 million, and $114.1 million related to its investment in various real estate joint ventures as of December 31, 2009, 2008, 2007, 2006, and 2005, respectively.

8 Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

9 Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

10 Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $6 million, $39 million, $110 million, $69 million, and $34 million for 2009, 2008, 2007, 2006, and 2005, respectively.

SELECTED FINANCIAL DATA (CONTINUED)

	2009	2008	2007	2006	2005
Earnings per share:					
From continuing operations:					
Basic	$ 0.29	$ 2.17	$ 2.30	$ 1.93	$ 2.38
Diluted	$ 0.29	$ 2.15	$ 2.27	$ 1.92	$ 2.35
Net income:					
Basic	$ 1.08	$ 3.21	$ 3.34	$ 2.84	$ 2.89
Diluted	$ 1.08	$ 3.19	$ 3.30	$ 2.81	$ 2.86
Return on beginning equity	4.1%	11.7%	13.8%	12.1%	13.9%
Cash dividends per share	$ 1.26	$ 1.235	$ 1.12	$ 0.975	$ 0.90
At Year End					
Shareholders of record	3,197	3,269	3,381	3,506	3,628
Shares outstanding	41.0	41.0	42.4	42.6	44.0
Long-term debt – non-current	$ 406	$ 452	$ 452	$ 401	$ 296

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

The Company, from time to time, may make or may have made certain forward-looking statements, whether orally or in writing, such as forecasts and projections of the Company's future performance or statements of management's plans and objectives. These statements are "forward-looking" statements as that term is defined in the Private Securities Litigation Reform Act of 1995. Such forward-looking statements may be contained in, among other things, SEC filings, such as the Forms 10-K, 10-Q and 8-K, the Annual Report to Shareholders, press releases made by the Company, the Company's Internet Web sites (including Web sites of its subsidiaries), and oral statements made by the officers of the Company. Except for historical information contained in these written or oral communications, such communications contain forward-looking statements. These include, for example, all references to 2010 or future years. New risk factors emerge from time to time and it is not possible for the Company to predict all such risk factors, nor can it assess the impact of all such risk factors on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. Accordingly, forward-looking statements cannot be relied upon as a guarantee of future results and involve a number of risks and uncertainties that could cause actual results to differ materially from those projected in the statements, including, but not limited to the factors that are described in Part I, Item 1A under the caption of "Risk Factors" of this Form 10-K, which section is incorporated herein by reference. The Company is not required, and undertakes no obligation, to revise or update forward-looking statements or any factors that may affect actual results, whether as a result of new information, future events, or circumstances occurring after the date of this report.

OVERVIEW

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is designed to provide a discussion of the Company's financial condition, results of operations, liquidity and certain other factors that may affect its future results from the perspective of management. The discussion that follows is intended to provide information that will assist in understanding the changes in the Company's financial statements from year to year, the primary factors that accounted for those changes, and how certain accounting principles, policies and estimates affect the Company's financial statements. MD&A is provided as a supplement to, and should be read in conjunction with, the consolidated financial statements and the accompanying notes to the financial statements. MD&A is presented in the following sections:

- Business Overview
- Critical Accounting Estimates
- Consolidated Results of Operations
- Analysis of Operating Revenue and Profit by Segment
- Liquidity and Capital Resources
- Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements
- Business Outlook
- Other Matters

BUSINESS OVERVIEW

Alexander & Baldwin, Inc. ("A&B"), founded in 1870, is a multi-industry corporation headquartered in Honolulu that operates in five segments in three industries—Transportation, Real Estate, and Agribusiness.

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment, which is conducted through Matson Navigation Company, Inc. ("Matson"), a wholly-owned subsidiary of A&B, is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities.

The Logistics Services segment, which is conducted through Matson Integrated Logistics, Inc. ("MIL"), a wholly-owned subsidiary of Matson, is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services (collectively "Highway"). Warehousing and distribution services are provided by Matson Global Distribution Services, Inc. ("MGDS"), a wholly-owned subsidiary of MIL. MGDS's operations also include Pacific American Services, LLC ("PACAM"), a San Francisco bay-area regional warehousing, packaging, and distribution company acquired in the third quarter of 2008.

The Transportation Industry accounted for 78 percent, 54 percent, and 49 percent of the revenue, operating profit, and identifiable assets, respectively, in 2009 on a consolidated basis before discontinued operations.

Real Estate: The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. Mainland. The Real Estate Sales segment generates its revenues through the development and sale of land and commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. Real estate activities are conducted through A&B Properties, Inc. and various other wholly-owned subsidiaries of A&B.

The Real Estate Industry accounted for 15 percent, 69 percent, and 44 percent of the revenue, operating profit, and identifiable assets, respectively, in 2009 on a consolidated basis before discontinued operations.

Agribusiness: Agribusiness, a division of A&B, contains one segment and produces and transports bulk raw sugar, specialty food grade sugars, and molasses; produces, markets, and distributes green coffee, roasted coffee, and specialty food-grade sugars; provides general trucking services, mobile equipment maintenance, and repair services; and generates and sells, to the extent not used in the Company's Agribusiness operations, electricity.

In the fourth quarter of 2009, the Company became the sole member in Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services to its members, and therefore, the Company consolidated HS&TC beginning December 1, 2009 in accordance with Financial Accounting Standards Board ("FASB") Accounting Standards Codification ("ASC") Topic 810 related to consolidation.

The Agribusiness Industry accounted for 7 percent of revenue and identifiable assets in 2009 on a consolidated basis before discontinued operations.

CRITICAL ACCOUNTING ESTIMATES

The Company's significant accounting policies are described in Note 1 to the Consolidated Financial Statements. The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America, upon which the MD&A is based, requires that management exercise judgment when making estimates and assumptions about future events that may affect the amounts reported in the financial statements and accompanying notes. Future events and their effects cannot be determined with absolute certainty and actual results will, inevitably, differ from those critical accounting estimates. These differences could be material.

The Company considers an accounting estimate to be critical if: (i)(a) the accounting estimate requires the Company to make assumptions that are difficult or subjective about matters that were highly uncertain at the time that the accounting estimate was made, (b) changes in the estimate are reasonably likely to occur in periods subsequent to the period in which the estimate was made, or (c) use of different estimates by the Company could have been used, and (ii) changes in those assumptions or estimates would have had a material impact on the financial condition or results of operations of the Company. The critical accounting estimates inherent in the preparation of the Company's financial statements are described below.

Impairment of Long-Lived Assets: The Company's long-lived assets are reviewed for possible impairment when events or circumstances indicate that the carrying value may not be recoverable. In such an evaluation, the estimated future undiscounted cash flows generated by the asset are compared with the amount recorded for the asset to determine if its carrying value is not recoverable. If this review determines that the recorded value will not be recovered, the amount recorded for the asset is reduced to estimated fair value. The Company has evaluated certain long-lived assets for impairment; however, no impairment charges were recorded as a result of this process. These asset impairment loss analyses are highly subjective because they require management to make assumptions and apply considerable judgments to, among others, estimates of the timing and amount of future cash flows, expected useful lives of the assets, uncertainty about future events, including changes in economic conditions, changes in operating performance, changes in the use of the assets, and ongoing costs of maintenance and improvements of the assets, and thus, the accounting estimates may change from period to period. If management uses different assumptions or if different conditions occur in future periods, the Company's financial condition or its future operating results could be materially impacted.

Impairment of Investments: The Company's investments in unconsolidated affiliates are reviewed for impairment whenever there is evidence that fair value may be below carrying cost. An investment is written down to fair value if fair value is below carrying cost and the impairment is other-than-temporary. In evaluating the fair value of an investment, the Company reviews discounted projected cash flows associated with the investment and other relevant information. In evaluating whether an impairment is other-than-temporary, the Company considers all available information, including the length of time and extent of the impairment, the financial condition and near-term prospects of the affiliate, the Company's ability and intent to hold the investment for a period of time sufficient to allow for any anticipated recovery in market value, and projected industry and economic trends, among others.

In determining the fair value of an investment and assessing whether any identified impairment is other-than-temporary, significant estimates and considerable judgments are involved. These estimates and judgments are based, in part, on the Company's current and future evaluation of economic conditions in general, as well as a joint venture's current and future plans. These impairment calculations are highly subjective because they also require management to make assumptions and apply judgments to, among others, estimates of the timing and amount of future cash flows, probabilities related to various cash flow scenarios, and appropriate discount rates. Changes in these and other assumptions could affect the projected operational results of the unconsolidated affiliates, and accordingly, may require valuation adjustments to the Company's investments that may materially impact the Company's financial condition or its future operating results. For example, if the current market conditions continue to deteriorate or a joint venture's plans change, additional impairment charges may be required in future periods, and those charges could be material.

In 2009, the Company evaluated certain investments in unconsolidated affiliates for impairment. As a result of this process, the Company recorded an impairment loss of approximately $2.5 million related to its Ka Milo joint venture investment. Continued weakness in the real estate sector or difficulty in obtaining or renewing project-level financing may affect the value or feasibility of certain development projects owned by the Company or by its joint ventures and could lead to additional impairment charges in the future.

Legal Contingencies: The Company's results of operations could be affected by significant litigation adverse to the Company, including, but not limited to, liability claims, antitrust claims, and claims related to coastwise trading matters. The Company records accruals for legal matters when the information available indicates that it is probable that a liability has been incurred and the amount of the loss can be reasonably estimated. Management makes adjustments to these accruals to reflect the impact and status of negotiations, settlements, rulings, advice of counsel and other information and events that may pertain to a particular matter. Predicting the outcome of claims and lawsuits and estimating related costs and exposure involves substantial uncertainties that could cause actual costs to vary materially from those estimates. In making determinations of likely outcomes of litigation matters, the Company considers many factors. These factors include, but are not limited to, the nature of specific claims including unasserted claims, the Company's experience with similar types of claims, the jurisdiction in which the matter is filed, input from outside legal counsel, the likelihood of resolving the matter through alternative dispute resolution mechanisms and the matter's current status. A detailed discussion of significant litigation matters is contained in Note 12 to the Consolidated Financial Statements.

Allowance for Doubtful Accounts: Receivables are recorded net of an allowance for doubtful accounts. The Company estimates future write-offs based on delinquencies, credit ratings, aging trends, and historical experience. The Company believes the allowance for doubtful accounts is adequate to cover anticipated losses; however, significant deterioration in any of the aforementioned factors or in general economic conditions could change these expectations, and accordingly, the Company's financial condition and/or its future operating results could be materially impacted.

Revenue Recognition for Certain Long-term Real Estate Developments: As discussed in Note 1 to the Consolidated Financial Statements, revenues from real estate sales are generally recognized when sales are closed and title, risk and rewards passes to the buyer. For certain real estate sales, the Company and its joint venture partners account for revenues on long-term real estate development projects that have material continuing post-closing involvement, such

CONSOLIDATED RESULTS OF OPERATIONS

The following analysis of the consolidated financial condition and results of operations of Alexander & Baldwin, Inc. and its subsidiaries (collectively, the "Company") should be read in conjunction with the consolidated financial statements and related notes thereto. Amounts in this narrative are rounded to millions, but per-share calculations and percentages were calculated based on thousands. Accordingly, a recalculation of some per-share amounts and percentages, if based on the reported data, may be slightly different than the more accurate amounts included herein.

(dollars in millions, except per-share amounts)	2009	Chg.	2008	Chg.	2007
Operating Revenue	$ 1,405	-25%	$ 1,880	14%	$ 1,651
Operating Costs and Expenses	1,363	-21%	1,731	15%	1,502
Operating Income	42	-72%	149	--%	149
Other Income and (Expense)	(22)	-3X	(8)	NM	8
Income Taxes	(8)	-85%	(52)	-12%	(59)
Discontinued Operations (net of taxes)	32	-26%	43	-2%	44
Net Income	$ 44	-67%	$ 132	-7%	$ 142
Basic Earnings Per Share	$ 1.08	-66%	$ 3.21	-4%	$ 3.34
Diluted Earnings Per Share	$ 1.08	-66%	$ 3.19	-3%	$ 3.30

2009 vs. 2008

Operating Revenue for 2009 decreased 25 percent, or $475 million, to $1,405 million. Real estate sales revenue decreased 93 percent in 2009 (after subtracting revenue from discontinued operations) due principally to sales at the Company's Keola La'i condominium project in 2008. Ocean transportation revenue decreased 13 percent, principally due to lower Hawaii volumes, lower China yields and lower fuel surcharge revenues, partially offset by improved Hawaii service yields and cargo mix. Logistics services revenue decreased 26 percent, principally due to lower volumes and yields, partially offset by revenue from MGDS's warehousing and distribution business, which acquired Pacific American Services, LLC ("PACAM"), a San Francisco bay-area regional warehousing, packaging and distribution company, in August 2008. Agribusiness revenue decreased 18 percent, primarily due to lower power sales volume and pricing and lower bulk raw sugar sales volume. Real estate leasing revenue increased 6 percent in 2009 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to a positive effect from the timing of property acquisitions and dispositions, partially offset by lower mainland occupancy and rents. The reasons for business- and segment-specific year-to-year fluctuations in revenue growth are further described below in the Analysis of Operating Revenue and Profit by Segment.

Because of the recurring nature of property sales, the Company views changes in real estate sales and real estate leasing revenues on a year-over-year basis before the reclassification of revenue to discontinued operations to be more meaningful in assessing segment performance. Additionally, due to the timing of sales for development properties and the mix of properties sold, management believes performance is more appropriately assessed over a multi-year period. Furthermore, year-over-year comparisons of revenue are not complete without the consideration of results from the Company's investment in its real estate joint ventures, which are not included in consolidated operating revenue, but are included in segment operating profit. The Analysis of Operating Revenue and Profit by Segment that follows, provides additional information on changes in real estate sales revenue and operating profit before reclassifications to discontinued operations.

Operating Costs and Expenses for 2009 decreased by 21 percent, or $368 million, to $1,363 million. Real estate sales and leasing costs decreased by 74 percent, primarily related to cost of sales for condominiums sold at Keola La'i in 2008, partially offset by higher depreciation expenses on commercial properties. Logistics services cost decreased 27 percent due primarily to lower volumes. Ocean transportation costs decreased 10 percent, primarily due to lower volume-related expenses, partially offset by higher contractual stevedoring rates and higher vessel repair costs. Selling, General and Administrative costs ("SG&A"), decreased 6 percent due principally to cost reduction initiatives, including workforce and benefit reductions, as well as lower performance-based compensation. Agribusiness costs decreased 2 percent due principally to personnel cost savings and lower volume of sugar sold. These cost decreases were partially offset by a $24 million year-over-year increase in non-cash pension expense, which is embedded in the segment figures and general and administrative expenses, was principally due to plan asset losses in 2008. The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Income Taxes were lower in 2009 compared with 2008 on an absolute basis due principally to lower income. The effective tax rate in 2009 was higher than the rate in 2008 principally due to an adjustment to prior year taxes, non-deductible expenses that had a greater impact on the effective rate as a result of lower income relative to 2008, the recognition of certain tax benefits in 2008 as a result of certain statute of limitations expirations, and newly enacted tax legislation which unfavorably affected the effective rate.

Other Income and Expense in 2009 decreased $14 million in 2009 compared with 2008, due primarily to $9 million in lower real estate joint venture income, an $8 million gain on a fire insurance settlement recognized in 2008, and $1 million in higher interest expense in 2009 resulting from lower capitalized interest and a higher weighted-average interest rate, partially offset by a $5 million gain recorded upon consolidation of HS&TC (as further described in Note 3 to the Consolidated Financial Statements).

2008 vs. 2007

Operating Revenue for 2008 increased 14 percent, or $229 million over 2007 results, to $1,880 million. Real estate sales revenue increased more than ninefold in 2008 (after subtracting revenue from discontinued operations) due principally to sales at the Company's Keola La'i condominium project. Real estate leasing revenue increased 10 percent in 2008 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to the favorable effect from the timing of acquisitions and dispositions, partially offset by lower mainland occupancy. Ocean transportation revenue increased 2 percent, principally due to higher fuel surcharge revenues, improved Hawaii service yields and cargo mix, and higher China service yields, partially offset by lower volumes. Logistics services revenue increased 1 percent, principally due to the commencement of MGDS's warehousing operations, the acquisition of

PACAM, and higher rates, principally fuel surcharges. Agribusiness revenue decreased modestly, primarily due to lower bulk raw sugar sales volumes.

Operating Costs and Expenses for 2008 increased by 15 percent, or $229 million, to $1,731 million. Real estate sales and leasing costs more than quadrupled, primarily related to cost of sales for condominiums sold at Keola La'i, and to a lesser extent higher depreciation expenses on commercial properties. Ocean transportation costs increased 5 percent, primarily due to higher vessel and terminal handling costs, partially offset by lower operations overhead costs, principally lower westbound container repositioning costs. Agribusiness costs increased 11 percent due principally to higher crop production costs. These increases were partially offset by lower consolidated SG&A, which decreased 1 percent due principally to lower performance-based compensation.

Other Income and Expense in 2008 is comprised of equity in earnings of real estate joint ventures, interest revenue and interest expense. Equity in income of real estate affiliates was $14 million lower in 2008 due principally to $12.1 million higher earnings from the Company's Kai Malu joint venture project in 2007. Interest expense of $24 million in 2008 was $5 million higher than 2007 due to higher average debt balances. Impairment losses related to the Company's investments totaled approximately $3 million and interest income in 2008 was $2 million lower than 2007 due to lower average rates and lower average invested balances. These decreases in 2008 were partially offset by an $8 million gain recognized in 2008 for an insurance settlement related to a 2005 casualty loss.

Income Taxes were lower in 2008 compared with 2007 on an absolute and percentage basis due to lower income and a reduction in the effective income tax rate. The lower effective income tax rate in 2008 was principally due to the recognition of $2 million in unrecognized tax benefits as a result of the expiration of certain statute of limitations, tax credits related to renewable energy and investments, and a decrease in certain non-deductible expenses.

ANALYSIS OF OPERATING REVENUE AND PROFIT BY SEGMENT

Additional detailed information related to the operations and financial performance of the Company's Industry Segments is included in Part II Item 6 and Note 13 to the Consolidated Financial Statements. The following information should be read in relation to the information contained in those sections.

Transportation Industry

***Ocean Transportation**: 2009 compared with 2008*

(dollars in millions)		2009		2008	Change
Revenue	$	**888.6**	$	1,023.7	-13%
Operating profit	$	**58.3**	$	105.8	-45%
Operating profit margin		**6.6%**		10.3%	
Volume* (units):					
Hawaii containers		**136,100**		152,700	-11%
Hawaii automobiles		**83,400**		86,300	-3%
China containers		**46,600**		47,800	-3%
Guam containers		**14,100**		13,900	1%

* Container volumes included for the period are based on the voyage departure date, but revenue and operating profit are adjusted to reflect the percentage of revenue and operating profit earned during the reporting period for voyages that straddle the beginning and/or end of the reporting period.

Ocean Transportation revenue decreased $135.1 million, or 13 percent, in 2009 compared to 2008. This decrease was principally due to $82.5 million of lower revenue, resulting from lower net volumes and $76.1 million in reduced fuel surcharges resulting from a reduction in average bunker fuel prices. These decreases were partially offset by a $21.0 million net improvement in yields and cargo mix and revenue of $5.2 million in higher revenue from a U.S. Government charter in 2009. The net improvement in yields were driven by improved yields in the Hawaii trade, but was partially offset by rate deterioration in China.

Total Hawaii container volume was down 11 percent in 2009 compared with 2008, reflecting a broad-based decline in demand caused by the ongoing softness in Hawaii's economy. Matson's Hawaii automobile volume for the year was 3 percent lower than 2008, also reflecting economic weakness that is negatively impacting new car shipments from manufacturers to Hawaii auto dealers and rental car companies. China container volume decreased 3 percent in 2009, compared with 2008, principally due to weak demand for U.S. bound imports. Guam container volumes were essentially unchanged.

Operating profit decreased $47.5 million, or 45 percent, in 2009 compared to 2008. The decrease in operating profit was principally due to $59.7 million related to lower net volumes, $11.4 million from higher terminal costs as a result of higher contractual stevedoring rates, $2.2 million in higher general and administrative expenses, and $1.9 million in higher vessel costs. General and administrative expenses were higher principally due to $10 million in higher pension costs and a first quarter 2009 expense of $6.0 million related to Matson's headcount reduction program, which was partially offset by the ongoing benefit of the headcount reduction. Vessel expenses were impacted by the direct and indirect costs associated with emergency rudder repairs, totaling $6.3 million, and increased drydock and insurance expenses totaling $5.3 million, partially offset by $9.7 million in reduced expenses that were principally the result of efficient fleet deployment initiatives. The decrease in operating profit was partially offset by a $21.0 million improvement in yields and cargo mix, net of the impact resulting from China rate deterioration, the increased contribution of $2.8 million from U.S. Government charters, and $2.3 million in lower outside transportation expenses resulting from reduced truck and ocean carrier costs.

***Discontinued Operations**; Real-Estate* – The revenue, operating profit, and after-tax effects of discontinued operations for 2009, 2008 and 2007 were as follows (in millions, except per-share amounts):

		2009		2008		2007
Sales Revenue	**$**	**109.6**	$	125.4	$	94.8
Leasing Revenue	**$**	**14.6**	$	26.1	$	35.4
Sales Operating Profit	**$**	**44.3**	$	55.0	$	50.8
Leasing Operating Profit	**$**	**8.0**	$	14.3	$	20.4
After-tax Earnings	**$**	**32.3**	$	43.1	$	44.3
Basic Earnings Per Share	**$**	**0.79**	$	1.04	$	1.04
Diluted Earnings Per Share	**$**	**0.79**	$	1.04	$	1.03

2009: The revenue and expenses of Hawaii Business Park, an industrial property on Oahu, Southbank II, an office building in Arizona, San Jose Avenue Warehouse, an industrial property in California, Pacific Guardian Tower, an office property on Oahu, Village at Indian Wells, an office property in California, and various parcels on Maui have been classified as discontinued operations. Additionally, a retail property on Oahu was classified as discontinued operations.

2008: The revenue and expenses of two retail properties on the mainland, one mainland office property, a multi-tenant residential rental property, three commercial properties on Maui, land previously leased to a telecommunications tenant on Maui, and several land parcels on Maui, and have been classified as discontinued operations.

2007: The revenue and expenses of land leased to a retail tenant on Oahu, several commercial properties on Maui, a leased fee parcel on Maui, and a commercial property in California have been classified as discontinued operations.

Agribusiness

The Company's Hawaiian Commercial & Sugar Company division and Gay & Robinson ("G&R") were members in Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services to its members. In the fourth quarter of 2009, G&R ceased production of raw sugar. As a result, G&R's membership in the cooperative terminated because a cooperative member must be an active producer. Consequently, upon G&R's withdrawal, the Company became the sole member in HS&TC and consolidated HS&TC beginning December 1, 2009 in accordance with FASB ASC Topic 810 related to consolidation.

The identifiable assets and liabilities from HS&TC were recorded based upon their estimated fair values at December 1, 2009. Approximately $5 million of identifiable assets, net of liabilities, measured at fair value, was recorded as a gain and classified as Other Income (Expense) in the consolidated statements of income.

***Agribusiness**; 2009 compared with 2008*

(dollars in millions)		**2009**		2008	Change
Revenue	**$**	**107.0**	$	124.3	-14%
Operating loss	**$**	**(27.8)**	$	(12.9)	-2X
Tons sugar produced		**126,800**		145,200	-13%

Agribusiness revenue decreased $17.3 million in 2009 compared with 2008. The decrease was primarily due to a $16.6 million reduction in power revenue stemming from lower power prices and volume and $9.2 million in lower raw sugar sales volume, partially offset by a $5.4 million non-operating gain recognized upon consolidation of HS&TC and $3.4 million in higher specialty sugar volume. Power prices, which decreased by more than 50 percent compared to the prior year, are determined by an avoided cost calculation for the public utilities in Hawaii, and have been negatively impacted by a reduction in fossil fuel costs as well as a regulatory change in the avoided cost formula.

Operating loss increased $14.9 million in 2009 compared with 2008. The increase in operating loss was primarily due to $18.8 million reduction in power sales margin resulting from lower sales prices and volume and higher boiler fuel consumption and prices. The increase in operating loss was partially offset by a $5.4 million non-operating gain recorded upon consolidation of HS&TC.

Sugar production in 2009 was 13 percent lower than in 2008 due to the ongoing effects of severe drought conditions in 2007-2008. Additionally, fewer acres were harvested in 2009 to allow growing cane to mature more fully before harvest. The average revenue per ton of sugar for 2009 was $352, or 1 percent lower than the average revenue per ton of $355 in 2008.

Approximately 73 percent of the Company's sugar production was sold to Hawaiian Sugar & Transportation Cooperative ("HS&TC") during 2009 under a marketing contract. The remainder was sold as specialty sugar. HS&TC sells its raw sugar to C&H Sugar Company, Inc. at a price equal to the New York No. 16 Contract settlement price, less a discount and less costs for sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Company. In 2009, HS&TC entered into a new contract for the delivery and sale of raw sugar with C&H Sugar Company, Inc., which replaced the contract that was set to expire in December 2009. The new contract was executed in October 2009 and has 3-year term.

***Agribusiness**; 2008 compared with 2007*

(dollars in millions)	**2008**	2007	Change

Revenue	$	**124.3**	$	123.7	--%
Operating profit (loss)	$	**(12.9)**	$	0.2	NM
Tons sugar produced		**145,200**		164,500	-12%

Agribusiness revenue increased $0.6 million in 2008 compared with 2007. The increase was principally due to $6.1 million in higher power prices and volumes, $4.6 million in higher specialty sugar sales volumes, and $1.5 million in higher raw sugar prices, partially offset by $8.8 million in lower raw sugar sales volumes and $2.9 million in lower revenue from soil and molasses sales.

Operating loss for 2008 was $12.9 million compared with an operating profit of $0.2 million for 2007. The operating loss was primarily due to $14.9 million in lower sugar margins that were the result of lower production volumes and higher operating costs than 2007, $1.6 million in lower soil sales, $1.5 million in lower profits from other operations and $1.2 million in lower molasses sales prices. This unfavorable variance was partially offset by $6.1 million in higher power revenue from higher prices.

Compared with 2007, sugar production in 2008 was 12 percent, or 19,300 tons, lower due to lower yields. Lower sugar yields were principally the result of extended drought conditions. The average revenue per ton of sugar for 2008 was $355, or 4 percent higher than the average revenue per ton of $342 in 2007.

LIQUIDITY AND CAPITAL RESOURCES

Overview: The Company has a $325 million revolving credit facility, which expires in December 2011. As of December 31, 2009, the Company had approximately $281 million of available capacity under the facility. Additionally, as of December 31, 2009, the Company had access to approximately $71 million of remaining capacity on a $400 million term facility, under which the ability to draw additional amounts under the facility expires in April 2012, and $74 million of remaining capacity on a facility that expires in June 2015. The Company has discussed credit availability with its lenders and currently believes that its lenders are able and willing to lend pursuant to the terms of the respective credit facilities. Additionally, the Company is currently in compliance with all of its covenants under its debt agreements. As a result, the Company believes its ability to access cash under its facilities will be adequate to meet anticipated future cash requirements to fund working capital, capital expenditures, dividends, potential acquisitions, stock repurchases, and other cash needs for the foreseeable future. There can be no assurance, however, that the Company will continue to generate cash flows at or above current levels or that it will be able to maintain its ability to borrow under its available credit facilities.

While Matson is subject to restrictions on the transfer of net assets to A&B under certain debt agreements, these restrictions have not had any effect on the Company's shareholder dividend policy, and the Company does not anticipate that these restrictions will have any impact in the future. At December 31, 2009, the amount of net assets of Matson that may not be transferred to the Company was approximately $286 million.

On January 29, 2009, the Company committed to a fourth series of senior promissory notes, Series D notes, totaling $100 million under its Prudential facility more fully described in Note 7 to the Consolidated Financial Statements. The notes carry interest at an annual fixed-rate of 6.9 percent with a final maturity on March 9, 2020. Interest is paid semi-annually and the principal under the note will be repaid in annual installments commencing in March 2012.

Cash Flows: Cash flows provided by operating activities continue to be the Company's most significant source of liquidity. Cash flows from operating activities totaled $115 million for 2009, $275 million for 2008, and $124 million for 2007. The decrease in 2009 over 2008 was due principally to proceeds from the sale of 330 residential units and two commercial units at the Company's Keola La'i condominium project in 2008 and lower Agribusiness and Matson earnings in 2009. The increase in 2008 over 2007 was due principally to proceeds from the sale of units at Keola La'i previously mentioned, lower 2008 spending on real estate development inventory, partially offset by lower 2008 Agribusiness and Matson earnings and higher 2008 income tax payments.

Cash flows used in investing activities were $31 million for 2009, $149 million for 2008, and $145 million for 2007. Of the 2009 amount, $31 million was for capital expenditures, including $14 million related to real estate investments, $13 million related to the purchase of transportation-related assets, and $4 million principally related to routine replacements for agricultural operations. Other cash flows used in investing activities included $48 million related principally to additional investments in joint venture projects. These cash outflows were offset by $32 million in cash proceeds received that were primarily related to property sales, $10 million due principally to the consolidation of HS&TC, and $6 million principally related to distributions from joint ventures. The cash used in investing activities for 2009 excludes $95 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period.

Of the 2008 amount, $109 million was for capital expenditures, including $54 million related to real estate investments, such as the reverse 1031 acquisition of Savannah Logistics Center and other leasing portfolio improvements, $38 million related to the purchase of transportation-related assets, and $15 million principally related to routine replacements for agricultural operations. Other cash flows used in investing activities included $41 million related to additional investments in joint venture projects, and $24 million for the acquisition of PACAM. These cash outflows were partially offset by $27 million in cash proceeds received that were primarily related to property sales. The $149 million of cash used in investing activities for 2008 excludes $46 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period. Additionally, expenditures for real estate held-for-sale are excluded from capital expenditures and included in Cash Flows from Operating Activities because they are considered an operating activity of the Company.

Of the 2007 amount, $122 million was for capital expenditures that included $68 million for the purchase of transportation-related assets, $34 million for real estate leasing and property improvements (excluding non-cash 1031 transactions and real estate development activity), and $20 million related to agricultural operations, primarily for the expansion of specialty sugar facilities. The $122 million for 2007 excludes $91 million of 1031 tax-deferred purchases since the Company did not actually take control of the cash during the exchange period.

In 2010, the Company expects that its required minimum capital expenditures will approximate the amount required in 2009. However, in 2010, the Company's total capital budget is expected to be approximately $335 million, which includes spending for new, but currently unidentified, investment opportunities as well as expenditures for real estate developments and currently unidentified 1031 lease portfolio acquisitions that are not included in the caption entitled "Capital expenditures for property and developments" under investing activities in the statement of cash flows. These real estate expenditures are excluded from "Capital expenditures for property and developments" because the expenditures either relate to the Company's real estate held-for-sale inventory that is treated as an operating activity, and therefore, reflected in operating cash flows, or are expenditures that are made using tax-deferred proceeds from prior tax-deferred sales, and therefore, reflected as non-cash activities (since the Company does not take control of the cash during the exchange period).

difficult to forecast precisely and will be influenced by the attractiveness of potential sales prices as well as the return potential of the replacement property.

In 2010, the Company expects to see an increase in real estate investment opportunities that meet its underwriting criteria. Accordingly, the Company expects to increase its placement of capital for the real estate segments relative to 2009. In making these investments, the Company intends to focus primarily on investment opportunities in Hawaii. However, the timing and scale of these investments is not certain and will be dependent upon a number of factors, including, but not limited to, return and risk thresholds, underlying valuations, and the availability of alternative capital investment opportunities.

In 2009, unit sales activity for the Company's residential development projects (including joint ventures) declined significantly from levels experienced in 2008. In 2010, the Company expects that residential development sales activity will remain suppressed. The Company will continue to vigorously pursue entitlement, design and permitting at various projects, which will position the Company well to meet demand that is expected to materialize over the longer-term as the real estate markets recover.

Agribusiness: In 2009, the Company's Agribusiness operations generated significant losses due to reduced power sales, low sugar production and higher non-cash pension expenses. Power revenue was impacted by lower rates, stemming from lower crude oil prices and from a mid-2008 public utility commission ruling that modified the avoided cost formula, as well as by lower volume. In 2010, the Company expects that losses will moderate significantly, primarily due to improved sugar pricing and forecasted higher sugar production levels.

A comprehensive review of the Company's sugar operations led to a decision to continue operations through 2010. This decision was based, among other factors, primarily on the recent spike in sugar prices, as well as prospects for increased sugar production. Continuation of operations beyond 2010, however, remains subject to a favorable outcome in the water cases pending before the State Commission on Water Resource Management, as well as other factors, such as the Company's ability to attain higher sugar production levels. Favorable water rulings are critical to the long-term viability of the plantation. Resolution of the water cases is expected in the first half of 2010.

OTHER MATTERS

Management Changes: The following management changes occurred during 2009 and through February 25, 2010.

On October 22, 2009, the Company announced the retirement of W. Allen Doane, chairman of the board and chief executive officer. Effective January 1, 2010, Stanley M. Kuriyama, A&B president, succeeded Mr. Doane as chief executive officer. Mr. Kuriyama was also named to serve on the A&B board of directors, effective January 1, 2010. Mr. Doane will continue to serve A&B as a director. Walter A. Dods, Jr., who had served as Lead Independent Director since 2006, became chairman of the A&B board, also effective January 1, 2010.

G. Stephen Holaday retired from his position as president, Agribusiness, where he held oversight responsibility for A&B's Kauai Coffee Company, Inc., Kahului Trucking & Storage, Inc., and Kauai Commercial Company, Incorporated. His retirement was effective as of April 15, 2009.

Frank E. Kiger, formerly general manager of Hawaiian Commercial & Sugar Company, retired effective June 1, 2009.

Christopher J. Benjamin was appointed general manager, Hawaiian Commercial & Sugar Company, effective March 9, 2009, replacing Mr. Kiger. Mr. Benjamin also has assumed oversight responsibilities for A&B's other Agribusiness units and continues to serve as senior vice president, chief financial officer and treasurer of Alexander & Baldwin, Inc.

James S. Andrasick, chairman of the board of Matson Navigation Company, Inc., retired effective August 31, 2009. Stanley M. Kuriyama was appointed chairman of the board of Matson effective September 1, 2009.

Robert C. Papworth, President of Matson Integrated Logistics, Inc., retired effective December 1, 2009.

Robert K. Sasaki, Vice Chairman of A&B Properties, Inc. retired effective January 1, 2010.

Kevin L. Halloran, vice president of corporate development and investor relations of A&B, announced his resignation, which will be effective February 28, 2010.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31, 2009	2008	2007
Operating Revenue:			
Ocean transportation	$ 887	$ 1,021	$ 1,003
Logistics services	321	436	433
Real estate leasing	84	79	72
Real estate sales	16	225	23
Agribusiness	97	119	120
Total operating revenue	1,405	1,880	1,651
Operating Costs and Expenses:			
Cost of ocean transportation services	740	825	789
Cost of logistics services	280	381	381
Cost of real estate sales and leasing	59	229	47
Cost of agribusiness goods and services	130	133	120
Selling, general and administrative	154	163	165
Total operating costs and expenses	1,363	1,731	1,502
Operating Income	42	149	149
Other Income and (Expense):			
Gain on insurance settlement and other	–	8	1
Gain on consolidation of HS&TC (Note 3)	5	--	--
Equity in income of real estate affiliates	–	9	23
Impairment loss on investment	(2)	(2)	--
Interest income	–	1	3
Interest expense	(25)	(24)	(19)
Income From Continuing Operations Before Income Taxes	20	141	157
Income taxes	8	52	59
Income From Continuing Operations	12	89	98
Income from discontinued operations, net of income taxes (Note 2)	32	43	44
Net Income	$ 44	$ 132	$ 142
Basic Earnings per Share of Common Stock:			
Continuing operations	$ 0.29	$ 2.17	$ 2.30
Discontinued operations	0.79	1.04	1.04
Net income	$ 1.08	$ 3.21	$ 3.34
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ 0.29	$ 2.15	$ 2.27
Discontinued operations	0.79	1.04	1.03
Net income	$ 1.08	$ 3.19	$ 3.30
Weighted Average Number of Shares Outstanding:			
Basic	41.0	41.2	42.5
Diluted	41.1	41.5	43.1

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31, 2009	2008	2007
Cash Flow from Operating Activities:			
Net income	**$ 44**	$ 132	$ 142
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	**105**	101	93
Deferred income taxes	**1**	19	26
Gains on disposal of assets, net of impairment losses	**(51)**	(91)	(64)
Casualty gain from receipt of insurance proceeds	**–**	(8)	--
Gain on consolidation of HS&TC	**(5)**	--	--
Share-based expense	**9**	11	17
Equity in income of affiliates, net of distributions	**(1)**	11	1
Changes in operating assets and liabilities:			
Accounts and notes receivable	**(16)**	24	(9)
Inventories	**(6)**	(6)	(3)
Prepaid expenses and other assets	**(5)**	3	12
Deferred dry-docking costs	**10**	(9)	(22)
Liability for employee benefit plans	**–**	(3)	(3)
Accounts and income taxes payable	**20**	(37)	19
Other liabilities	**11**	(17)	14
Real Estate Developments Held for Sale:			
Real estate inventory sales	**5**	184	11
Expenditures for real estate inventory	**(6)**	(39)	(110)
Net cash provided by operations	**115**	275	124
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	**(31)**	(109)	(122)
Proceeds from disposal of income-producing property, investments and other assets	**32**	19	18
Proceeds from insurance settlement related to 2005 casualty loss	**–**	8	--
Deposits into Capital Construction Fund	**(4)**	(7)	(30)
Withdrawals from Capital Construction Fund	**4**	8	30
Acquisition of businesses, net of cash acquired	**10**	(27)	--
Payments for purchases of investments	**(48)**	(60)	(43)
Proceeds from sale and maturity of investments	**6**	19	2
Net cash used in investing activities	**(31)**	(149)	(145)
Cash Flows from Financing Activities:			
Proceeds from issuance of long-term debt	**241**	127	139
Payments of long-term debt and deferred financing costs	**(288)**	(138)	(88)
Proceeds from (payments on) short-term borrowings, net	**13**	(5)	15
Repurchases of capital stock	**–**	(59)	(33)
Proceeds from issuance of capital stock, net of excess tax benefit	**(1)**	2	8
Dividends paid	**(52)**	(51)	(48)
Net cash used in financing activities	**(87)**	(124)	(7)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	**(3)**	2	(28)
Balance, beginning of year	**19**	17	45
Balance, end of year	**$ 16**	$ 19	$ 17
Other Cash Flow Information:			
Interest paid, net of amounts capitalized	**$ (24)**	$ (25)	$ (25)
Income taxes paid	**$ (38)**	$ (63)	$ (55)
Non-cash Activities:			
Debt assumed in real estate purchase	**$ –**	$ 11	$ --
Tax-deferred property sales	**$ 109**	$ 112	$ 83
Tax-deferred property purchases	**$ (95)**	$ (46)	$ (91)

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2009	December 31, 2008
ASSETS		
Current Assets		
Cash and cash equivalents	**$ 16**	$ 19
Accounts and notes receivable, less allowances of $10 for 2009 and $8 for 2008	**172**	163
Inventories	**43**	28
Real estate held for sale	**36**	20
Deferred income taxes	**6**	--
Section 1031 exchange proceeds	**1**	23
Prepaid expenses and other assets	**33**	31
Total current assets	**307**	284
Investments in Affiliates	**242**	208
Real Estate Developments	**88**	78
Property – net	**1,536**	1,590
Employee Benefit Plan Assets	**3**	3
Other Assets	**204**	187
Total	**$ 2,380**	$ 2,350
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	**$ 65**	$ 52
Accounts payable	**132**	105
Payroll and vacation benefits	**18**	18
Uninsured claims	**9**	10
Deferred income taxes	**--**	1
Accrued and other liabilities	**73**	52
Total current liabilities	**297**	238
Long-term Liabilities		
Long-term debt	**406**	452
Deferred income taxes	**428**	414
Employee benefit plans	**116**	122
Uninsured claims and other liabilities	**48**	52
Total long-term liabilities	**998**	1,040
Commitments and Contingencies (Note 12)		
Shareholders' Equity		
Capital stock – common stock without par value; authorized, 150 million shares ($0.75 stated value per share); outstanding, 41.0 million shares in 2009 and 2008	**33**	33
Additional capital	**210**	204
Accumulated other comprehensive loss	**(81)**	(96)
Retained earnings	**934**	942
Cost of treasury stock	**(11)**	(11)
Total shareholders' equity	**1,085**	1,072
Total	**$ 2,380**	$ 2,350

See notes to consolidated financial statements.

INDUSTRY SEGMENTS (CONTINUED)

Industry segment information for 2009, 2008, and 2007 is summarized below (in millions):

For the Year		2009		2008		2007
Revenue:						
Transportation:						
Ocean transportation	$	888.6	$	1,023.7	$	1,006.9
Logistics services		320.9		436.0		433.5
Real Estate:						
Leasing		103.2		107.8		108.5
Sales		125.6		350.2		117.8
Less amounts reported in discontinued operations [1]		(124.2)		(151.5)		(130.2)
Agribusiness[5]		107.0		124.3		123.7
Reconciling Items [2]		(16.3)		(10.7)		(9.2)
Total revenue	$	1,404.8	$	1,879.8	$	1,651.0
Operating Profit:						
Transportation:						
Ocean transportation[3]	$	58.3	$	105.8	$	126.5
Logistics services		6.7		18.5		21.8
Real Estate:						
Leasing		43.2		47.8		51.6
Sales[3]		39.1		95.6		74.4
Less amounts reported in discontinued operations [1]		(52.3)		(69.3)		(71.2)
Agribusiness[5]		(27.8)		(12.9)		0.2
Total operating profit		67.2		185.5		203.3
Interest expense, net[4]		(25.9)		(23.7)		(18.8)
General corporate expenses		(21.8)		(21.0)		(27.3)
Income from continuing operations before income taxes		19.5		140.8		157.2
Income taxes		7.6		51.5		59.3
Income from continuing operations		11.9		89.3		97.9
Discontinued operations		32.3		43.1		44.3
Net income	$	44.2	$	132.4	$	142.2

[1] Prior year amounts restated for amounts treated as discontinued operations. See Notes 1 and 2 for additional information.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $6.2 million, $5.2 million, and $10.7 million of equity in earnings from its investment in SSAT for 2009, 2008, and 2007, respectively. The Real Estate Sales segment includes approximately $9.0 million and $22.6 million in equity in earnings from its various real estate joint ventures for 2008 and 2007, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] Includes Ocean Transportation interest expense of $9.0 million for 2009, $11.6 million for 2008, and $13.9 million for 2007. Substantially all other interest expense was at the parent company.

[5] Includes a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

INDUSTRY SEGMENTS (CONTINUED)

As of December 31:	2009	2008	2007
Identifiable Assets:			
Ocean transportation[6]	**$ 1,095.2**	$ 1,153.9	$ 1,215.0
Logistics services	**72.4**	74.2	58.6
Real estate leasing	**627.4**	590.2	595.4
Real estate sales[6]	**415.6**	344.6	408.9
Agribusiness	**156.8**	172.2	174.6
Other	**12.2**	15.1	26.6
Total assets	**$ 2,379.6**	$ 2,350.2	$ 2,479.1
Capital Expenditures:			
Ocean transportation	**$ 12.7**	$ 35.5	$ 65.8
Logistics services[7]	**0.6**	2.4	2.0
Real estate leasing[8]	**108.8**	100.2	124.5
Real estate sales[9]	**0.1**	0.6	0.3
Agribusiness	**3.4**	15.2	20.5
Other	**0.3**	0.8	0.3
Total capital expenditures	**$ 125.9**	$ 154.7	$ 213.4
Depreciation and Amortization:			
Ocean transportation	**$ 67.1**	$ 66.1	$ 63.2
Logistics services	**3.5**	2.3	1.5
Real estate leasing[1]	**19.5**	17.9	15.7
Real estate sales	**0.3**	0.2	0.2
Agribusiness	**11.9**	11.5	10.7
Other	**3.1**	2.7	1.3
Total depreciation and amortization	**$ 105.4**	$ 100.7	$ 92.6

[6] The Ocean Transportation segment includes approximately $47.2 million, $44.6 million, and $48.6 million related to its investment in SSAT as of December 31, 2009, 2008, and 2007, respectively. The Real Estate Sales segment includes approximately $193.3 million, $162.1 million, and $134.1 million related to its investment in various real estate joint ventures as of December 31, 2009, 2008, and 2007, respectively.

[7] Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as Payments for Purchases of Investments in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

[8] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[9] Excludes capital expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for capital expenditures related to real estate developments were $6 million, $39 million, and $110 million for 2009, 2008, and 2007, respectively.

14. QUARTERLY INFORMATION (Unaudited)

Segment results by quarter for 2009 are listed below (in millions, except per-share amounts):

	2009			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 201.1	$ 218.5	$ 234.2	$ 234.8
Logistics services	76.2	80.3	82.3	82.1
Real Estate:				
Leasing	27.2	25.9	25.2	24.9
Sales	25.2	21.3	14.9	64.2
Less amounts reported in discontinued operations [1]	(29.6)	(20.8)	(13.4)	(60.4)
Agribusiness[2]	17.7	29.2	32.5	27.6
Reconciling Items [3]	(2.3)	(2.8)	(3.0)	(8.2)
Total revenue	$ 315.5	$ 351.6	$ 372.7	$ 365.0
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ (0.5)	$ 21.1	$ 24.2	$ 13.5
Logistics services	1.5	1.8	2.2	1.2
Real Estate:				
Leasing	12.0	11.0	10.2	10.0
Sales	5.6	9.6	3.5	20.4
Less amounts reported in discontinued operations [1]	(11.3)	(12.1)	(5.5)	(23.4)
Agribusiness[2]	(1.9)	(11.3)	(13.8)	(0.8)
Total operating profit	5.4	20.1	20.8	20.9
Interest Expense	(5.6)	(6.9)	(6.7)	(6.7)
General Corporate Expenses	(6.1)	(4.5)	(4.9)	(6.3)
Income From Continuing Operations before Income Taxes	(6.3)	8.7	9.2	7.9
Income taxes (benefit)	(2.3)	3.6	4.1	2.2
Income From Continuing Operations	(4.0)	5.1	5.1	5.7
Discontinued Operations[1]	7.0	7.5	3.4	14.4
Net Income	$ 3.0	$ 12.6	$ 8.5	$ 20.1
Earnings Per Share:				
Basic	$ 0.07	$ 0.31	$ 0.21	$ 0.49
Diluted	$ 0.07	$ 0.31	$ 0.21	$ 0.49

1 See Note 2 for discussion of discontinued operations.

2 Includes a $5.4 million gain recorded upon consolidation of HS&TC in the fourth quarter of 2009.

3 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

Segment results by quarter for 2008 are listed below (in millions, except per-share amounts):

	2008			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 243.0	$ 268.4	$ 272.8	$ 239.5
Logistics services	102.6	115.5	118.1	99.8
Real Estate:				
Leasing	28.8	27.3	26.2	25.5
Sales	187.4	31.2	77.2	54.4
Less amounts reported in discontinued operations [1]	(8.3)	(19.0)	(75.9)	(48.3)
Agribusiness	22.5	36.2	37.5	28.1
Reconciling Items [2]	(1.5)	(2.6)	(3.0)	(3.6)
Total revenue	$ 574.5	$ 457.0	$ 452.9	$ 395.4
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 15.9	$ 37.4	$ 31.4	$ 21.1
Logistics services	4.7	4.6	5.1	4.1
Real Estate:				
Leasing	13.9	12.6	11.1	10.2
Sales	41.4	9.1	25.8	19.3
Less amounts reported in discontinued operations [1]	(4.9)	(10.8)	(30.0)	(23.6)
Agribusiness	4.8	(4.9)	(6.7)	(6.1)
Total operating profit	75.8	48.0	36.7	25.0
Interest Expense	(6.1)	(5.6)	(5.8)	(6.2)
General Corporate Expenses	(5.7)	(5.4)	(5.3)	(4.6)
Income From Continuing Operations before Income Taxes	64.0	37.0	25.6	14.2
Income taxes	25.1	14.1	7.4	4.9
Income From Continuing Operations	38.9	22.9	18.2	9.3
Discontinued Operations [1]	3.2	6.7	18.6	14.6
Net Income	$ 42.1	$ 29.6	$ 36.8	$ 23.9
Earnings Per Share:				
Basic	$ 1.02	$ 0.72	$ 0.89	$ 0.58
Diluted	$ 1.01	$ 0.71	$ 0.89	$ 0.58

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

15. PARENT COMPANY CONDENSED FINANCIAL INFORMATION

Set forth below are the unconsolidated condensed financial statements of Alexander & Baldwin, Inc. ("Parent Company"). The significant accounting policies used in preparing these financial statements are substantially the same as those used in the preparation of the consolidated financial statements as described in Note 1, except that, for purposes of the tables presented in this footnote, subsidiaries are carried under the equity method.

The following table presents the Parent Company's condensed balance sheets as of December 31, 2009 and 2008 (in millions):

	2009	2008
ASSETS		
Current Assets:		
Cash and cash equivalents	$ 1	$ --
Accounts and other receivables, net	12	3
Inventories	6	--
Real estate held for sale	7	--
Income tax receivable	--	24
Section 1031 exchange proceeds	--	23
Prepaid expenses and other	15	23
Total current assets	41	73
Investments:		
Subsidiaries consolidated, at equity	1,210	1,131
Property, at Cost	455	432
Less accumulated depreciation and amortization	226	219
Property -- net	229	213
Other Assets	32	43
Total	$ 1,512	$ 1,460
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 40	$ 28
Accounts payable	10	8
Income taxes payable	24	--
Non-qualified benefit plans	17	4
Other	15	12
Total current liabilities	106	52
Long-term Debt	239	200
Employee Benefit Plans	22	49
Non-qualified Benefit Plans	8	17
Other Long-term Liabilities	4	6
Deferred Income Taxes	42	30
Due to Subsidiaries	6	34
Shareholders' Equity:		
Capital stock	33	33
Additional capital	210	204
Accumulated other comprehensive loss	(81)	(96)
Retained earnings	934	942
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,085	1,072
Total	$ 1,512	$ 1,460

The following table presents the Parent Company's condensed statements of income for the years ended December 31, 2009, 2008 and 2007 (in millions):

	2009	2008	2007
Revenue:			
Agribusiness	$ 73	$ 91	$ 92
Real estate leasing	22	19	18
Real estate sales	8	6	6
Interest and other	2	3	8
Total revenue	105	119	124
Costs and Expenses:			
Cost of agribusiness goods and services	109	110	97
Cost of real estate sales and leasing	14	11	10
Selling, general and administrative	21	21	28
Interest and other	16	14	12
Income tax benefit	(21)	(16)	(7)
Total costs and expenses	139	140	140
Loss from Continuing Operations	(34)	(21)	(16)
Discontinued Operations, net of income taxes	8	17	4
Loss Before Equity in Income of Subsidiaries Consolidated	(26)	(4)	(12)
Equity in Income from Continuing Operations of Subsidiaries Consolidated	46	111	114
Equity in Income from Discontinued Operations of Subsidiaries Consolidated	24	25	40
Net Income	44	132	142
Other Comprehensive Income (Loss), net of income taxes	15	(91)	15
Comprehensive Income	$ 59	$ 41	$ 157

The following table presents the Parent Company's condensed statements of cash flows for the years ended December 31, 2009, 2008 and 2007 (in millions):

	2009	2008	2007
Cash Flows from Operations (including dividends received from subsidiaries)	$ 90	$ 144	$ 17
Cash Flows from Investing Activities:			
Capital expenditures	(6)	(16)	(18)
Purchase of investments	(96)	(12)	--
Proceeds from disposal of property and sale of investments	28	9	5
Net cash used in investing activities	(74)	(19)	(13)
Cash Flows from Financing Activities:			
Change in intercompany payables/receivables	(13)	(4)	(15)
Proceeds from (repayments of) long-term debt, net	51	(16)	85
Proceeds from issuance of capital stock, including tax benefit	(1)	2	8
Repurchases of capital stock	--	(59)	(33)
Dividends paid	(52)	(51)	(48)
Net cash used in financing activities	(15)	(128)	(3)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	1	(3)	1
Balance, beginning of year	--	3	2
Balance, end of year	$ 1	$ --	$ 3
Other Cash Flow Information:			
Interest paid	$ (13)	$ (13)	$ (12)
Income taxes paid, net of refunds	$ (38)	$ (63)	$ (55)
Other Non-cash Information:			
Depreciation expense	$ 17	$ 15	$ 15
Tax-deferred property sales	$ 29	$ 60	$ --
Tax-deferred property purchases	$ (40)	$ (5)	$ --

General Information: The Parent Company is headquartered in Honolulu, Hawaii and is engaged in the operations that are generally described in Note 13, "Industry Segments." Additional information related to the Parent Company is described in the foregoing notes to the consolidated financial statements.

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2010

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _______ to _______

Commission file number 000-00565

ALEXANDER & BALDWIN, INC.

(Exact name of registrant as specified in its charter)

Hawaii (State or other jurisdiction of incorporation or organization)	**99-0032630** (I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	**NYSE**

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 15, 2011:
41,553,779

Aggregate market value of Common Stock held by non-affiliates at June 30, 2010:
$1,201,686,640

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically and posted on its corporate Web site, if any, every Interactive Data File required to be submitted and posted pursuant to Rule 405 of Regulation S-T during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☒

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒	Accelerated filer ☐
Non-accelerated filer ☐ (Do not check if a smaller reporting company)	Smaller reporting company ☐

Exhibit E-R4

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement dated March 11, 2011 (Part III of Form 10-K)

TABLE OF CONTENTS

PART I

PART II

ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2010

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Alexander & Baldwin, Inc. ("A&B") is a multi-industry corporation with its primary operations centered in Hawaii. It was founded in 1870 and incorporated in 1900. Ocean transportation operations, related shoreside operations in Hawaii, and intermodal, truck brokerage and logistics services are conducted by a wholly-owned subsidiary, Matson Navigation Company, Inc. ("Matson"), and two Matson subsidiaries. Property development and agribusiness operations are conducted by A&B and certain other subsidiaries of A&B.

The business industries of A&B are generally as follows:

A. *Transportation* - carrying freight, primarily between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports; arranging domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services; and providing terminal, stevedoring and container equipment maintenance services in Hawaii.

B. *Real Estate* - engaging in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property.

C. *Agribusiness* - growing sugar cane and coffee in Hawaii; producing bulk raw sugar, specialty food-grade sugars, molasses, green coffee and roasted coffee; marketing and distributing green coffee, roasted coffee and specialty food-grade sugars; generating and selling, to the extent not used in A&B's operations, electricity; and providing general trucking services in Hawaii, including sugar and molasses hauling, and mobile equipment maintenance and repair services.

For information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2010, see Note 14 ("Industry Segments") to A&B's financial statements in Item 8 of Part II below.

DESCRIPTION OF BUSINESS AND PROPERTIES

A. Transportation

(1) Freight Services

Matson's Hawaii Service offers containership freight services between the ports of Long Beach, Oakland, Seattle, and the major ports in Hawaii on the islands of Oahu, Kauai, Maui and Hawaii. Roll-on/roll-off service is provided between California and the major ports in Hawaii. Matson is the principal carrier of ocean cargo between the U.S. Pacific Coast and Hawaii. Principal westbound cargoes carried by Matson to Hawaii include dry containers of mixed commodities, refrigerated commodities, building materials, packaged foods, automobiles and household goods. Principal eastbound cargoes carried by Matson from Hawaii include automobiles, household goods, dry containers of mixed commodities, livestock and food and beverages. The majority of Matson's Hawaii Service revenue is derived from the westbound carriage of containerized freight and automobiles.

Matson's Guam Service provides weekly containership freight services between the U.S. Pacific Coast and Guam. Additional freight destined to and from the Commonwealth of the Marianas Islands, the Republic of Palau and the island of Yap in the Federated States of Micronesia is transferred at Guam to and from connecting carriers for delivery to and from those locations.

Matson's Micronesia Service offers container and conventional freight service between the U.S. Pacific Coast and the islands of Kwajalein, Ebeye and Majuro in the Republic of the Marshall Islands and the islands of Pohnpei, Chuuk and Kosrae in the Federated States of Micronesia. Cargo is transferred at Guam to a Matson-operated ship that provides bi-weekly service to and from those islands. Matson also carries cargo originating in Asia to these islands by receiving cargo transferred from other carriers in Guam.

Matson's China Service consists of two vessel strings. The first is part of an integrated Hawaii/Guam/China service. This service employs five Matson containerships in a weekly service that carries cargo from the U.S. Pacific Coast to Honolulu, then to Guam. The vessels continue to the ports of Xiamen, Ningbo and Shanghai in China, where they are loaded with cargo to be discharged in Long Beach. These ships also carry cargo destined to and originating from Guam, the Commonwealth of Northern Marianas, the Republic of Palau and the Republic of the Marshall Islands. The second vessel string employs five chartered containerships in a weekly service that carries cargo from the U.S. Pacific Coast directly to the ports of Hong Kong, Yantian and Shanghai in China, where they also are loaded with cargo to be discharged in Long Beach.

See "Rate Regulation" below for a discussion of Matson's freight rates.

(2) Vessels

Matson's fleet consists of 10 containerships, excluding six containerships time-chartered from third parties, that serve the Micronesia and new China Service; three combination container/roll-on/roll-off ships; one roll-on/roll-off barge and two container barges equipped with cranes that serve the neighbor islands of Hawaii; and one container barge equipped with cranes that is available for charter. The 17 Matson-owned vessels in the fleet represent an investment of approximately $1.2 billion expended over the past 40 years. The majority of vessels in the Matson fleet have been acquired with the assistance of withdrawals from a Capital Construction Fund ("CCF") established under Section 607 of the Merchant Marine Act, 1936, as amended.

Vessels owned by Matson are described on page 4.

As a complement to its fleet, Matson owns approximately 33,200 containers, 14,000 container chassis and generators, 900 auto-frames and miscellaneous other equipment. Capital expenditures incurred by Matson in 2010 for vessels, equipment and systems totaled approximately $69 million.

(3) Terminals

Matson Terminals, Inc. ("Matson Terminals"), a wholly-owned subsidiary of Matson, provides container stevedoring, container equipment maintenance and other terminal services for Matson and other ocean carriers at its 105-acre marine terminal in Honolulu. Matson Terminals owns and operates seven cranes at the terminal, which handled approximately 351,200 lifts in 2010 (compared with 335,400 lifts in 2009). The terminal can accommodate three vessels at one time. Matson Terminals' lease with the State of Hawaii runs through September 2016. Matson Terminals also provides

Cottonwood Center in Sandy, Utah.

A&B's mainland commercial properties owned as of year-end 2010 were as follows:

Property	Location	Type	Leasable Area (sq. ft.)
Heritage Business Park	Dallas, TX	Industrial	1,316,400
Savannah Logistics Park	Savannah, GA	Industrial	1,035,700
Midstate 99 Distribution Center	Visalia, CA	Industrial	790,400
Sparks Business Center	Sparks, NV	Industrial	396,100
Republic Distribution Center	Pasadena, TX	Industrial	312,500
Activity Distribution Center	San Diego, CA	Industrial	252,300
Centennial Plaza	Salt Lake City, UT	Industrial	244,000
Meadows on the Parkway	Boulder, CO	Retail	216,400
1800 and 1820 Preston Park	Plano, TX	Office	198,800
Ninigret Office Park X and XI	Salt Lake City, UT	Office	185,200
San Pedro Plaza	San Antonio, TX	Office/Retail	171,900
Rancho Temecula Town Center	Temecula, CA	Retail	165,500
2868 Prospect Park	Sacramento, CA	Office	162,900
Little Cottonwood Center	Sandy, UT	Retail	141,600
Concorde Commerce Center	Phoenix, AZ	Office	140,700
Arbor Park Shopping Center	San Antonio, TX	Retail	139,500
Deer Valley Financial Center	Phoenix, AZ	Office	126,600
Northpoint Industrial	Fullerton, CA	Industrial	119,400
Broadlands Marketplace	Broomfield, CO	Retail	103,900
2890 Gateway Oaks	Sacramento, CA	Office	58,700
Wilshire Shopping Center	Greeley, CO	Retail	46,500
Royal MacArthur Center	Dallas, TX	Retail	44,000
Firestone Boulevard Building	La Mirada, CA	Office	28,100

A&B's mainland commercial properties' occupancy rate of 85 percent in 2010 remained unchanged from 2009, compared to 95 percent in 2008, reflecting the continued difficult leasing environment in certain mainland markets.

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870, and the production of coffee in Hawaii since 1987. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) a coffee plantation on the island of Kauai, operated by its Kauai Coffee Company, Inc. ("Kauai Coffee") subsidiary, and (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide several types of trucking services, including sugar and molasses hauling on Maui, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai.

HC&S is Hawaii's only producer of raw sugar, producing approximately 171,800 tons of raw sugar in 2010 (compared with 126,800 tons in 2009). The primary reasons for the increase in production were improved yields on the plantation due to better agronomic practices, a higher average age of the crop at harvest, and increased delivery of irrigation water. HC&S harvested 15,488 acres of sugar cane in 2010 (compared with 15,028 in 2009). Yields averaged 11.1 tons of sugar per acre in 2010 (compared to 8.4 in 2009). As a by-product of sugar production, HC&S also produced approximately 52,800 tons of molasses in 2010 (compared to 41,700 in 2009).

In 2010, approximately 16,300 tons of sugar (compared to 34,300 tons in 2009) were processed by HC&S into specialty food-grade sugars under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. This reduction in Maui Brand ® sugar was planned and in response to the high raw sugar market pricing that HC&S was able to capitalize on. HC&S is able to produce either raw sugar or specialty sugars.

During 2010, Kauai Coffee had approximately 3,000 acres of coffee trees under cultivation. The 2010 harvest yielded approximately 3.3 million pounds of green coffee, compared with 2.6 million pounds in 2009.

In December 2010, Kauai Coffee entered into an agreement with Massimo Zanetti Beverage, USA, Inc., a subsidiary of the Italian global coffee company Massimo Zanetti Beverage Group. Under the agreement, Massimo Zanetti Beverage, USA will operate the Kauai Coffee estate and processing facilities and will market, sell, and distribute the Kauai Coffee ® brand throughout the United States and internationally through its subsidiary companies. The transaction, which is subject to certain material contingencies, is scheduled to close in the first quarter of 2011.

HC&S and McBryde Sugar Company, Limited ("McBryde"), a subsidiary of A&B and the parent company of Kauai Coffee, produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels. McBryde produces power solely by hydroelectric generation. The price for the power sold by HC&S and McBryde is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. See "Energy" below for power production and sales data.

(2) Marketing of Sugar and Coffee

Approximately 91 percent of the bulk raw sugar produced by HC&S in 2010 was purchased by C&H Sugar Company, Inc. ("C&H"). C&H processes the raw cane sugar at its refinery at Crockett, California and markets the refined products primarily in the western and central United States.

The remaining 9 percent of the raw sugar was used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand ® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" product line.

Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a sugar grower cooperative in Hawaii (of which HC&S currently is the only member), has a supply contract with C&H ending in December 2012. Pursuant to the supply contract, the cooperative sells raw sugar to C&H at a price equal to the New York No. 16 Contract settlement price, less a discount and less costs of sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to HC&S. Most of Kauai Coffee's crop is being marketed on the U.S. Mainland as green bean coffee. In addition to the sale of green bean coffee, Kauai Coffee produces and sells roasted, packaged coffee under the Kauai Coffee® trademark. Kauai Coffee's customers include specialty and commodity brokers, hotels, and large regional roasters.

(3) Sugar Competition and Legislation

Hawaii sugar growers have traditionally produced more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the U.S. Mainland market. Hawaiian refined sugar is marketed primarily west of Chicago. This is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

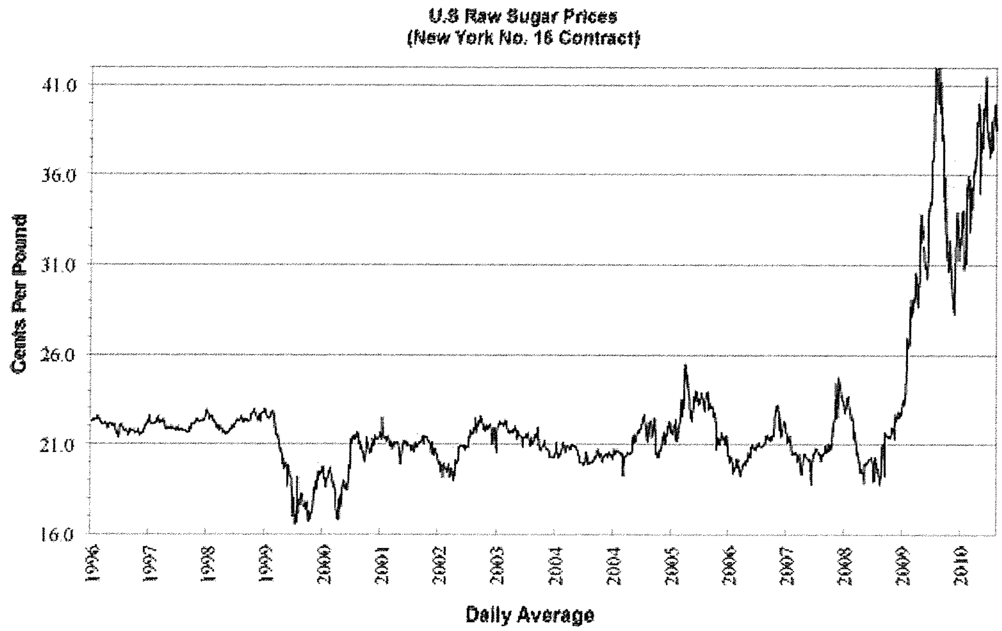
The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current legislation is the Food Conservation and Energy Act of 2008, which expires on December 31, 2012 ("2008 Farm Bill"). The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports from countries other than Canada and Mexico by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount. Also, a new but limited sucrose ethanol program was added in 2008, which allows sugar to be diverted into ethanol production when the market is deemed to be oversupplied.

The 2008 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18.50 cents per pound ("¢/lb") for raw cane sugar is in effect for the 2010 and 2011 crops. The loan rate increases to 18.75 ¢/lb for the 2012 and 2013 crops (the last year of the bill). The U.S. rates are adjusted by region to reflect the cost of transportation. The 2010 adjusted crop loan rate in Hawaii is 16.52 ¢/lb.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement. In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately or phased out. Starting in 2008, Mexico can ship an unlimited quantity of sugar duty-free to the U.S. each year.

U.S. raw sugar prices remained relatively stable and flat for over thirty years. The full implementation of NAFTA in 2008, which unified the U.S. and Mexican sugar markets, increased price volatility. In 2009, a tight NAFTA supply/demand outlook and a soaring world raw sugar market combined to push U.S. raw sugar prices to 29-year highs. Prices settled down slightly in early 2010, but have since risen again to historic highs in the second half of 2010. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 16 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



U.S Raw Sugar Prices
(New York No. 16 Contract)
Cents Per Pound
41.0
36.0
31.0
26.0
21.0
16.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2004
2005
2006
2007
2008
2009
2010
Daily Average

(4) Coffee Competition and Prices

Kauai Coffee competes with coffee growers located worldwide, including in Hawaii. The market for specialty coffee in the United States is highly competitive. Relative to other Hawaii growers, Kauai Coffee produces a large amount of green coffee beans each year, with its crop divided among specialty, midrange and commodity grades. It has been successful at selling its specialty and midgrade coffees at a premium to world commodity market prices. Kauai Coffee sells its specialty and midgrade green beans primarily to long-term, repeat customers, though there is strong competition and pricing and other terms are subject to annual renegotiations. These grades are also utilized in Kauai Coffee's wholesale and direct retail roasted programs. Kauai Coffee also produces commodity-grade green beans, whose prices are more closely tied to world commodity market prices.

Kauai Coffee's green bean coffee total production volume, volume by grade and unit costs vary each year depending upon growing and harvesting conditions. The unit cost per pound impacts the profitability of green bean sales as well as the cost of goods for Kauai Coffee's wholesale roasted and retail programs.

(5) Land Designations and Water

The HC&S sugar plantation, the largest in Hawaii, consists of approximately 43,300 acres, including a small portion of leased lands. Approximately 34,700 acres are under cultivation, and the balance is leased to third parties, is not suitable for cane cultivation, or is used for plantation purposes such as roads, reservoirs, ditches and plant sites.

On Kauai, approximately 3,000 acres are cultivated by Kauai Coffee.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to fulfill the State constitutional mandate to protect agricultural lands, promote diversified agriculture, increase the State's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. In 2008, the Legislature passed a package of incentives, which is necessary to trigger the IAL system of land designation. In 2009, A&B received approval from the State Land Use Commission for the designation of over 27,000 acres on Maui and over 3,700 acres on Kauai as IAL. These designations were the result of voluntary petitions filed by A&B.

It is crucial for HC&S and Kauai Coffee to have access to reliable sources of water supply and efficient irrigation systems. A&B's plantations conserve water by using "drip" irrigation systems that distribute water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated. All of Kauai Coffee's fields are drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the last ten years have supplied approximately 58 percent of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provided approximately 15 percent of the irrigation water used by HC&S over the last ten years. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

D. Employees and Labor Relations

As of December 31, 2010, A&B and its subsidiaries had approximately 2,300 regular full-time employees. About 1,000 regular full-time employees were engaged in the agribusiness segment, 1,200 were engaged in the transportation segment, 40 were engaged in the real estate segment, and the remaining were in administration. Approximately 45 percent were covered by collective bargaining agreements with unions.

At December 31, 2010, the active Matson fleet employed seagoing personnel in 197 billets. Each billet corresponds to a position on a ship that typically is filled by two or more employees because seagoing personnel rotate between active sea duty and time ashore. Approximately 25 percent of Matson's regular full-time employees and all of the seagoing employees were covered by collective bargaining agreements.

Historically, collective bargaining with longshore and seagoing unions has been complex and difficult. However, Matson and Matson Terminals consider their relations with those unions, other unions and their non-union employees generally to be satisfactory.

Matson's seagoing employees are represented by six unions, three representing unlicensed crew members and three representing licensed crew members. Matson negotiates directly with these unions. Matson's agreements with the Seafarer's International Union, the Sailors Union of the Pacific and the Marine Firemen's Union were renewed in mid-2008 through June 2013. Contracts that Matson has with the American Radio Association were renewed in mid-2009 through August 15, 2013. Contracts that Matson has with the Masters, Mates & Pilots ("MM&P") and the Marine Engineers Beneficial Association ("MEBA") for ships built prior to 2003 were renewed in mid-2009 through August 15, 2013. Contracts that Matson has with MM&P and the MEBA for ships built after 2003 expire on August 15, 2013 and include provisions for a wage reopener, which was negotiated in mid-2009 to cover the remaining contract period.

SSAT, the previously-described joint venture of Matson and SSA, provides stevedoring and terminal services for Matson vessels calling at U.S. Pacific Coast ports. Matson, SSA and SSAT are members of the Pacific Maritime Association ("PMA") which, on behalf of its members, negotiates collective bargaining agreements with the ILWU on the U.S. Pacific Coast. A six-year PMA/ILWU Master Contract, which covers all Pacific Coast longshore labor, was negotiated in 2008 and will expire on July 1, 2014. Matson Terminals provides stevedoring and terminal services to Matson and other vessel operators calling at Honolulu and on the islands of Hawaii, Maui and Kauai. Matson Terminals is a member of the Hawaii Stevedore Industry Committee, which negotiates with the ILWU in Hawaii on behalf of its members. In 2008, Matson signed six-year agreements with each of the ILWU units, which will expire on June 30, 2014.

During 2010, Matson maintained its collective bargaining agreements with ILWU clerical workers in Honolulu and Oakland, which are in effect through June 2014. The bargaining agreement with ILWU clerical workers in Long Beach was renegotiated in 2010 for another three-year period. The health & welfare and pension provisions were not renegotiated; however, the parties agreed to match the provisions that are negotiated between the ILWU clerical workers in Long Beach and the other employers. Those negotiations are continuing and are expected to be finalized in 2011.

During 2010, Matson contributed to multiemployer pension plans for vessel crews. If Matson were to withdraw from or significantly reduce its obligation to contribute to one of the plans, Matson would review and evaluate data, actuarial assumptions, calculations and other factors used in determining its withdrawal liability, if any. In the event that any third parties materially disagree with Matson's determination, Matson would pursue the various means available to it under federal law for the adjustment or removal of its withdrawal liability. Matson Terminals participates in a multiemployer pension plan for its Hawaii ILWU non-clerical employees. For a discussion of withdrawal liabilities under the Hawaii longshore and seagoing plans, see Note 10 ("Employee Benefit Plans") to A&B's consolidated financial statements in Item 8 of Part II below.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the ILWU. The agreements with the HC&S production unit employees and clerical and technical employees bargaining units, covering approximately 640 workers, expired on January 31, 2011 and are being renegotiated. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. The bulk sugar employees' agreement expires on June 30, 2014, and the agreement with all other employees expires on March 31, 2012. There are two collective bargaining agreements with KCC employees represented by the ILWU. These agreements expire on April 30, 2011, with renegotiations expected to begin in spring of 2011. There is a collective bargaining agreement with the ILWU for the production unit employees of Kauai Coffee. This contract expired on January 31, 2011, and is being renegotiated.

E. Energy

Matson and Matson Terminals purchase residual fuel oil, lubricants, gasoline and diesel fuel for their operations. Residual fuel oil is by far Matson's largest energy-related expense. In 2010, Matson vessels purchased approximately 2.1 million barrels of residual fuel oil (compared with 1.8 million barrels in 2009).

Residual fuel oil prices paid by Matson in 2010 started at $70.97 per barrel and ended the year at $85.30. The low price for the year was $67.45 per barrel in September, and the high price was $86.64 in December. Sufficient fuel for Matson's requirements is expected to be available in 2011.

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced or during periods when bagasse is not produced in sufficient quantities. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory and farming operations, HC&S sells electricity. In 2010, HC&S produced and sold, respectively, approximately 190,400 MWH and 68,300 MWH of electric power (compared with 188,000 MWH produced and 72,800 MWH sold in 2009). The slight decrease in power sold was due to increased power used for irrigation pumps to improve soil moisture levels and yields. Hydroelectric generation was lower during the year due to extended drought conditions on Maui. HC&S's use of oil in 2010 of 16,700 barrels was 42 percent less than the 28,800 barrels used in 2009. The decrease was primarily due to higher bagasse production used in power generation as a result of improved yields on the farm. Coal used for power generation was 61,200 short tons, about 28,100 tons less than that used in 2009. Less coal was required because of the higher bagasse production from the fields.

In 2010, McBryde produced approximately 29,500 MWH of hydroelectric power (compared with approximately 30,800 MWH in 2009). To the extent it is not used in A&B's coffee operations, McBryde sells electricity to Kauai Island Utility Cooperative. Power sales in 2010 amounted to approximately 19,000 MWH (compared with 22,800 MWH in 2009).

F. Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

The business of A&B and its subsidiaries (collectively, the "Company") faces numerous risks, including those set forth below or those described elsewhere in this Form 10-K or in the Company's filings with the SEC. The risks described below are not the only risks that the Company faces, nor are they listed in order of significance. Other risks and uncertainties may also impair its business operations. Any of these risks may have a material adverse effect on the Company's business, liquidity, financial condition, results of operations and cash flows. All forward-looking statements made by the Company or on the Company's behalf are qualified by the risks described below.

Changes in U.S., global, or regional economic conditions that result in a further decrease in consumer confidence or market demand for the Company's services and products in Hawaii, the U.S. Mainland, Guam or Asia may adversely affect the Company's financial position, results of operations, liquidity, or cash flows.

A continuation or further weakening of the U.S., Guam, Asian or global economies may adversely impact the level of freight volumes, freight rates, and real estate leasing, sales and development activity. Within the U.S., a continuation or further weakening of economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, or the further weakening of consumer confidence, market demand or the economy in the U.S. Mainland, may further reduce the demand for goods to and from Hawaii and Asia, travel to Hawaii and domestic transportation of goods, adversely affecting inland and ocean transportation volumes or rates, the sale of Hawaii real estate, and the real estate leasing and development markets. In addition, overcapacity in the global or transpacific ocean transportation markets may adversely affect freight volumes or rates in the Company's China service. Additionally, a change in the cost of goods or currency exchange rates may cause these adverse effects as well.

The Company may face new or increased competition.

The Company's transportation segment may face new competition by established or start-up shipping operators that enter the Company's markets. The entry of a new competitor or the addition of ships or capacity by existing competition on any of the Company's routes could result in a significant increase in available shipping capacity that could have an adverse effect on volumes or rates. See also discussion under "Business and Properties - Transportation - Competition" above.

For the Company's real estate segments, there are numerous other developers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with the Company for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Increased vacancies, decreased rents, sales prices or sales volume, or lack of development opportunities may lead to a deterioration in results from the Company's real estate business.

The Company's significant operating agreements and leases could be replaced on less favorable terms or may not be replaced.

The significant operating agreements and leases of the Company in its various businesses expire at various points in the future and may not be replaced or could be replaced on less favorable terms, thereby adversely affecting the Company's future financial position, results of operations and cash flows.

The reduction in availability of mortgage financing and the volatility and reduction in liquidity in the financial markets may adversely affect the Company's real estate business.

During 2008 and 2009, the financial industry experienced significant instability due to, among other things, declining property values and increasing defaults on loans. This led to tightened credit requirements, reduced liquidity and increased credit risk premiums for virtually all borrowers. Fewer loan products and tighter loan qualifications make it more difficult for borrowers to finance the purchase of units in the Company's projects. Tightening of credit in the commercial markets may adversely affect the Company's ability to secure construction or other financing on acceptable or favorable terms for the Company's residential and commercial projects, working capital requirements, or investment needs. Additionally, the stringent requirements to obtain financing for buyers of commercial properties make it significantly more difficult for the Company to sell commercial properties and may negatively impact the sales prices and other terms of such sales. The stringent credit environment may also impact the Company in other ways, including the credit or solvency of customers, vendors, or joint venture partners, and the ability of partners to fund their equity obligations to the joint venture.

A future downgrade in the Company's credit rating or disruptions on the credit markets could restrict its ability to access the debt capital markets or increase the cost of debt.

In January 2011, Standard and Poor's issued a research update that indicated a continuation of the Company's BBB+ rating with a Negative outlook. Further changes in the Company's credit ratings may ultimately have an adverse impact on the Company's ability to access debt in the private or public market and also may increase its borrowing costs. If the Company's credit ratings fall below investment grade, its access to the debt capital markets or its ability to renew its committed lines of credit may become restricted. Because the Company relies on its ability to draw on its revolving credit facilities to support its operations, when required, any volatility in the credit and financial markets that prevents the Company from accessing funds (for example, a lender that does not fulfill its lending obligation), could have an adverse effect on the Company's financial condition and cash flows. Additionally, the Company's credit agreements generally include an increase in borrowing rates if the Company's ratings are downgraded, and renegotiation of the Company's primary revolving credit line upon its expiration in 2011 could be negatively affected by ratings downgrades.

Failure to comply with certain restrictive financial covenants contained in the Company's credit facilities could preclude the payment of dividends, impose restrictions on the Company's business segments, capital resources or other activities or otherwise adversely affect the Company.

The Company's credit facilities contain certain restrictive financial covenants, the most restrictive of which include the maintenance of minimum shareholders' equity levels, a maximum ratio of debt to earnings before interest, depreciation, amortization, and taxes, and the maintenance of a minimum unencumbered property investment value. If the Company does not maintain the required covenants, and that breach of covenants is not cured timely or waived by the lenders, resulting in default, the Company's access to credit may be limited or terminated, dividends may be suspended, and the lenders could declare any outstanding amounts due and payable.

An increase in fuel prices, or changes in the Company's ability to collect fuel surcharges, may adversely affect the Company's profits.

Fuel is a significant operating expense for the Company's shipping and agribusiness operations. The price and supply of fuel are unpredictable and fluctuate based on events beyond the Company's control. Increases in the price of fuel may adversely affect the Company's results of operations based on market and competitive conditions. Increases in fuel costs also can lead to other expense increases, through, for example, increased costs of energy, petroleum-based raw materials and purchased transportation services. In the Company's ocean transportation and logistics services segments, the Company is able to utilize fuel surcharges to partially recover increases in fuel expense, although increases in the fuel surcharge may adversely affect the Company's competitive position and may not correspond exactly with the timing of increases in fuel expense. Changes in the Company's ability to collect fuel surcharges may adversely affect its results of operations. Increases in energy costs for the Company's leased real estate portfolio are typically recovered from lessees, although the Company's share of energy costs increases as a result of lower occupancies and higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices also may increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting the Company's development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Noncompliance with, or changes to, federal, state or local law or regulations, including passage of climate change legislation or regulation, may adversely affect the Company's business.

The Company is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, government administration of the U.S. sugar program, environmental regulations including those relating to air quality initiatives at port locations, and cabotage laws. Noncompliance with, or changes to, the laws and regulations governing the Company's business could impose significant additional costs on the Company and adversely affect the Company's financial condition and results of operations. For example, if the Jones Act and the regulations promulgated thereunder were repealed, amended, or otherwise modified, non-U.S. competitors with significantly lower costs may consequently enter any of the Jones Act routes or the Company's business may be significantly altered, all of which may have an adverse effect on the Company's shipping business. In addition, changes in environmental laws impacting the shipping business, including passage of climate change legislation or other regulatory initiatives that restrict emissions of greenhouse gasses, may require costly vessel modifications, the use of higher-priced fuel and changes in operating practices that may not all be able to be recovered through increased payments from customers. The real estate segments are subject to numerous federal, state and local laws and regulations, which, if changed, may adversely affect the Company's business. The agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the 2008 Farm Bill, and the Hawaii Public Utilities Commission's regulation of avoided energy cost rates paid to the Company in connection with it sale of electric power. Further changes to these laws and regulations could adversely affect the Company. Climate change legislation, such as limiting and reducing greenhouse gas emissions through a "cap and trade" system of allowances and credits, if enacted, may have an adverse effect on the Company's business.

Work stoppages or other labor disruptions by the unionized employees of the Company or other companies in related industries may adversely affect the Company's operations.

As of December 31, 2010, the Company had approximately 2,300 regular full-time employees, of which approximately 45 percent were covered by collective bargaining agreements with unions. The Company's transportation, real estate and agribusiness segments may be adversely affected by actions taken by employees of the Company or other companies in related industries against efforts by management to control labor costs, restrain wage or benefits increases or modify work practices. Strikes and disruptions may occur as a result of the failure of the Company or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its real estate sales segment, the Company may be unable to complete construction of its projects if building materials or labor is unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor and customer relationships may adversely affect the Company's business.

The Company's business is dependent on its relationships with key vendors, customers and tenants. The ocean transportation business relies on its relationships with freight forwarders, large retailers and consumer goods and automobile manufacturers, as well as other larger customers. Relationships with railroads and shipping companies are important in the Company's intermodal business. For agribusiness, HC&S's relationship with C&H Sugar Company, Inc. is critical. The loss of or damage to any of these key relationships may affect the Company's business adversely.

Interruption or failure of the Company's information technology and communications systems could impair the Company's ability to operate and adversely affect its business.

The Company is highly dependent on information technology systems. For example, in the ocean transportation segment, these dependencies include accounting, billing, disbursement, cargo booking and tracking, vessel scheduling and stowage, equipment tracking, customer service, banking, payroll and employee communication systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. The Company may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at the Company's facilities. Any failure of the Company's systems could result in interruptions in its service or production, reductions in its revenue and profits and damage to its reputation.

The Company is susceptible to weather and natural disasters.

The Company's transportation operations are vulnerable to disruption as a result of weather and natural disasters such as bad weather at sea, hurricanes, typhoons, tsunamis, floods and earthquakes. Such events will interfere with the Company's ability to provide on-time scheduled service, resulting in increased expenses and potential loss of business associated with such events. In addition, severe weather and natural disasters can result in interference with the Company's terminal operations, and may cause serious damage to its vessels, loss or damage to containers, cargo and other equipment, and loss of life or physical injury to its employees, all of which could have an adverse effect on the Company's business.

For the real estate segments, the occurrence of natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, could damage its real estate holdings, resulting in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, the Company's properties.

For the Agribusiness segment, drought, greater than normal rainfall, hurricanes, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar and coffee planting, harvesting and production, and the Agribusiness segment's facilities, including dams and reservoirs.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact the Company's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability or willingness of tourists to travel to Hawaii, thereby adversely affecting Hawaii's economy and the Company. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets. Acts of war or terrorism may be directed at the Company's shipping operations or real estate holdings, or may cause the U.S. government to take control of Matson's vessels for military operation. Heightened security measures are likely to slow the movement and increase the cost of freight through U.S. or foreign ports, across borders or on U.S. or foreign railroads or highways and could adversely affect the Company's business and results of operations.

Loss of the Company's key personnel could adversely affect its business.

The Company's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, the Company may have to incur significant costs to replace them, and the Company's ability to execute its business model could be impaired if it cannot replace them in a timely manner. The Company does not expect to maintain key person insurance on any of its key personnel.

The Company is involved in joint ventures and is subject to risks associated with joint venture relationships.

The Company is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as:

- the Company may not have voting control over the joint venture;
- the Company may not be able to maintain good relationships with its venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with the Company's;
- the venture partner may fail to fund its share of capital for operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to the Company;
- the joint venture or venture partner could lose key personnel; and
- the venture partner could become insolvent, requiring the Company to assume all risks and capital requirements related to the joint venture project.

In connection with its real estate joint ventures, the Company is sometimes asked to guarantee completion of a joint venture's construction and development of a project, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If the Company were to become obligated to perform under such arrangement, the Company may be adversely affected.

The Company is subject to, and may in the future be subject to, disputes, legal or other proceedings, or government inquiries or investigations, that could have an adverse effect on the Company.

The nature of the Company's business exposes it to the potential for disputes, legal or other proceedings, or government inquiries or investigations, relating to antitrust matters, labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section or in other Company filings with the SEC. For example, Matson is a common carrier, whose tariffs, rates, rules and practices in dealing with its customers are governed by extensive and complex foreign, federal, state and local regulations, which may be the subject of disputes or administrative or judicial proceedings. These disputes, individually or collectively, could harm the Company's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by the Company, or result in significant changes to Matson's tariffs, rates, rules and practices in dealing with its customers, all of which could have an adverse effect on the Company's future operating results, including profitability, cash flows, and financial condition. As a real estate developer, the Company may face warranty and construction defect claims, as described below in the "Real Estate" section of this "Risk Factors" item. For a description of significant legal proceedings involving the Company, see "Legal Proceedings" below.

Changes in the value of pension assets, or a change in pension law or key assumptions, may adversely affect the Company's financial performance.

The amount of the Company's employee pension and postretirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, changes in discount rates, higher health care costs, or lower actual or expected returns on plan assets, may adversely affect the Company's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect the Company's single-employer and multiemployer pension plans and plan funding. These factors, as well as a decline in the fair value of pension plan assets, may put upward pressure on the cost of providing pension and medical benefits and may increase future pension expense and required funding contributions. Although the Company has actively sought to control increases in these costs, there can be no assurance that it will be successful in limiting future cost and expense increases, and continued upward pressure in costs and expenses could further reduce the profitability of the Company's businesses.

The Company may have exposure under its multiemployer plans in which it participates that extends beyond its funding obligation with respect to the Company's employees.

The Company contributes to various multiemployer pension plans. In the event of a partial or complete withdrawal by the Company from any plan that is underfunded, the Company would be liable for a proportionate share of such plan's unfunded vested benefits. Based on the limited information available from plan administrators, which the Company cannot independently validate, the Company believes that its portion of the contingent liability in the case of a full withdrawal or termination may be material to its financial position and results of operations. In the event that any other contributing employer withdraws from any plan that is underfunded, and such employer (or any member in its controlled group) cannot satisfy its obligations under the plan at the time of withdrawal, then the Company, along with the other remaining contributing employers, would be liable for its proportionate share of such plan's unfunded vested benefits. In addition, if a multiemployer plan fails to satisfy the minimum funding requirements, the Internal Revenue Service will impose certain penalties and taxes.

TRANSPORTATION

The Company is subject to risks associated with conducting business in a foreign shipping market.

The Company, through Matson's China service, is subject to risks associated with conducting business in a foreign shipping market, which include:

- challenges in operating in a foreign country and doing business and developing relationships with foreign companies;
- difficulties in staffing and managing foreign operations;
- U.S. and foreign legal and regulatory restrictions, including compliance with the Foreign Corrupt Practices Act and foreign laws that prohibit corrupt payments to government officials;
- global vessel overcapacity that may lead to decreases in volumes and shipping rates;
- competition with established and new shippers;
- currency exchange rate fluctuations;
- political and economic instability;
- protectionist measures that may affect the Company's operation of its wholly-owned foreign enterprise; and
- challenges caused by cultural differences.

Any of these risks has the potential to adversely affect the Company's operating results.

Compliance with environmental laws and regulations may adversely affect the Company's business.

The Company's vessel operations are subject to various federal, state and local environmental laws and regulations, including, but not limited to, the Oil Pollution Act of 1990, the Comprehensive Environmental Response Compensation & Liability Act of 1980, the Clean Water Act, the Invasive Species Act and the Clean Air Act. Continued compliance with these laws and regulations may result in additional costs and changes in operating procedures that may adversely affect the Company's business.

The Company is subject to risks related to a marine accident or spill event.

The Company's vessel operations could be faced with a maritime accident, oil spill, or other environmental mishap. Such event may lead to personal injury, loss of life, damage of property, pollution and suspension of operations. As a result, such event could have an adverse effect on the Company's business.

Acquisitions may have an adverse effect on the Company's business.

The Company's growth strategy includes expansion through acquisitions. Acquisitions may result in difficulties in assimilating acquired companies, and may result in the diversion of the Company's capital and its management's attention from other business issues and opportunities. The Company may not be able to integrate companies that it acquires successfully, including their personnel, financial systems, distribution, operations and general operating procedures. The Company may also encounter challenges in achieving appropriate internal control over financial reporting in connection with the integration of an acquired company. The Company may pay a premium for an acquisition, resulting in goodwill that may later be determined to be impaired, adversely affecting the Company's financial condition and results of operations.

The Company's logistics services are dependent upon third parties for equipment, capacity and services essential to operate the Company's logistics business, and if the Company fails to secure sufficient third party services, its business could be adversely affected.

The Company's logistics services are dependent upon rail, truck and ocean transportation services provided by independent third parties. If the Company cannot secure sufficient transportation equipment, capacity or services from these third parties at a reasonable rate to meet its customers' needs and schedules, customers may seek to have their transportation and logistics needs met by other third parties on a temporary or permanent basis. As a result, the Company's business, consolidated results of operations and financial condition could be adversely affected.

The loss of several of the Company's major customers could have an adverse effect on the revenue and business of the Company's logistics business.

The Company's logistics business derives a significant portion of its revenues from its largest customers. For 2010, the Company's logistics business' largest ten customers accounted for approximately 29 percent of the business' revenue. A reduction in or termination of the Company's logistics services by several of the logistics business' largest customers could have an adverse effect on the Company's revenue and business.

REAL ESTATE

The Company is subject to risks associated with real estate construction and development.

The Company's development projects are subject to risks relating to the Company's ability to complete its projects on time and on budget. Factors that may result in a development project exceeding budget or being prevented from completion include:

- an inability of the Company or buyers to secure sufficient financing or insurance on favorable terms, or at all;
- construction delays, defects, or cost overruns, which may increase project development costs;
- an increase in commodity or construction costs, including labor costs;
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues;
- an inability to obtain, or significant delay in obtaining, zoning, occupancy and other required governmental permits and authorizations;
- difficulty in complying with local, city, county and state rules and regulations regarding permitting, zoning, subdivision, utilities, affordable housing, and water quality as well as federal rules and regulations regarding air and water quality and protection of endangered species and their habitats;
- an inability to have access to sufficient and reliable sources of water or to secure water service or meters for its projects;
- an inability to secure tenants necessary to support the project or maintain compliance with debt covenants;
- failure to achieve or sustain anticipated occupancy or sales levels;
- buyer defaults, including defaults under executed or binding contracts; and
- an inability to sell the Company's constructed inventory.

Any of these risks has the potential to adversely affect the Company's operating results.

A decline in leasing rental income could adversely affect the Company.

The Company owns a portfolio of commercial income properties. Factors that may adversely affect the portfolio's profitability include:

- a significant number of the Company's tenants are unable to meet their obligations;
- increases in non-recoverable operating and ownership costs;
- the Company is unable to lease space at its properties when the space becomes available;
- the rental rates upon a renewal or a new lease are significantly lower than prior rents or do not increase sufficiently to cover increases in operating and ownership costs;
- the providing of lease concessions, such as free or discounted rents and tenant improvement allowances; and
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues at the property.

Governmental entities have adopted or may adopt regulatory requirements that may restrict the Company's development activity.

The Company is subject to extensive and complex laws and regulations that affect the land development process, including laws and regulations related to zoning and permitted land uses. Government entities have adopted or may approve regulations or laws that could negatively impact the availability of land and development opportunities within those areas. For example, in December 2007, Maui County adopted an ordinance requiring verification of water source availability and sustainability for all developments prior to submission of subdivision construction plans. This requirement adds further process delays and burdens the developer with identifying and developing new water sources. It is possible that increasingly stringent requirements will be imposed on developers in the future that could adversely affect the Company's ability to develop projects in the affected markets or could require that the Company satisfy additional administrative and regulatory requirements, which could delay development progress or increase the development costs of the Company. Any such delays or costs could have an adverse effect on the Company's revenues and earnings.

Real estate development projects are subject to warranty and construction defect claims in the ordinary course of business that can be significant.

As a developer, the Company is subject to warranty and construction defect claims arising in the ordinary course of business. The amounts payable under these claims, both in legal fees and remedying any construction defects, can be significant and exceed the profits made from the project. As a consequence, the Company may maintain liability insurance, obtain indemnities and certificates of insurance from contractors generally covering claims related to workmanship and materials, and create warranty and other reserves for projects based on historical experience and qualitative risks associated with the type of project built. Because of the uncertainties inherent to these matters, the Company cannot provide any assurance that its insurance coverage, contractor arrangements and reserves will be adequate to address some or all of the Company's warranty and construction defect claims in the future. For example, contractual indemnities may be difficult to enforce, the Company may be responsible for applicable self-insured retentions, and certain claims may not be covered by insurance or may exceed applicable coverage limits. Additionally, the coverage offered and the availability of liability insurance for construction defects could be limited or costly. Accordingly, the Company cannot provide any assurance that such coverage will be adequate or available at all, or available at an acceptable cost.

AGRIBUSINESS

The lack of water for agricultural irrigation could adversely affect the Company.

It is crucial for the Company's Agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane and coffee. As further described in "Legal Proceedings" below, there are challenges to the Company's ability to divert water from streams in Maui. In addition, the Company's access to water is subject to weather patterns that cannot be reliably predicted. If the Company is not permitted to divert stream waters for its use or there is insufficient rainfall, it would have an adverse effect on the Company's sugar operations, including possible cessation of operations.

A decline in raw sugar or coffee prices will adversely affect the Company's business.

The business and results of operations of the Company's agribusiness segment are substantially affected by market factors, particularly the domestic prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops and suppliers, weather conditions, and United States farm and trade policies. If the price for sugar or coffee were to decline, the Company's agribusiness segment would be adversely affected. See also discussion under "Business and Properties - Agribusiness - Competition and Sugar Legislation" above.

The Company is subject to risks associated with raw sugar and coffee production.

The Company's production of raw sugar and coffee is subject to numerous risks that could adversely affect the volume and quality of sugar or coffee produced, including:

- weather and natural disasters;
- disease;
- weed control;
- uncontrolled fires, including arson;
- government restrictions on farming practices due to cane burning;
- increases in costs, including, but not limited to fuel, fertilizer, herbicide, and drip tubing;
- water availability (see risk factor above regarding lack of water);
- equipment failures in factory or power plant;

ITEM 6. SELECTED FINANCIAL DATA

The following financial data should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except shareholders of record and per-share amounts):

	2010	2009	2008	2007	2006
Revenue:					
Transportation:					
Ocean transportation	$ **1,045.0**	$ 888.6	$ 1,023.7	$ 1,006.9	$ 945.8
Logistics services	**355.6**	320.9	436.0	433.5	444.2
Real Estate:					
Leasing	**94.4**	103.2	107.8	108.5	100.6
Sales	**136.1**	125.6	350.2	117.8	97.3
Less amounts reported in discontinued operations[1]	**(122.5)**	(132.4)	(160.3)	(138.5)	(136.5)
Agribusiness[5]	**163.9**	107.0	124.3	123.7	127.4
Reconciling Items[2]	**(26.3)**	(16.3)	(10.7)	(9.2)	(14.2)
Total revenue	$ **1,646.2**	$ 1,396.6	$ 1,871.0	$ 1,642.7	$ 1,564.6
Operating Profit:					
Transportation:					
Ocean transportation[3]	$ **99.4**	$ 58.3	$ 105.8	$ 126.5	$ 105.6
Logistics services	**7.2**	6.7	18.5	21.8	20.8
Real Estate:					
Leasing	**35.3**	43.2	47.8	51.6	50.3
Sales[3]	**50.1**	39.1	95.6	74.4	49.7
Less amounts reported in discontinued operations[1]	**(51.9)**	(57.0)	(74.6)	(76.0)	(67.5)
Agribusiness[5]	**6.1**	(27.8)	(12.9)	0.2	6.9
Total operating profit	**146.2**	62.5	180.2	198.5	165.8
Interest expense, net[4]	**(25.5)**	(25.9)	(23.7)	(18.8)	(15.0)
General corporate expenses	**(23.3)**	(21.8)	(21.0)	(27.3)	(22.3)
Income from continuing operations before income taxes	**97.4**	14.8	135.5	152.4	128.5
Income taxes	**38.5**	5.8	49.2	57.5	48.0
Income from continuing operations	**58.9**	9.0	86.3	94.9	80.5
Income from discontinued operations	**33.2**	35.2	46.1	47.3	42.0
Net Income	$ **92.1**	$ 44.2	$ 132.4	$ 142.2	$ 122.5

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $12.8 million, $6.2 million, $5.2 million, $10.7 million, and $13.3 million of equity in earnings from its investment in SSAT for 2010, 2009, 2008, 2007, and 2006, respectively. Additionally, in August 2010, Matson initiated its second China string, which incurred start-up losses of approximately $19.3 million principally occurring in the fourth quarter of 2010 . The Real Estate Sales segment includes approximately $2.0 million, $9.0 million, $22.6 million, and $14.4 million in equity in earnings from its various real estate joint ventures for 2010, 2008, 2007, and 2006, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] Includes Ocean Transportation interest expense of $8.2 million for 2010, $9.0 million for 2009, $11.6 million for 2008, $13.9 million for 2007, and $13.3 million for 2006. Substantially all other interest expense was incurred at the parent company.

[5] Includes a $4.9 million gain in 2010 related to a crop disaster relief payment for drought experienced in prior years and a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

SELECTED FINANCIAL DATA (CONTINUED)

	2010	2009	2008	2007	2006
Identifiable Assets:					
Transportation:					
Ocean transportation[6]	$ 1,095.5	$ 1,095.2	$ 1,153.9	$ 1,215.0	$ 1,185.3
Logistics services	73.8	72.4	74.2	58.6	56.4
Real Estate:					
Leasing	739.4	627.4	590.2	595.4	525.5
Sales[6]	420.8	415.6	344.6	408.9	295.0
Agribusiness	150.3	156.8	172.2	174.6	168.7
Other	14.8	12.2	15.1	26.6	20.3
Total assets	$ 2,494.6	$ 2,379.6	$ 2,350.2	$ 2,479.1	$ 2,251.2
Capital Expenditures:					
Transportation:					
Ocean transportation	$ 69.4	$ 12.7	$ 35.5	$ 65.8	$ 217.1
Logistics services[7]	1.8	0.6	2.4	2.0	1.7
Real Estate:					
Leasing[8]	164.7	108.8	100.2	124.5	93.0
Sales[9]	0.1	0.1	0.6	0.3	1.3
Agribusiness	6.8	3.4	15.2	20.5	15.0
Other	0.3	0.3	0.8	0.3	1.5
Total capital expenditures	$ 243.1	$ 125.9	$ 154.7	$ 213.4	$ 329.6
Depreciation and Amortization:					
Transportation:					
Ocean transportation	$ 69.0	$ 67.1	$ 66.1	$ 63.2	$ 58.1
Logistics services	3.2	3.5	2.3	1.5	1.5
Real Estate:					
Leasing[1]	20.3	19.5	17.9	15.7	14.1
Sales	0.2	0.3	0.2	0.2	0.1
Agribusiness	12.7	11.9	11.5	10.7	10.1
Other	1.9	3.1	2.7	1.3	0.9
Total depreciation and amortization	$ 107.3	$ 105.4	$ 100.7	$ 92.6	$ 84.8

[6] The Ocean Transportation segment includes approximately $52.9 million, $47.2 million, $44.6 million, $48.6 million, and $49.8 million related to its investment in SSAT as of December 31, 2010, 2009, 2008, 2007, and 2006, respectively. The Real Estate Sales segment includes approximately $274.8 million, $193.3 million, $162.1 million, $134.1 million, and $98.4 million related to its investment in various real estate joint ventures as of December 31, 2010, 2009, 2008, 2007, and 2006, respectively.

[7] Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as acquisition of businesses in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

[8] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[9] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for expenditures related to real estate developments were $22 million, $6 million, $39 million, $110 million, and $69 million for 2010, 2009, 2008, 2007, and 2006, respectively.

SELECTED FINANCIAL DATA (CONTINUED)

	2010	2009	2008	2007	2006
Earnings per share:					
From continuing operations:					
Basic	$ **1.43**	$ 0.22	$ 2.09	$ 2.23	$ 1.86
Diluted	$ **1.42**	$ 0.22	$ 2.08	$ 2.20	$ 1.85
Net income:					
Basic	$ **2.23**	$ 1.08	$ 3.21	$ 3.34	$ 2.84
Diluted	$ **2.22**	$ 1.08	$ 3.19	$ 3.30	$ 2.81
Return on beginning equity	**8.5%**	4.1%	11.7%	13.8%	12.1%
Cash dividends per share	$ **1.26**	$ 1.26	$ 1.235	$ 1.12	$ 0.975
At Year End					
Shareholders of record	**3,079**	3,197	3,269	3,381	3,506
Shares outstanding	**41.3**	41.0	41.0	42.4	42.6
Long-term debt – non-current	$ **386**	$ 406	$ 452	$ 452	$ 401

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

The Company, from time to time, may make or may have made certain forward-looking statements, whether orally or in writing, such as forecasts and projections of the Company's future performance or statements of management's plans and objectives. These statements are "forward-looking" statements as that term is defined in the Private Securities Litigation Reform Act of 1995. Such forward-looking statements may be contained in, among other things, SEC filings, such as the Forms 10-K, 10-Q and 8-K, the Annual Report to Shareholders, press releases made by the Company, the Company's Internet Web sites (including Web sites of its subsidiaries), and oral statements made by the officers of the Company. Except for historical information contained in these written or oral communications, such communications contain forward-looking statements. These include, for example, all references to 2011 or future years. New risk factors emerge from time to time and it is not possible for the Company to predict all such risk factors, nor can it assess the impact of all such risk factors on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. Accordingly, forward-looking statements cannot be relied upon as a guarantee of future results and involve a number of risks and uncertainties that could cause actual results to differ materially from those projected in the statements, including, but not limited to the factors that are described in Part I, Item 1A under the caption of "Risk Factors" of this Form 10-K, which section is incorporated herein by reference. The Company is not required, and undertakes no obligation, to revise or update forward-looking statements or any factors that may affect actual results, whether as a result of new information, future events, or circumstances occurring after the date of this report.

OVERVIEW

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is designed to provide a discussion of the Company's financial condition, results of operations, liquidity and certain other factors that may affect its future results from the perspective of management. The discussion that follows is intended to provide information that will assist in understanding the changes in the Company's financial statements from year to year, the primary factors that accounted for those changes, and how certain accounting principles, policies and estimates affect the Company's financial statements. MD&A is provided as a supplement to, and should be read in conjunction with, the consolidated financial statements and the accompanying notes to the financial statements. MD&A is presented in the following sections:

- Business Overview
- Critical Accounting Estimates
- Consolidated Results of Operations
- Analysis of Operating Revenue and Profit by Segment
- Liquidity and Capital Resources
- Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements
- Business Outlook
- Other Matters

BUSINESS OVERVIEW

Alexander & Baldwin, Inc. ("A&B"), founded in 1870, is a multi-industry corporation headquartered in Honolulu that operates in five segments in three industries—Transportation, Real Estate, and Agribusiness.

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment, which is conducted through Matson Navigation Company, Inc. ("Matson"), a wholly-owned subsidiary of A&B, is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity (SSA Terminals, LLC or "SSAT") that provides terminal and stevedoring services at U.S. Pacific Coast facilities.

The Logistics Services segment, which is conducted through Matson Integrated Logistics, Inc. ("MIL"), a wholly-owned subsidiary of Matson, is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services (collectively "Highway"). Warehousing and distribution services are provided by Matson Global Distribution Services, Inc. ("MGDS"), a wholly-owned subsidiary of MIL. MGDS's operations also include Pacific American Services, LLC ("PACAM"), a San Francisco bay-area regional warehousing, packaging, and distribution company.

The Transportation Industry accounted for 78 percent, 54 percent, and 47 percent of the revenue, operating profit, and identifiable assets, respectively, in 2010 on a consolidated basis before discontinued operations.

Real Estate: The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. Mainland. The Real Estate Sales segment generates its revenues through the development and sale of land and commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. Real estate activities are conducted through A&B Properties, Inc. and various other subsidiaries and affiliates of A&B.

The Real Estate Industry accounted for 13 percent, 43 percent, and 47 percent of the revenue, operating profit, and identifiable assets, respectively, in 2010 on a consolidated basis before discontinued operations.

Agribusiness: Agribusiness, which contains one segment, produces bulk raw sugar, specialty food grade sugars, molasses, green coffee and roasted coffee; markets and distributes green coffee, roasted coffee, and specialty food-grade sugars; provides general trucking services, mobile equipment maintenance, and repair services in Hawaii; and generates and sells, to the extent not used in the Company's Agribusiness operations, electricity. The Company also is the sole member in Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services. HS&TC was consolidated with the Company's results beginning December 1, 2009.

In December 2010, the Company entered into an agreement to lease land and sell certain assets used in the coffee business to Massimo Zanetti Beverage USA, Inc. ("MZB"), including intangible assets. The assets will be sold at book value, or an approximate price of $15 million. The transaction, which is not expected to result in a gain or loss, is subject to certain material contingencies and, assuming the satisfaction of those conditions, is expected to close in the first quarter of 2011. The Company will retain fee simple ownership of the land, buildings, power generation, and power distribution assets.

The Agribusiness Industry accounted for 9 percent, 3 percent, and 6 percent of the revenue, operating profit, identifiable assets in 2010, respectively, on a consolidated basis before discontinued operations.

CRITICAL ACCOUNTING ESTIMATES

The Company's significant accounting policies are described in Note 1 to the Consolidated Financial Statements. The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America, upon which the MD&A is based, requires that management exercise judgment when making estimates and assumptions about future events that may affect the amounts reported in the financial statements and accompanying notes. Future events and their effects cannot be determined with certainty and actual results will, inevitably, differ from those critical accounting estimates. These differences could be material.

The Company considers an accounting estimate to be critical if: (i)(a) the accounting estimate requires the Company to make assumptions that are difficult or subjective about matters that were highly uncertain at the time that the accounting estimate was made, (b) changes in the estimate are reasonably likely to occur in periods subsequent to the period in which the estimate was made, or (c) use of different estimates by the Company could have been used, and (ii) changes in those assumptions or estimates would have had a material impact on the financial condition or results of operations of the Company. The critical accounting estimates inherent in the preparation of the Company's financial statements are described below.

Impairment of Long-Lived Assets and Finite-Lived Intangible Assets: The Company's long-lived assets, including finite-lived intangible assets, are reviewed for possible impairment when events or circumstances indicate that the carrying value may not be recoverable. In such an evaluation, the estimated future undiscounted cash flows generated by the asset are compared with the amount recorded for the asset to determine if its carrying value is not recoverable. If this review determines that the recorded value will not be recovered, the amount recorded for the asset is reduced to estimated fair value. The Company has evaluated certain long-lived assets, including intangible assets, for impairment; however, no impairment charges were recorded in 2010, 2009, and 2008 as a result of this process. These asset impairment loss analyses are highly subjective because they require management to make assumptions and apply considerable judgments to, among others, estimates of the timing and amount of future cash flows, expected useful lives of the assets, uncertainty about future events, including changes in economic conditions, changes in operating performance, changes in the use of the assets, and ongoing costs of maintenance and improvements of the assets, and thus, the accounting estimates may change from period to period. If management uses different assumptions or if different conditions occur in future periods, the Company's financial condition or its future operating results could be materially impacted.

Impairment of Investments: The Company's investments in unconsolidated affiliates are reviewed for impairment whenever there is evidence that fair value may be below carrying cost. An investment is written down to fair value if fair value is below carrying cost and the impairment is other-than-temporary. In evaluating the fair value of an investment, the Company reviews probability-weighted discounted projected cash flows associated with the investment and other relevant information. In evaluating whether an impairment is other-than-temporary, the Company considers all available information, including the length of time and extent of the impairment, the financial condition and near-term prospects of the affiliate, the Company's ability and intent to hold the investment for a period of time sufficient to allow for any anticipated recovery in market value, and projected industry and economic trends, among others.

Significant estimates and considerable judgments are involved in determining the fair value of an investment and assessing whether any identified impairment is other-than-temporary. These estimates and judgments are based, in part, on the Company's current and future evaluation of economic conditions in general, as well as a joint venture's current and future plans. These impairment calculations are highly subjective because they also require management to make assumptions and apply judgments to estimates of the timing and amount of future cash flows, probabilities related to various cash flow scenarios, and appropriate discount rates based on the perceived risks, among others. Changes in these and other assumptions could affect the projected operational results and fair value of the unconsolidated affiliates, and accordingly, may require valuation adjustments to the Company's investments that may materially impact the Company's financial condition or its future operating results. For example, if current market conditions deteriorate significantly or a joint venture's plans change materially, impairment charges may be required in future periods, and those charges could be material.

In 2010, the Company evaluated certain investments for impairment. As a result of this process, the Company recorded an impairment loss of approximately $1.9 million related to its Santa Barbara joint venture investment. Continued weakness in the real estate sector or difficulty in obtaining or renewing project-level financing may affect the value or feasibility of certain development projects owned by the Company or by its joint ventures and could lead to additional impairment charges in the future.

Legal Contingencies: The Company's results of operations could be affected by significant litigation adverse to the Company, including, but not limited to, liability claims, construction defect claims, antitrust claims, and claims related to coastwise trading matters. The Company records accruals for legal matters when the information available indicates that it is probable that a liability has been incurred and the amount of the loss can be reasonably estimated. Management makes adjustments to these accruals to reflect the impact and status of negotiations, settlements, rulings, advice of counsel and other information and events that may pertain to a particular matter. Predicting the outcome of claims and lawsuits and estimating related costs and exposure involves substantial uncertainties that could cause actual costs to vary materially from those estimates. In making determinations of likely outcomes of litigation matters, the Company considers many factors. These factors include, but are not limited to, the nature of specific claims including unasserted claims, the Company's experience with similar types of claims, the jurisdiction in which the matter is filed, input from outside legal counsel, the likelihood of resolving the matter through alternative dispute resolution mechanisms and the matter's current status. A detailed discussion of significant litigation matters is contained in Note 13 to the Consolidated Financial Statements.

Allowance for Doubtful Accounts: Receivables are recorded net of an allowance for doubtful accounts. The Company estimates future write-offs based on delinquencies, credit ratings, aging trends, and historical experience. The Company believes the allowance for doubtful accounts is adequate to cover anticipated losses; however, significant deterioration in any of the aforementioned factors or in general economic conditions could change these expectations, and accordingly, the Company's financial condition or its future operating results could be materially impacted.

2010: The revenue and expenses of Ontario Distribution Center, an industrial property in California, Valley Freeway Corporate Park, an industrial facility in Washington, Mililani Shopping Center, a retail center in Hawaii, Kele Shopping Center on Maui, and various Maui parcels have been classified as discontinued operations. Additionally, a retail property on Maui that was held for sale at year-end was classified as discontinued operations.

2009: The revenue and expenses of Hawaii Business Park, an industrial property on Oahu, Southbank II, an office building in Arizona, San Jose Avenue Warehouse, an industrial property in California, Pacific Guardian Tower, an office property on Oahu, Village at Indian Wells, an office property in California, and various parcels on Maui have been classified as discontinued operations. Additionally, a retail property on Oahu was classified as discontinued operations.

2008: The revenue and expenses of two retail properties on the mainland, one mainland office property, a multi-tenant residential rental property, three commercial properties on Maui, land previously leased to a telecommunications tenant on Maui, and several land parcels on Maui, and have been classified as discontinued operations.

Agribusiness

As of December 1, 2009, the Company began consolidating the results of the Hawaiian Sugar & Transportation Cooperative ("HS&TC") because the Company became the sole member. Since HS&TC is a wholly-owned consolidated subsidiary, revenue recognition on raw sugar and molasses sales occurs when HS&TC delivers the sugar and molasses to the Company's third-party customers on the U.S. mainland. Prior to consolidation, the Company recognized revenue when the raw sugar was delivered to HS&TC, which occurred as sugar was produced and delivered to the sugar warehouse on Maui, where title and risk of loss passed. As a result of the HS&TC consolidation, the timing of revenue recognition differs between 2009 and 2010 and results in year-over-year variances.

***Agribusiness**; 2010 compared with 2009*

(dollars in millions)		2010		2009	Change
Revenue	$	**163.9**	$	107.0	53%
Operating profit (loss)	$	**6.1**	$	(27.8)	NM
Operating profit margin		**3.7%**		-26.0%	
Tons sugar produced		**171,800**		126,800	35%
Tons sugar sold		**176,700**		124,000	43%

Agribusiness revenue increased $56.9 million in 2010 compared with 2009. The increase was primarily due to $62.8 million in higher bulk raw sugar revenue that was the result of higher sugar prices and higher sales volume, as well as $3.3 million in higher coffee revenues related to higher volume and prices. These increases were partially offset by a $7.1 million reduction in specialty sugar revenue due to lower sales volume.

Operating profit was $6.1 million in 2010 compared with an operating loss of $27.8 million in 2009. The improvement in operating profit was primarily due to a $33.4 million improvement in raw sugar margins. The improvement in raw sugar margins is principally the result of higher sugar prices and an increase in the volume of sugar production over which costs are allocated, resulting in lower per unit costs. Operating profit also benefited from a $7.9 million increase in specialty sugar margins, due primarily to lower per unit production costs previously described. The increase in operating profit was partially offset by a $3.0 million reduction in coffee results, principally due to a $1.9 million lower of cost or market adjustment to coffee inventory in the first quarter of 2010, as well as a $2.8 million reduction in molasses margins due principally to higher delivery costs and lower sales volume.

Sugar production in 2010 was 35 percent higher than in 2009 due principally to higher average yields per acre. The higher yields in 2010 were principally the result of improved growing conditions and factory enhancements. The average revenue per ton of sugar for 2010 was $575 or 63 percent higher than the average revenue per ton of $352 in 2009.

***Agribusiness**; 2009 compared with 2008*

(dollars in millions)		2009		2008	Change
Revenue	$	**107.0**	$	124.3	-14%
Operating profit (loss)	$	**(27.8)**	$	(12.9)	-2X
Tons sugar produced		**126,800**		145,200	-13%

Agribusiness revenue decreased $17.3 million in 2009 compared with 2008. The decrease was primarily due to a $16.6 million reduction in power revenue stemming from lower power prices and volume and $9.2 million in lower raw sugar sales volume, partially offset by a $5.4 million non-operating gain recognized upon consolidation of HS&TC and $3.4 million in higher specialty sugar volume. Power prices, which decreased by more than 50 percent compared to the prior year, are determined by an avoided cost calculation for the public utilities in Hawaii, and have been negatively impacted by a reduction in fossil fuel costs as well as a regulatory change in the avoided cost formula.

Operating loss increased $14.9 million in 2009 compared with 2008. The increase in operating loss was primarily due to $18.8 million reduction in power sales margin resulting from lower sales prices and volume and higher boiler fuel consumption and prices. The increase in operating loss was partially offset by a $5.4 million non-operating gain recorded upon consolidation of HS&TC.

Sugar production in 2009 was 13 percent lower than in 2008 due to the ongoing effects of severe drought conditions in 2007-2008. Additionally, fewer acres were harvested in 2009 to allow growing cane to mature more fully before harvest. The average revenue per ton of sugar for 2009 was $352 or 1 percent lower than the average revenue per ton of $355 in 2008.

Of the Company's 2009 sugar production, approximately 73 percent was sold to Hawaiian Sugar & Transportation Cooperative ("HS&TC") under a marketing contract. The remainder was sold as specialty sugar. HS&TC sells its raw sugar to C&H Sugar Company, Inc. at a price equal to the New York No. 16 Contract settlement price, less a discount and less costs for sugar vessel discharge and stevedoring. This price, after deducting the marketing, operating, distribution, transportation and interest costs of HS&TC, reflects the gross revenue to the Company. In 2009, HS&TC entered into a new contract for the delivery and sale of raw sugar with C&H Sugar Company, Inc., which replaced the contract that was set to expire in December 2009. The new contract was executed in October 2009 and has 3-year term.

LIQUIDITY AND CAPITAL RESOURCES

Overview: The Company has two revolving senior credit facilities with six commercial banks that provide for an aggregate commitment of $325 million, which consist of a $225 million facility and a $100 million facility for A&B and Matson, respectively. The A&B facility expires in December 2011 and the Matson facility expires in December 2012. As of December 31, 2010, the Company had approximately $198 million of available capacity under the facilities. Additionally, as of December 31, 2010, the Company had access to approximately $97 million of remaining capacity on a $400 million term facility, under which the ability to draw additional amounts under the facility expires in April 2012, and $63 million of remaining capacity on a facility that expires in June 2015. The Company is currently in compliance with all of its covenants under its debt agreements. As a result, the Company believes its ability to access cash under its facilities, as well as its ability to generate cash from operations, will be adequate to meet anticipated future cash requirements to fund working capital, capital expenditures, dividends, potential acquisitions, stock repurchases, and other cash needs for the foreseeable future. There can be no assurance, however, that the Company will continue to generate cash flows at or above current levels or that it will be able to maintain its ability to borrow under its available credit facilities.

While Matson is subject to restrictions on the transfer of net assets to A&B under certain debt agreements, these restrictions have not had any effect on the Company's shareholder dividend policy, and the Company does not anticipate that these restrictions will have any impact in the future. At December 31, 2010, the amount of net assets of Matson that may not be transferred to the Company was approximately $292 million.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31, 2010	2009	2008
Operating Revenue:			
Ocean transportation	$ 1,040	$ 887	$ 1,021
Logistics services	355	321	436
Real estate leasing	85	76	70
Real estate sales	14	16	225
Agribusiness	152	97	119
Total operating revenue	1,646	1,397	1,871
Operating Costs and Expenses:			
Cost of ocean transportation services	853	740	825
Cost of logistics services	314	280	381
Cost of real estate sales and leasing	62	56	225
Cost of agribusiness goods and services	150	130	133
Selling, general and administrative	158	154	163
Total operating costs and expenses	1,537	1,360	1,727
Operating Income	109	37	144
Other Income and (Expense):			
Gain on insurance settlement and other	6	--	8
Crop disaster relief payment	5	--	--
Gain on consolidation of HS&TC (Note 3)	--	5	--
Equity in income of real estate affiliates	2	--	9
Impairment loss on investment	(1)	(2)	(2)
Interest income	2	--	1
Interest expense	(26)	(25)	(24)
Income From Continuing Operations Before Income Taxes	97	15	136
Income taxes	38	6	50
Income From Continuing Operations	59	9	86
Income from discontinued operations, net of income taxes (Note 2)	33	35	46
Net Income	$ 92	$ 44	$ 132
Basic Earnings per Share of Common Stock:			
Continuing operations	$ 1.43	$ 0.22	$ 2.09
Discontinued operations	0.80	0.86	1.12
Net income	$ 2.23	$ 1.08	$ 3.21
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ 1.42	$ 0.22	$ 2.08
Discontinued operations	0.80	0.86	1.11
Net income	$ 2.22	$ 1.08	$ 3.19
Weighted Average Number of Shares Outstanding:			
Basic	41.2	41.0	41.2
Diluted	41.5	41.1	41.5

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31, 2010	2009	2008
Cash Flows from Operating Activities:			
Net income	$ 92	$ 44	$ 132
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	107	105	101
Deferred income taxes	5	1	19
Gains on disposal of assets, net of impairment losses	(51)	(51)	(91)
Gain from receipt of insurance proceeds	(1)	--	(8)
Gain on consolidation of HS&TC	--	(5)	--
Share-based expense	8	9	11
Equity in income of affiliates, net of distributions	(8)	(1)	11
Changes in operating assets and liabilities:			
Accounts and notes receivable	8	(16)	24
Inventories	6	(6)	(6)
Prepaid expenses and other assets	(18)	(5)	3
Deferred dry-docking costs	9	10	(9)
Liability for employee benefit plans	15	--	(3)
Accounts and income taxes payable	9	20	(37)
Other liabilities	(15)	11	(17)
Real estate developments held for sale:			
Real estate inventory sales	6	5	184
Expenditures for real estate inventory	(22)	(6)	(39)
Net cash provided by operations	150	115	275
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	(95)	(31)	(109)
Proceeds from disposal of income-producing property, investments and other assets	34	32	19
Proceeds from insurance settlement	--	--	8
Deposits into Capital Construction Fund	(4)	(4)	(7)
Withdrawals from Capital Construction Fund	4	4	8
Acquisition of businesses, net of cash acquired	--	10	(27)
Payments for purchases of investments	(102)	(48)	(60)
Proceeds from investments	13	6	19
Net cash used in investing activities	(150)	(31)	(149)
Cash Flows from Financing Activities:			
Proceeds from issuance of debt	245	241	127
Payments of debt and deferred financing costs	(198)	(288)	(138)
Proceeds from (payments on) line-of-credit agreement, net	(4)	13	(5)
Repurchases of capital stock	--	--	(59)
Proceeds from issuance of capital stock and other	7	(1)	2
Dividends paid	(52)	(52)	(51)
Net cash used in financing activities	(2)	(87)	(124)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	(2)	(3)	2
Balance, beginning of year	16	19	17
Balance, end of year	$ 14	$ 16	$ 19
Other Cash Flow Information:			
Interest paid, net of amounts capitalized	$ (25)	$ (24)	$ (25)
Income taxes paid	$ (46)	$ (38)	$ (63)
Non-cash Activities:			
Debt assumed in real estate purchase	$ 8	$ --	$ 11
Real estate received in settlement of a mortgage note	$ 8	$ --	$ --
Tax-deferred property sales	$ 120	$ 109	$ 112
Tax-deferred property purchases	$ (148)	$ (95)	$ (46)

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2010	December 31, 2009
ASSETS		
Current Assets		
Cash and cash equivalents	$ 14	$ 16
Accounts and notes receivable, less allowances of $8 for 2010 and $10 for 2009	165	172
Inventories	35	43
Real estate held for sale	8	36
Deferred income taxes	8	6
Section 1031 exchange proceeds	1	1
Prepaid expenses and other assets	33	33
Total current assets	264	307
Investments in Affiliates	329	242
Real Estate Developments	122	88
Property – net	1,651	1,536
Employee Benefit Plan Assets	3	3
Other Assets	126	204
Total	$ 2,495	$ 2,380
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	$ 136	$ 65
Accounts payable	137	132
Payroll and vacation benefits	20	18
Uninsured claims	10	9
Accrued and other liabilities	50	73
Total current liabilities	353	297
Long-term Liabilities		
Long-term debt	386	406
Deferred income taxes	431	428
Employee benefit plans	135	116
Uninsured claims and other liabilities	54	48
Total long-term liabilities	1,006	998
Commitments and Contingencies (Note 13)		
Shareholders' Equity		
Capital stock – common stock without par value; authorized, 150 million shares ($0.75 stated value per share); outstanding, 41.3 million shares in 2010 and 41.0 million shares in 2009	34	33
Additional capital	223	210
Accumulated other comprehensive loss	(82)	(81)
Retained earnings	972	934
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,136	1,085
Total	$ 2,495	$ 2,380

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF SHAREHOLDERS' EQUITY
For the three years ended December 31, 2010
(In millions, except per-share amounts)

	Capital Stock					Accumulated Other Compre-hensive Loss		
	Issued		In Treasury					
	Shares	Stated Value	Shares	Cost	Additional Capital		Retained Earnings	Total
Balance, December 31, 2007	**46.0**	**34**	**3.6**	**(11)**	**200**	**(4)**	**911**	**1,130**
Net income	—	—	—	—	—	—	132	132
Other comprehensive income, net of tax:								
Defined benefit plans:								
Net loss/prior service cost	—	—	—	—	—	(93)	—	(93)
Less: Amortization of net loss/prior service cost	—	—	—	—	—	1	—	1
Total comprehensive income								40
Shares repurchased	(1.4)	(1)	—	—	(8)	—	(50)	(59)
Shares issued	—	—	—	—	1	—	—	1
Share-based compensation	—	—	—	—	11	—	—	11
Dividends ($1.23 per share)	—	—	—	—	—	—	(51)	(51)
Balance, December 31, 2008	**44.6**	**33**	**3.6**	**(11)**	**204**	**(96)**	**942**	**1,072**
Net income	—	—	—	—	—	—	44	44
Other comprehensive income, net of tax:								
Defined benefit plans:								
Net gain/prior service (cost)	—	—	—	—	—	7	—	7
Less: Amortization of net loss/prior service cost	—	—	—	—	—	8	—	8
Total comprehensive income								59
Excess tax benefit and share withholding	—	—	—	—	(3)	—	—	(3)
Share-based compensation	—	—	—	—	9	—	—	9
Dividends ($1.26 per share)	—	—	—	—	—	—	(52)	(52)
Balance, December 31, 2009	**44.6**	**$ 33**	**3.6**	**$ (11)**	**$ 210**	**$ (81)**	**$ 934**	**$ 1,085**
Net income	—	—	—	—	—	—	**92**	**92**
Other comprehensive income, net of tax:								
Defined benefit plans:								
Net gain/prior service (cost)	—	—	—	—	—	**(13)**	—	**(13)**
Less: Amortization of net loss/prior service cost	—	—	—	—	—	**12**	—	**12**
Total comprehensive income								**91**
Excess tax benefit and share withholding	—	—	—	—	**(1)**	—	**(2)**	**(3)**
Shares issued	**0.3**	**1**	—	—	**6**	—	—	**7**
Share-based compensation	—	—	—	—	**8**	—	—	**8**
Dividends ($1.26 per share)	—	—	—	—	—	—	**(52)**	**(52)**
Balance, December 31, 2010	**44.9**	**$ 34**	**3.6**	**$ (11)**	**$ 223**	**$ (82)**	**$ 972**	**$ 1,136**

See notes to consolidated financial statements.

November 30, 2010, the judge dismissed the complaint with prejudice. On December 22, 2010, the plaintiffs filed an appeal to the Ninth Circuit Court of Appeals. The Company and Matson will continue to vigorously defend themselves in this lawsuit. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this lawsuit if an amended complaint is filed.

In February 2011, the Environmental Protection Agency ("EPA") issued nationwide standards for controlling hazardous air pollutant emissions from industrial, commercial, institutional boilers and process heaters, which would apply to Hawaiian Commercial & Sugar Company's three boilers. The standards require that prescribed emissions be reduced to allowable levels as detailed in the final regulations. The Company is currently evaluating the impact of the new standards, which require compliance by early 2014. Given the Company's continuing evaluation of alternative operating models for its sugar business and the requirement to perform a thorough analysis of the new standards, the Company is unable to predict at this time, the financial impact of the regulations.

The Company is subject to possible climate change legislation, regulation and international accords. Numerous bills related to climate change, such as limiting and reducing greenhouse gas emissions through a "cap and trade" system of allowances and credits, have been introduced in the U.S. Congress. In addition, the EPA is in the process of adopting and implementing regulations limiting greenhouse gas emissions in lieu of Congressional action. If enacted, these regulations could impose significant additional costs on the Company, including increased energy costs, higher material prices, and costly mandatory vessel and equipment modifications. The Company is unable to predict, at this time, the outcome or financial impact, if any, of future climate change related legislation.

A&B and its subsidiaries are parties to, or may be contingently liable in connection with, other legal actions arising in the normal conduct of their businesses, the outcomes of which, in the opinion of management after consultation with counsel, would not have a material adverse effect on A&B's results of operations or financial position.

14. INDUSTRY SEGMENTS

Operating segments are components of an enterprise that engage in business activities from which it may earn revenues and incur expenses, whose operating results are regularly reviewed by the chief operating decision maker to make decisions about resources to be allocated to the segment and assess its performance, and for which discrete financial information is available. The Company's chief operating decision maker is its Chief Executive Officer. Based on the foregoing, the Company has five segments that operate in three industries: Transportation, Real Estate and Agribusiness.

The Transportation Industry consists of two segments. Ocean Transportation carries freight between various U.S. Pacific Coast, major Hawaii ports, Guam, China and other Pacific ports and provides terminal, stevedoring and container equipment management services in Hawaii. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities. Logistics Services arranges domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited freight services, and warehousing and distribution services.

The Real Estate Industry consists of two segments. The Real Estate Sales segment generates its revenues through the development and sale of land, commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. When property that was previously leased is sold, the sales revenue and operating profit are included with the Real Estate Sales segment.

Agribusiness, which consists of one segment, grows sugar cane and coffee; produces bulk raw sugar, specialty food-grade sugars, molasses, green coffee and roasted coffee; markets and distributes roasted coffee, green coffee and specialty food-grade sugars; provides general trucking services, mobile equipment maintenance and repair services in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

The accounting policies of the operating segments are described in the summary of significant accounting policies. Reportable segments are measured based on operating profit, exclusive of interest expense, general corporate expenses, and income taxes.

Industry segment information for 2010, 2009, and 2008 is summarized below (in millions):

For the Year	**2010**	2009	2008
Revenue:			
Transportation:			
Ocean transportation	**$ 1,045.0**	$ 888.6	$ 1,023.7
Logistics services	**355.6**	320.9	436.0
Real Estate:			
Leasing	**94.4**	103.2	107.8
Sales	**136.1**	125.6	350.2
Less amounts reported in discontinued operations [1]	**(122.5)**	(132.4)	(160.3)
Agribusiness[5]	**163.9**	107.0	124.3
Reconciling Items [2]	**(26.3)**	(16.3)	(10.7)
Total revenue	**$ 1,646.2**	$ 1,396.6	$ 1,871.0
Operating Profit:			
Transportation:			
Ocean transportation[3]	**$ 99.4**	$ 58.3	$ 105.8
Logistics services	**7.2**	6.7	18.5
Real Estate:			
Leasing	**35.3**	43.2	47.8
Sales[3]	**50.1**	39.1	95.6
Less amounts reported in discontinued operations [1]	**(51.9)**	(57.0)	(74.6)
Agribusiness[5]	**6.1**	(27.8)	(12.9)
Total operating profit	**146.2**	62.5	180.2
Interest expense, net[4]	**(25.5)**	(25.9)	(23.7)

General corporate expenses	**(23.3)**	(21.8)	(21.0)
Income from continuing operations before income taxes	**97.4**	14.8	135.5
Income taxes	**38.5**	5.8	49.2
Income from continuing operations	**58.9**	9.0	86.3
Discontinued operations	**33.2**	35.2	46.1
Net income	**$ 92.1**	$ 44.2	$ 132.4

[1] Prior year amounts restated for amounts treated as discontinued operations. See Notes 1 and 2 for additional information.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $12.8 million, $6.2 million, and $5.2 million of equity in earnings from its investment in SSAT for 2010, 2009, and 2008, respectively. Additionally, in August 2010, Matson initiated its second China string, which incurred start-up losses of approximately $19.3 million principally occurring in the fourth quarter of 2010 . The Real Estate Sales segment includes approximately $2.0 million and $9.0 million in equity in earnings from its various real estate joint ventures for 2010 and 2008, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] Includes Ocean Transportation interest expense of $8.2 million for 2010, $9.0 million for 2009, and $11.6 million for 2008. Substantially all other interest expense was at the parent company.

[5] Includes a $4.9 million gain in 2010 related to a crop disaster relief payment for drought experienced in prior years and a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

INDUSTRY SEGMENTS (CONTINUED)

As of December 31:	2010	2009	2008
Identifiable Assets:			
Ocean transportation[6]	$ **1,095.5**	$ 1,095.2	$ 1,153.9
Logistics services	**73.8**	72.4	74.2
Real estate leasing	**739.4**	627.4	590.2
Real estate sales[6]	**420.8**	415.6	344.6
Agribusiness	**150.3**	156.8	172.2
Other	**14.8**	12.2	15.1
Total assets	$ **2,494.6**	$ 2,379.6	$ 2,350.2
Capital Expenditures:			
Ocean transportation	$ **69.4**	$ 12.7	$ 35.5
Logistics services[7]	**1.8**	0.6	2.4
Real estate leasing[8]	**164.7**	108.8	100.2
Real estate sales[9]	**0.1**	0.1	0.6
Agribusiness	**6.8**	3.4	15.2
Other	**0.3**	0.3	0.8
Total capital expenditures	$ **243.1**	$ 125.9	$ 154.7
Depreciation and Amortization:			
Ocean transportation	$ **69.0**	$ 67.1	$ 66.1
Logistics services	**3.2**	3.5	2.3
Real estate leasing[1]	**20.3**	19.5	17.9
Real estate sales	**0.2**	0.3	0.2
Agribusiness	**12.7**	11.9	11.5
Other	**1.9**	3.1	2.7
Total depreciation and amortization	$ **107.3**	$ 105.4	$ 100.7

[6] The Ocean Transportation segment includes approximately $52.9 million, $47.2 million, and $44.6 million related to its investment in SSAT as of December 31, 2010, 2009, and 2008, respectively. The Real Estate Sales segment includes approximately $274.8 million, $193.3 million, and $162.1 million related to its investment in various real estate joint ventures as of December 31, 2010, 2009, and 2008, respectively.

[7] Excludes expenditures related to Matson Integrated Logistics' acquisitions, which are classified as acquisition of businesses in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

[8] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[9] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for expenditures related to real estate developments were $22 million, $6 million, and $39 million for 2010, 2009, and 2008, respectively.

15. QUARTERLY INFORMATION (Unaudited)

Segment results by quarter for 2010 are listed below (in millions, except per-share amounts):

	2010			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 229.5	$ 257.2	$ 267.5	$ 290.8
Logistics services	77.1	88.6	92.4	97.5
Real Estate:				
Leasing	23.6	23.2	24.4	23.2
Sales	60.3	22.0	4.3	49.5
Less amounts reported in discontinued operations [1]	(57.3)	(19.7)	(2.2)	(43.3)
Agribusiness[2]	14.2	29.8	60.4	59.5
Reconciling Items [3]	(4.2)	(3.6)	(2.7)	(15.8)
Total revenue	$ 343.2	$ 397.5	$ 444.1	$ 461.4
Operating Profit (Loss):				
Transportation:				
Ocean transportation[4]	$ 10.4	$ 37.0	$ 40.4	$ 11.6
Logistics services	1.9	1.5	1.8	2.0
Real Estate:				
Leasing	9.1	8.5	9.3	8.4
Sales	21.4	8.0	2.9	17.8
Less amounts reported in discontinued operations [1]	(22.1)	(10.1)	(1.4)	(18.3)
Agribusiness[2]	(1.1)	1.8	0.8	4.6
Total operating profit	19.6	46.7	53.8	26.1
Interest Expense	(6.5)	(6.5)	(6.3)	(6.2)
General Corporate Expenses	(6.6)	(4.5)	(7.7)	(4.5)
Income From Continuing Operations before Income Taxes	6.5	35.7	39.8	15.4
Income taxes	3.3	13.2	15.1	6.9
Income From Continuing Operations	3.2	22.5	24.7	8.5
Discontinued Operations [1]	14.1	6.4	1.0	11.7
Net Income	$ 17.3	$ 28.9	$ 25.7	$ 20.2
Earnings Per Share:				
Basic	$ 0.42	$ 0.70	$ 0.62	$ 0.49
Diluted	$ 0.42	$ 0.70	$ 0.62	$ 0.48

1 See Note 2 for discussion of discontinued operations.
2 Includes a $4.9 million gain in the fourth quarter of 2010 related to a crop disaster relief payment for drought experienced in prior years.
3 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.
4 In the third quarter of 2010, Matson initiated its second China string, which incurred start-up losses of approximately $19.3 million principally occurring in the fourth quarter.

Segment results by quarter for 2009 are listed below (in millions, except per-share amounts):

	2009			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 201.1	$ 218.5	$ 234.2	$ 234.8
Logistics services	76.2	80.3	82.3	82.1
Real Estate:				
Leasing	27.2	25.9	25.2	24.9
Sales	25.2	21.3	14.9	64.2
Less amounts reported in discontinued operations [1]	(31.8)	(22.8)	(15.3)	(62.5)
Agribusiness [2]	17.7	29.2	32.5	27.6
Reconciling Items [3]	(2.3)	(2.8)	(3.0)	(8.2)
Total revenue	$ 313.3	$ 349.6	$ 370.8	$ 362.9
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ (0.5)	$ 21.1	$ 24.2	$ 13.5
Logistics services	1.5	1.8	2.2	1.2
Real Estate:				
Leasing	12.0	11.0	10.2	10.0
Sales	5.6	9.6	3.5	20.4
Less amounts reported in discontinued operations [1]	(12.7)	(13.2)	(6.6)	(24.5)
Agribusiness	(1.9)	(11.3)	(13.8)	(0.8)
Total operating profit	4.0	19.0	19.7	19.8
Interest Expense	(5.6)	(6.9)	(6.7)	(6.7)
General Corporate Expenses	(6.1)	(4.5)	(4.9)	(6.3)
Income From Continuing Operations before Income Taxes	(7.7)	7.6	8.1	6.8
Income taxes (benefit)	(2.9)	3.1	3.7	1.9
Income From Continuing Operations	(4.8)	4.5	4.4	4.9
Discontinued Operations [1]	7.8	8.1	4.1	15.2
Net Income	$ 3.0	$ 12.6	$ 8.5	$ 20.1
Earnings Per Share:				
Basic	$ 0.07	$ 0.31	$ 0.21	$ 0.49
Diluted	$ 0.07	$ 0.31	$ 0.21	$ 0.49

1 See Note 2 for discussion of discontinued operations.
2 Includes a $5.4 million gain recorded upon consolidation of HS&TC in the fourth quarter of 2009.
3 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

16. PARENT COMPANY CONDENSED FINANCIAL INFORMATION

Set forth below are the unconsolidated condensed financial statements of Alexander & Baldwin, Inc. ("Parent Company"). The significant accounting policies used in preparing these financial statements are substantially the same as those used in the preparation of the consolidated financial statements as described in Note 1, except that, for purposes of the tables presented in this footnote, subsidiaries are carried under the equity method.

The following table presents the Parent Company's condensed balance sheets as of December 31, 2010 and 2009 (in millions):

	2010	2009
ASSETS		
Current Assets:		
Cash and cash equivalents	$ -	$ 1
Accounts and other receivables, net	5	12
Inventories	16	15
Real estate held for sale	3	7
Prepaid expenses and other	6	6
Total current assets	30	41
Investments:		
Subsidiaries consolidated, at equity	1,299	1,210
Property, at Cost	501	455
Less accumulated depreciation and amortization	225	226
Property -- net	276	229
Other Assets	17	32
Total	$ 1,622	$ 1,512
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 108	$ 40
Accounts payable	8	10
Income taxes payable	2	24
Non-qualified benefit plans	1	17
Other	17	15
Total current liabilities	136	106
Long-term Debt	230	239
Employee Benefit Plans	27	22
Non-qualified Benefit Plans	10	8
Other Long-term Liabilities	11	4
Deferred Income Taxes	50	42
Due to Subsidiaries	22	6
Shareholders' Equity:		
Capital stock	34	33
Additional capital	223	210
Accumulated other comprehensive loss	(82)	(81)
Retained earnings	972	934
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,136	1,085
Total	$ 1,622	$ 1,512

The following table presents the Parent Company's condensed statements of income for the years ended December 31, 2010, 2009 and 2008 (in millions):

	2010	2009	2008
Revenue:			
Agribusiness	$ 117	$ 73	$ 91
Real estate leasing	17	14	10
Real estate sales	2	8	6
Interest and other	6	2	3
Total revenue	142	97	110
Costs and Expenses:			
Cost of agribusiness goods and services	114	109	110
Cost of real estate sales and leasing	11	10	11
Selling, general and administrative	24	21	21
Interest and other	16	16	14
Income tax benefit	(12)	(22)	(18)
Total costs and expenses	153	134	138
Loss from Continuing Operations	(11)	(37)	(28)
Discontinued Operations, net of income taxes	23	11	24
Loss Before Equity in Income of Subsidiaries Consolidated	12	(26)	(4)
Equity in Income from Continuing Operations of Subsidiaries Consolidated	70	46	114
Equity in Income from Discontinued Operations of Subsidiaries Consolidated	10	24	22
Net Income	92	44	132
Other Comprehensive Income (Loss), net of income taxes	(1)	15	(91)
Comprehensive Income	$ 91	$ 59	$ 41

UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2011

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from _______ to _______

Commission file number 000-00565

AB ALEXANDER & BALDWIN, INC.

(Exact name of registrant as specified in its charter)

Hawaii (State or other jurisdiction of incorporation or organization)	**99-0032630** (I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	**NYSE**

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 15, 2012:
41,871,540

Aggregate market value of Common Stock held by non-affiliates at June 30, 2011:
$1,980,995,573

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically and posted on its corporate Web site, if any, every Interactive Data File required to be submitted and posted pursuant to Rule 405 of Regulation S-T during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☒

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒ Accelerated filer ☐

Exhibit E-R5

Non-accelerated filer ☐ (Do not check if a smaller reporting company) Smaller reporting company ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement for the 2012 Annual Meeting of Shareholders (Part III of Form 10-K)

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PART II

ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2011

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Alexander & Baldwin, Inc. (“A&B” or the “Company”) is a multi-industry corporation with its primary operations centered in Hawaii. It was founded in 1870 and incorporated in 1900. Ocean transportation operations, related shoreside operations in Hawaii, and intermodal, truck brokerage and logistics services are conducted by a wholly-owned subsidiary, Matson Navigation Company, Inc. ("Matson"), and its subsidiaries. Property development, commerial real estate and agribusiness operations are conducted by A&B and certain other subsidiaries of A&B.

The business industries of A&B are generally as follows:

A. *Transportation* - carrying freight, primarily between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports; arranging domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services; and providing terminal, stevedoring and container equipment maintenance services in Hawaii.

B. *Real Estate* - engaging in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property.

C. *Agribusiness* - growing sugar cane in Hawaii; producing bulk raw sugar, specialty food-grade sugars and molasses; marketing and distributing specialty food-grade sugars; generating and selling, to the extent not used in A&B's operations, electricity; and providing general trucking services in Hawaii, including sugar and molasses hauling, and mobile equipment maintenance and repair services. In March 2011, the Company executed an agreement to lease land and sell coffee inventory and certain assets used in a coffee business it previously operated to Massimo Zanetti Beverage USA, Inc.

For information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2011, see Note 14 ("Industry Segments") to A&B's financial statements in Item 8 of Part II below.

Separation Transaction: On December 1, 2011, the Company announced that its Board of Directors unanimously approved a plan to pursue the separation of the Company to create two independent, publicly traded companies:

- A Hawaii-based land company with interests in real estate development, commercial real estate and agriculture (composed of the Real Estate and Agribusiness segments described above), which will retain the Alexander & Baldwin, Inc. name; and
- An ocean transportation company serving the U.S. West Coast, Hawaii, Guam, Micronesia and China, and a domestic logistics company under the Matson name (composed of the businesses in the Transportation segment described above).

The separation is expected to be completed in the second half of 2012.

On February 13, 2012, the Company entered into an Agreement and Plan of Merger to reorganize itself as a holding company incorporated in Hawaii. The holding company structure will help facilitate the separation by allowing the Company to organize and segregate the assets of its different businesses in an efficient manner prior to the separation and facilitate the third party and governmental consent and approval process. In addition, the holding company reorganization will help preserve the Company's status as a U.S. citizen under certain U.S. maritime and vessel documentation laws (popularly referred to as the Jones Act) by, among other things, limiting the percentage of outstanding shares of common stock in the holding company that may be owned (of record or beneficially) or controlled in the aggregate by non-U.S. citizens (as defined by the Jones Act) to a maximum permitted percentage of 22%. For more information on the Jones Act and its effect on the Company, see "Description of Business and Properties – Transportation – Jones Act."

DESCRIPTION OF BUSINESS AND PROPERTIES

A. Transportation

(1) Freight Services

Matson's Hawaii Service offers containership freight services between the ports of Long Beach, Oakland, Seattle and the major ports in Hawaii on the islands of Oahu, Kauai, Maui and Hawaii. Roll-on/roll-off service is provided between California and the major ports in Hawaii. Matson is the principal carrier of ocean cargo between the U.S. Pacific Coast and Hawaii. Principal westbound cargoes carried by Matson to Hawaii include dry containers of mixed commodities, refrigerated commodities, packaged foods, building materials, automobiles and household goods. Principal eastbound cargoes carried by Matson from Hawaii include automobiles, household goods, dry containers of mixed commodities, food and beverages, and livestock. The majority of Matson's Hawaii Service revenue is derived from the westbound carriage of containerized freight and automobiles.

Matson's Guam Service provides weekly containership freight services between the U.S. Pacific Coast and Guam. Additional freight destined to and from the Commonwealth of the Marianas Islands, the Republic of Palau and the island of Yap in the Federated States of Micronesia is transferred at Guam to and from connecting carriers for delivery to and from those locations.

Matson's Micronesia Service offers container and conventional freight service between the U.S. Pacific Coast and the islands of Kwajalein, Ebeye and Majuro in the Republic of the Marshall Islands and the islands of Pohnpei, Chuuk and Kosrae in the Federated States of Micronesia. Cargo is transferred at Guam to a Matson-operated ship that provides bi-weekly service to and from those islands. Matson also carries cargo originating in Asia to these islands by receiving cargo transferred from other carriers in Guam.

Matson's China Service is part of an integrated Hawaii/Guam/China service. This service employs five Matson containerships in a weekly service that carries cargo from the U.S. Pacific Coast to Honolulu, then to Guam. The vessels continue to the ports of Xiamen, Ningbo and Shanghai in China, where they are loaded with cargo to be discharged in Long Beach. These ships also carry cargo destined to and originating from Guam, the Commonwealth of Northern Marianas, the Republic of Palau and the Republic of the Marshall Islands. In 2011, Matson operated a second vessel string for part of the year that employed five chartered containerships in a weekly service that carried cargo from the U.S. Pacific Coast directly to the ports of Hong Kong, Yantian and Shanghai in China, where they also loaded cargo to be discharged in Long Beach. Operation of the second vessel string was terminated in the third quarter of 2011.

A&B's mainland commercial properties owned as of year-end 2011 were as follows:

Property	Location	Type	Leasable Area (sq. ft.)
Heritage Business Park	Dallas, TX	Industrial	1,316,400
Savannah Logistics Park	Savannah, GA	Industrial	1,035,700
Midstate 99 Distribution Center	Visalia, CA	Industrial	789,100
Sparks Business Center	Sparks, NV	Industrial	396,100
Republic Distribution Center	Pasadena, TX	Industrial	312,500
Activity Distribution Center	San Diego, CA	Industrial	252,300
Centennial Plaza	Salt Lake City, UT	Industrial	244,000
Meadows on the Parkway	Boulder, CO	Retail	216,400
1800 and 1820 Preston Park	Plano, TX	Office	198,800
Ninigret Office Park X and XI	Salt Lake City, UT	Office	185,500
San Pedro Plaza	San Antonio, TX	Office/Retail	171,900
Rancho Temecula Town Center	Temecula, CA	Retail	165,500
2868 Prospect Park	Sacramento, CA	Office	162,900
Issaquah Office Center	Issaquah, WA	Office	146,900
Little Cottonwood Center	Sandy, UT	Retail	141,600
Concorde Commerce Center	Phoenix, AZ	Office	140,700
Deer Valley Financial Center	Phoenix, AZ	Office	126,600
Northpoint Industrial	Fullerton, CA	Industrial	119,400
Broadlands Marketplace	Broomfield, CO	Retail	103,900
Union Bank	Everett, WA	Office	84,000
2890 Gateway Oaks	Sacramento, CA	Office	58,700
Wilshire Shopping Center	Greeley, CO	Retail	46,500
Royal MacArthur Center	Dallas, TX	Retail	44,100
Firestone Boulevard Building	La Mirada, CA	Office	28,100

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) renewable energy operations on the island of Kauai, operated by its McBryde Resources, Inc. subsidiary, (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide several types of trucking services, including sugar and molasses hauling on Maui, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai, and (4) Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a single member agricultural cooperative that provides raw sugar marketing and transportation services solely to HC&S. HS&TC owns the MV Moku Pahu, a Jones-Act qualified integrated tug barge bulk dry carrier, which is used to transport raw sugar from Hawaii to the U.S. West Coast and coal from the U.S. West Coast to Hawaii.

HC&S is Hawaii's only producer of raw sugar, producing approximately 182,800 tons of raw sugar in 2011 (compared with 171,800 tons in 2010). The primary reasons for the increase in production were improved yields on the plantation due to better agronomic practices, a higher average age of the crop at harvest, and increased delivery of irrigation water. HC&S harvested 15,063 acres of sugar cane in 2011 (compared with 15,488 in 2010). Yields averaged 12.1 tons of sugar per acre in 2011 (compared to 11.1 in 2010). As a by-product of sugar production, HC&S also produced approximately 53,100 tons of molasses in 2011 (compared to 52,800 in 2010).

In 2011, approximately 18,700 tons of sugar (compared to 16,300 tons in 2010) were processed by HC&S into specialty food-grade sugars under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. This increase in production was due to longer, steady production runs throughout the harvesting season, enhanced operation of the specialty brand sugar production line, and more efficient labor operations.

In March 2011, the Company executed an agreement to lease land and sell coffee inventory and certain assets used in a coffee business it previously operated to Massimo Zanetti Beverage USA, Inc. ("MZB"), including intangible assets. The Company has retained fee simple ownership of the land, buildings, power generation, and power distribution assets, but no longer operates the coffee plantation.

HC&S and McBryde Sugar Company, Limited ("McBryde"), a subsidiary of A&B, produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels. McBryde produces power solely by hydroelectric generation. The price for the power sold by HC&S and McBryde is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. See "Energy" below for power production and sales data.

(2) Marketing of Sugar

Approximately 90 percent of the bulk raw sugar produced by HC&S in 2011 was purchased by C&H Sugar Company, Inc. ("C&H"). C&H processes the raw cane sugar at its refinery at Crockett, California and markets the refined products primarily in the western and central United States.

The remaining 10 percent of the raw sugar was used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand ® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" product line.

Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a sugar grower cooperative in Hawaii (of which HC&S currently is the only member), has a supply contract with C&H ending in December 2012. Pursuant to the supply contract, the cooperative sells raw sugar to C&H at a price equal to the New York No. 16 Contract settlement price, less a volume-based discount.

(3) Sugar Competition and Legislation

Hawaii has traditionally produced more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the U.S. Mainland market. Hawaiian refined sugar is marketed primarily west of Chicago. This is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

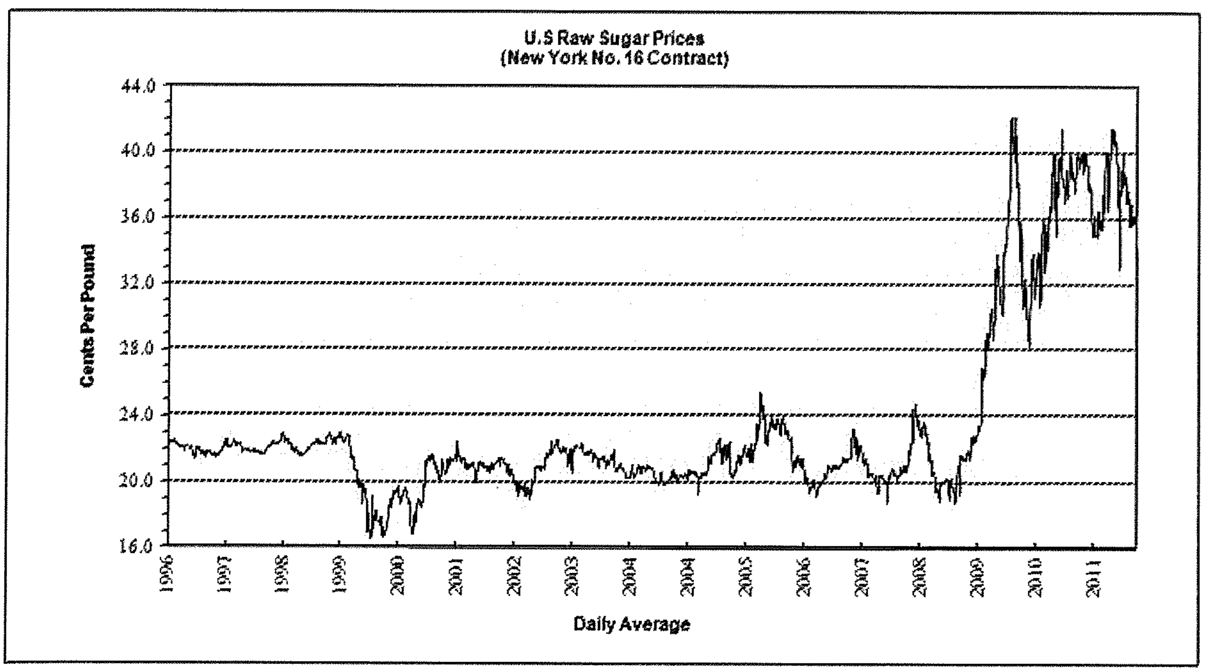
The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current legislation is the Food Conservation and Energy Act of 2008, which expires on December 31, 2012 ("2008 Farm Bill"). The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports from countries other than Canada and Mexico by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount. Also, a new but limited sucrose ethanol program was added in 2008, which allows sugar to be diverted into ethanol production when the market is deemed to be oversupplied.

The 2008 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18.50 cents per pound ("¢/lb") for raw cane sugar was in effect for the 2010 and 2011 crops. The loan rate increases to 18.75 ¢/lb for the 2012 and 2013 crops (the last year of the bill). The U.S. rates are adjusted by region to reflect the cost of transportation. The 2010 adjusted crop loan rate in Hawaii is 16.52 ¢/lb. The Company does not currently participate in the sugar price support loan program.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement. In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately or phased out. Starting in 2008, Mexico was permitted to ship an unlimited quantity of sugar duty-free to the U.S. each year.

U.S. raw sugar prices remained relatively stable and flat for over thirty years. The full implementation of NAFTA in 2008, which unified the U.S. and Mexican sugar markets, increased price volatility. In 2009, a tight NAFTA supply/demand outlook and a soaring world raw sugar market combined to push U.S. raw sugar prices to 29-year highs. Prices have remained at high levels for most of 2011. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 16 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



(4) Land Designations and Water

The HC&S sugar plantation, the only remaining sugar plantation in Hawaii, consists of 43,300 acres, with approximately 35,500 acres under active sugar cane cultivation.

On Kauai, approximately 3,000 acres are cultivated in coffee by Massimo Zanetti Beverage USA, Inc., which leases the land from the Company. Additional acreage is cultivated in seed corn and used for pasture purposes.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to fulfill the State constitutional mandate to protect agricultural lands, promote diversified agriculture, increase the State's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. In 2008, the Legislature passed a package of incentives, which is necessary to trigger the IAL system of land designation. In 2009, A&B received approval from the State Land Use Commission for the designation of over 27,000 acres on Maui and over 3,700 acres on Kauai as IAL. These designations were the result of voluntary petitions filed by A&B.

It is crucial for HC&S to have access to reliable sources of water supply and efficient irrigation systems. HC&S conserves water by using "drip" irrigation systems that distribute water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the last ten years have supplied approximately 58 percent of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provided approximately 14 percent of the irrigation water used by HC&S over the last ten years. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

D. Employees and Labor Relations

As of December 31, 2011, A&B and its subsidiaries had approximately 2,100 regular full-time employees. About 880 regular full-time employees were engaged in the agribusiness segment, 1,101 were engaged in the transportation segment, 42 were engaged in the real estate segment, and the remaining were in administration. Approximately 48 percent were covered by collective bargaining agreements with unions.

At December 31, 2011, the active Matson fleet employed seagoing personnel in 197 billets. Each billet corresponds to a position on a ship that typically is filled by two or more employees because seagoing personnel rotate between active sea duty and time ashore. Approximately 25 percent of Matson's regular full-time employees and all of the seagoing employees were covered by collective bargaining agreements.

Historically, collective bargaining with longshore and seagoing unions has been complex and difficult. However, Matson and Matson Terminals consider their relations with those unions, other unions and their non-union employees generally to be satisfactory.

Matson's seagoing employees are represented by six unions, three representing unlicensed crew members and three representing licensed crew members. Matson negotiates directly with these unions. Matson's agreements with the Seafarer's International Union, the Sailors Union of the Pacific and the Marine Firemen's Union were renewed in mid-2008 through June 2013. Contracts that Matson has with the American Radio Association were renewed in mid-2009 through August 15, 2013. Contracts that Matson has with the Masters, Mates & Pilots ("MM&P") and the Marine Engineers Beneficial Association ("MEBA") for ships built prior to 2003 were renewed in mid-2009 through August 15, 2013. Contracts that Matson has with MM&P and the MEBA for ships built after 2003 expire on August 15, 2013 and include provisions for a wage reopener, which was negotiated in mid-2009 to cover the remaining contract period. Matson's MEBA contracts were extended on December 29, 2011 and now expire on August 15, 2018.

SSAT, the previously-described joint venture of Matson and SSA, provides stevedoring and terminal services for Matson vessels calling at U.S. Pacific Coast ports. Matson, SSA and SSAT are members of the Pacific Maritime Association ("PMA") which, on behalf of its members, negotiates collective bargaining agreements with the ILWU on the U.S. Pacific Coast. A six-year PMA/ILWU Master Contract, which covers all Pacific Coast longshore labor, was negotiated in 2008 and will expire on July 1, 2014. Matson Terminals provides stevedoring and terminal services to Matson and other vessel operators calling at Honolulu and on the islands of Hawaii, Maui and Kauai. Matson Terminals is a member of the Hawaii Stevedore Industry Committee, which negotiates with the ILWU in Hawaii on behalf of its members. In 2008, Matson signed six-year agreements with each of the ILWU units, which will expire on July 1, 2014.

During 2010, Matson maintained its collective bargaining agreements with ILWU clerical workers in Honolulu and Oakland, which are in effect through June 2014. The bargaining agreement with ILWU clerical workers in Long Beach was renegotiated in 2010 for another three-year period. The health & welfare and pension provisions were not renegotiated; however, the parties agreed to match the provisions that are negotiated between the ILWU clerical workers in Long Beach and the other employers. Those negotiations are continuing and are expected to be finalized in 2012.

During 2011, Matson contributed to multiemployer pension plans for vessel crews. If Matson were to withdraw from or significantly reduce its obligation to contribute to one of the plans, Matson would review and evaluate data, actuarial assumptions, calculations and other factors used in determining its withdrawal liability, if any. In the event that any third parties materially disagree with Matson's determination, Matson would pursue the various means available to it under federal law for the adjustment or removal of its withdrawal liability. Also, Matson participates in a multiemployer pension plan for its office clerical workers in Long Beach. Matson Terminals participates in two multiemployer pension plans for its Hawaii ILWU non-clerical employees. For a discussion of withdrawal liabilities under the Hawaii longshore and seagoing plans, see Note 10 ("Employee Benefit Plans") to A&B's consolidated financial statements in Item 8 of Part II below.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the ILWU. The agreements with the HC&S production unit employees and clerical and technical employees bargaining units cover approximately 640 workers and expire on January 31, 2014. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. The bulk sugar employees' agreement expires on June 30, 2014 and the agreement with all other employees expires on March 31, 2012, with renegotiations expected to begin in March 2012. There are two collective bargaining agreements with KCC employees represented by the ILWU. These agreements expire on April 30, 2012, with renegotiations expected to begin in April 2012.

E. Energy

Matson and Matson Terminals purchase residual fuel oil, lubricants, gasoline and diesel fuel for their operations and also pay fuel surcharges to drayage providers and rail carriers. Residual fuel oil is by far Matson's largest energy-related expense. In 2011, Matson purchased approximately 2.7 million barrels of residual fuel oil for its vessels, which included fuel for Matson's CLX2 service discontinued in the third quarter of 2011, compared with 2.1 million barrels in 2010.

Residual fuel oil prices paid by Matson in 2011 on the west coast started at $83.23 per barrel and ended the year at $113.93. The lowest west coast price for the year was $82.13 per barrel in January, and the high price was $124.36 in December. Sufficient fuel for Matson's requirements is expected to be available in 2012.

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced or during periods when bagasse is not produced in sufficient quantities. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory and farming operations, HC&S sells electricity. In 2011, HC&S produced and sold, respectively, approximately 191,300 MWH and 64,900 MWH of electric power (compared with 190,400 MWH produced and 68,300 MWH sold in 2010). The decrease in power sold was due to increased power used for irrigation pumps to improve soil moisture levels and yields. Hydroelectric generation was depressed during the year due to extended drought conditions on Maui. HC&S's use of oil in 2011 of 9,700 barrels was 42 percent less than the 16,700 barrels used in 2010. The decrease was primarily due to higher bagasse production used in power generation as a result of improved yields on the farm. Coal used for power generation was 58,600 short tons, about 2,600 tons less than that used in 2010. Less coal was required because of the higher bagasse production from the fields.

In 2011, McBryde produced approximately 29,800 MWH of hydroelectric power (compared with approximately 29,500 MWH in 2010). To the extent it is not used in A&B-related operations, McBryde sells electricity to Kauai Island Utility Cooperative. Power sales in 2011 amounted to approximately 22,100 MWH (compared with 19,000 MWH in 2010).

F. Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

The business of A&B and its subsidiaries (collectively, the "Company") faces numerous risks, including those set forth below or those described elsewhere in this Form 10-K or in the Company's filings with the SEC. The risks described below are not the only risks that the Company faces, nor are they listed in order of significance. Other risks and uncertainties may also impair its business operations. Any of these risks may have a material adverse effect on the Company's business, liquidity, financial condition, results of operations and cash flows. All forward-looking statements made by the Company or on the Company's behalf are qualified by the risks described below.

Changes in U.S., global, or regional economic conditions that result in a further decrease in consumer confidence or market demand for the Company's services and products in Hawaii, the U.S. Mainland, Guam or Asia may adversely affect the Company's financial position, results of operations, liquidity, or cash flows.

A continuation or further weakening of the U.S., Guam, Asian or global economies may adversely impact the level of freight volumes, freight rates, and real estate leasing, sales and development activity. Within the U.S., a continuation or further weakening of economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, or the further weakening of consumer confidence, market demand or the economy in the U.S. Mainland, may further reduce the demand for goods to and from Hawaii and Asia, travel to Hawaii and domestic transportation of goods, adversely affecting inland and ocean transportation volumes or rates, the sale of Hawaii real estate, and the real estate leasing and development markets. In addition, overcapacity in the global or transpacific ocean transportation markets or a change in the cost of goods or currency exchange rates may adversely affect freight volumes or rates in the Company's China service.

The Company may face new or increased competition.

The Company's transportation segment may face new competition by established or start-up shipping operators that enter the Company's markets. The entry of a new competitor or the addition of ships or capacity by existing competition on any of the Company's routes could result in a significant increase in available shipping capacity that could have an adverse effect on volumes or rates. See also discussion under "Business and Properties - Transportation - Competition" above.

For the Company's real estate segments, there are numerous other developers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with the Company for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Increased vacancies, decreased rents, sales prices or sales volume, or lack of development opportunities may lead to a deterioration in results from the Company's real estate business.

The Company's significant operating agreements and leases could be replaced on less favorable terms or may not be replaced.

The significant operating agreements and leases of the Company in its various businesses expire at various points in the future and may not be replaced or could be replaced on less favorable terms, thereby adversely affecting the Company's future financial position, results of operations and cash flows.

The reduction in availability of mortgage financing and the volatility and reduction in liquidity in the financial markets may adversely affect the Company's real estate business.

During 2008 and 2009, the financial industry experienced significant instability due to, among other things, declining property values and increasing defaults on loans. This led to tightened credit requirements, reduced liquidity and increased credit risk premiums for virtually all borrowers. Fewer loan products, tighter loan qualifications and higher interest rates make it more difficult for borrowers to finance the purchase of units in the Company's projects. Tightening of credit in the commercial markets may adversely affect the Company's ability to secure construction or other financing on acceptable or favorable terms for the Company's residential and commercial projects, working capital requirements, or investment needs. Additionally, the stringent requirements to obtain financing for buyers of commercial properties make it significantly more difficult for the Company to sell commercial properties and may negatively impact the sales prices and other terms of such sales. The stringent credit environment may also impact the Company in other ways, including the credit or solvency of customers, vendors, or joint venture partners, and the ability of partners to fund their equity obligations to the joint venture.

A deterioration of the Company's credit profile or disruptions of the credit markets could restrict its ability to access the debt capital markets or increase the cost of debt.

A deterioration in the Company's credit profile may ultimately have an adverse effect on the Company's ability to access the private or public debt markets and also may increase its borrowing costs. If the Company's credit profile deteriorates significantly, its access to the debt capital markets or its ability to renew its committed lines of credit may become restricted, or the Company may not be able to refinance debt at the same levels or on the same terms. Because the Company relies on its ability to draw on its revolving credit facilities to support its operations, when required, any volatility in the credit and financial markets that prevents the Company from accessing funds (for example, a lender that does not fulfill its lending obligation) could have an adverse effect on the Company's financial condition and cash flows. Additionally, the Company's credit agreements generally include an increase in borrowing rates if the Company's credit profile deteriorates. Furthermore, the Company incurs interest under its revolving credit facilities based on floating rates. Floating rate debt creates higher debt service requirements if market interest rates increase, which would adversely affect the Company's cash flow and results of operations.

Failure to comply with certain restrictive financial covenants contained in the Company's credit facilities could preclude the payment of dividends, impose restrictions on the Company's business segments, capital resources or other activities or otherwise adversely affect the Company.

The Company's credit facilities contain certain restrictive financial covenants, the most restrictive of which include the maintenance of minimum shareholders' equity levels, a maximum ratio of debt to earnings before interest, depreciation, amortization, and taxes, and the maintenance of a minimum unencumbered property investment value. If the Company does not maintain the required covenants, and that breach of covenants is not cured timely or waived by the lenders, resulting in default, the Company's access to credit may be limited or terminated, dividends may be suspended, and the lenders could declare any outstanding amounts due and payable. Additionally, the Company's credit facilities contain other terms limiting its ability to incur additional indebtedness, including restrictions on total debt outstanding and restrictions on secured debt outstanding. The Company's continued ability to borrow under its credit facilities is subject to compliance with these financial and other non-financial covenants.

An increase in fuel prices, or changes in the Company's ability to collect fuel surcharges, may adversely affect the Company's profits.

Fuel is a significant operating expense for the Company's shipping and agribusiness operations. The price and supply of fuel are unpredictable and fluctuate based on events beyond the Company's control. Increases in the price of fuel may adversely affect the Company's results of operations based on market and competitive conditions. Increases in fuel costs also can lead to other expense increases, through, for example, increased costs of energy, petroleum-based raw materials and purchased transportation services. In the Company's ocean transportation and logistics services segments, the Company is able to utilize fuel surcharges to partially recover increases in fuel expense, although increases in the fuel surcharge may adversely affect the Company's competitive position and may not correspond exactly with the timing of increases in fuel expense. Changes in the Company's ability to collect fuel surcharges may adversely affect its results of operations. Increases in energy costs for the Company's leased real estate portfolio are typically recovered from lessees, although the Company's share of energy costs increases as a result of lower occupancies and higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices also may increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting the Company's development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Noncompliance with, or changes to, federal, state or local law or regulations, including passage of climate change legislation or regulation, may adversely affect the Company's business.

The Company is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, government administration of the U.S. sugar program, environmental regulations including those relating to air quality initiatives at port locations, and cabotage laws. Noncompliance with, or changes to, the laws and regulations governing the Company's business could impose significant additional costs on the Company and adversely affect the Company's financial condition and results of operations. In addition, changes in environmental laws impacting the shipping business, including passage of climate change legislation or other regulatory initiatives that restrict emissions of greenhouse gasses, may require costly vessel modifications, the use of higher-priced fuel and changes in operating practices that may not all be able to be recovered through increased payments from customers. The real estate segments are subject to numerous federal, state and local laws and regulations, which, if changed, may adversely affect the Company's business. The agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the 2008 Farm Bill, and the Hawaii Public Utilities Commission's regulation of avoided energy cost rates paid to the Company in connection with it sale of electric power. Further changes to these laws and regulations could adversely affect the Company. Climate change legislation, such as limiting and reducing greenhouse gas emissions through a "cap and trade" system of allowances and credits, if enacted, may have an adverse effect on the Company's business.

Work stoppages or other labor disruptions by the unionized employees of the Company or other companies in related industries may adversely affect the Company's operations.

As of December 31, 2011, the Company had approximately 2,100 regular full-time employees, of which approximately 48 percent were covered by collective bargaining agreements with unions. The Company's transportation, real estate and agribusiness segments may be adversely affected by actions taken by employees of the Company or other companies in related industries against efforts by management to control labor costs, restrain wage or benefits increases or modify work practices. Strikes and disruptions may occur as a result of the failure of the Company or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its real estate sales segment, the Company may be unable to complete construction of its projects if building materials or labor is unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor, agent and customer relationships may adversely affect the Company's business.

The Company's business is dependent on its relationships with key vendors, agents, customers and tenants. The ocean transportation business relies on its relationships with freight forwarders, large retailers and consumer goods and automobile manufacturers, as well as other larger customers. Relationships with railroads and shipping companies and agents are important in the Company's intermodal business. For agribusiness, HC&S's relationship with C&H Sugar Company, Inc. is critical. The loss of or damage to any of these key relationships may affect the Company's business adversely.

Interruption or failure of the Company's information technology and communications systems could impair the Company's ability to operate and adversely affect its business.

The Company is highly dependent on information technology systems. For example, in the ocean transportation segment, these dependencies include accounting, billing, disbursement, cargo booking and tracking, vessel scheduling and stowage, equipment tracking, customer service, banking, payroll and employee communication systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. The Company may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at the Company's facilities. Any failure of the Company's systems could result in interruptions in its service or production, reductions in its revenue and profits and damage to its reputation.

The Company is susceptible to weather and natural disasters.

The Company's transportation operations are vulnerable to disruption as a result of weather and natural disasters such as bad weather at sea, hurricanes, typhoons, tsunamis, floods and earthquakes. Such events will interfere with the Company's ability to provide on-time scheduled service, resulting in increased expenses and potential loss of business associated with such events. In addition, severe weather and natural disasters can result in interference with the Company's terminal operations, and may cause serious damage to its vessels, loss or damage to containers, cargo and other equipment, and loss of life or physical injury to its employees, all of which could have an adverse effect on the Company's business.

For the real estate segments, the occurrence of natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, could damage its real estate holdings, resulting in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, the Company's properties.

For the Agribusiness segment, drought, greater than normal rainfall, hurricanes, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar planting, harvesting and production, electricity generation and sales, and the Agribusiness segment's facilities, including dams and reservoirs.

The Company maintains casualty insurance under policies it believes to be adequate and appropriate. These policies are generally subject to large retentions and deductibles. Some types of losses, such as losses resulting from a port blockage, Matson business interruption, physical damage to dams, pollution stemming from non-marine operations or crop damage , generally are not insured. In some cases the Company retains the entire risk of loss because it is not economically prudent to purchase insurance coverage or because of the perceived remoteness of the risk. Other risks are uninsured because insurance coverage may not be commercially available. Finally, the Company retains all risk of loss that exceeds the limits of its insurance.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact the Company's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability or willingness of tourists to travel to Hawaii, thereby adversely affecting Hawaii's economy and the Company. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets. Acts of war or terrorism may be directed at the Company's shipping operations or real estate holdings, or may cause the U.S. government to take control of Matson's vessels for military operation. Heightened security measures are likely to slow the movement and increase the cost of freight through U.S. or foreign ports, across borders or on U.S. or foreign railroads or highways and could adversely affect the Company's business and results of operations.

Loss of the Company's key personnel could adversely affect its business.

The Company's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, the Company may have to incur significant costs to replace them, and the Company's ability to execute its business model could be impaired if it cannot replace them in a timely manner. The Company does not expect to maintain key person insurance on any of its key personnel.

The Company is involved in joint ventures and is subject to risks associated with joint venture relationships.

The Company is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as:

- the Company may not have voting control over the joint venture;
- the Company may not be able to maintain good relationships with its venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with the Company's;
- the venture partner may fail to fund its share of capital for operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to the Company;
- the joint venture or venture partner could lose key personnel; and
- the venture partner could become bankrupt, requiring the Company to assume all risks and capital requirements related to the joint venture project, and the related bankruptcy proceedings could have an adverse impact on the operation of the partnership or joint venture.

In connection with its real estate joint ventures, the Company is sometimes asked to guarantee completion of a joint venture's construction and development of a project, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If the Company were to become obligated to perform under such arrangement, the Company may be adversely affected.

The Company is subject to, and may in the future be subject to, disputes, legal or other proceedings, or government inquiries or investigations, that could have an adverse effect on the Company.

The nature of the Company's business exposes it to the potential for disputes, legal or other proceedings, or government inquiries or investigations, relating to antitrust matters, labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section or in other Company filings with the SEC. For example, Matson is a common carrier, whose tariffs, rates, rules and practices in dealing with its customers are governed by extensive and complex foreign, federal, state and local regulations, which may be the subject of disputes or administrative or judicial proceedings. These disputes, individually or collectively, could harm the Company's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by the Company, or result in significant changes to Matson's tariffs, rates, rules and practices in dealing with its customers, all of which could have an adverse effect on the Company's future operating results, including profitability, cash flows, and financial condition. As a real estate developer, the Company may face warranty and construction defect claims, as described below in the "Real Estate" section of this "Risk Factors" item. For a description of significant legal proceedings involving the Company, see "Legal Proceedings" below.

Changes in the value of pension assets, or a change in pension law or key assumptions, may adversely affect the Company's financial performance.

The amount of the Company's employee pension and postretirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, changes in discount rates, higher health care costs, or lower actual or expected returns on plan assets, may adversely affect the Company's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect the Company's single-employer and multiemployer pension plans and plan funding. These factors, as well as a decline in the fair value of pension plan assets, may put upward pressure on the cost of providing pension and medical benefits and may increase future pension expense and required funding contributions. Although the Company has actively sought to control increases in these costs, there can be no assurance that it will be successful in limiting future cost and expense increases, and continued upward pressure in costs and expenses could further reduce the profitability of the Company's businesses.

The Company may have exposure under its multiemployer plans in which it participates that extends beyond its funding obligation with respect to the Company's employees.

The Company contributes to various multiemployer pension plans. In the event of a partial or complete withdrawal by the Company from any plan that is underfunded, the Company would be liable for a proportionate share of such plan's unfunded vested benefits. Based on the limited information available from plan administrators, which the Company cannot independently validate, the Company believes that its portion of the contingent liability in the case of a full withdrawal or termination may be material to its financial position and results of operations. In the event that any other contributing employer withdraws from any plan that is underfunded, and such employer (or any member in its controlled group) cannot satisfy its obligations under the plan at the time of withdrawal, then the Company, along with the other remaining contributing employers, would be liable for its proportionate share of such plan's unfunded vested benefits. In addition, if a multiemployer plan fails to satisfy the minimum funding requirements, the Internal Revenue Service will impose certain penalties and taxes.

The Company's proposed separation into two independent, publicly-traded companies (one company comprising the Company's real estate and agriculture businesses and the other comprising the Company's transportation business) is subject to risks inherent to a large-scale transaction.

The proposed separation of the Company into two independent, publicly-traded companies is subject to multiple risks and uncertainties, including the risk that the separation will not be consummated, the risk that financing transactions contemplated as part of the separation cannot be consummated on terms and conditions acceptable to the Company, and the risk that the transaction does not qualify for tax-free treatment under applicable sections of the Internal Revenue Code. If the separation is consummated, it is possible that, due to unforeseen changes in market and economic conditions or other events, the two resulting companies may not achieve the full strategic and financial benefits expected from separation or that such benefits may be delayed. As a result, the aggregate market price of the common stock of the two resulting companies could be less than the market price of the Company's common stock if the separation had not occurred.

TRANSPORTATION

The value of the Company's development projects and its commercial properties are affected by a number of factors.

Weakness in the real estate sector, difficulty in obtaining or renewing project-level financing, and changes in the Company's investment and development strategy, among other factors, may affect the value of commercial properties or the feasibility of certain development projects owned by the Company or by its joint ventures. If the fair value of the Company's development projects or the undiscounted cash flows of its commercial properties were to decline below the carrying value of those assets, the Company would be required to recognize an impairment loss, which would have an adverse effect on the Company's financial position and results of operations.

AGRIBUSINESS

The lack of water for agricultural irrigation could adversely affect the Company.

It is crucial for the Company's Agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane. As further described in "Legal Proceedings" below, there are challenges to the Company's ability to divert water from streams in Maui. In addition, the Company's access to water is subject to weather patterns that cannot be reliably predicted. If the Company is not permitted to divert stream waters for its use or there is insufficient rainfall, it would have an adverse effect on the Company's sugar operations, including possible cessation of operations.

A decline in raw sugar prices will adversely affect the Company's business.

The business and results of operations of the Company's agribusiness segment are substantially affected by market factors, particularly the domestic prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops and suppliers, weather conditions, and United States farm and trade policies. If the price for sugar were to decline, the Company's Agribusiness segment would be adversely affected. See also discussion under "Business and Properties - Agribusiness - Competition and Sugar Legislation" above.

The Company is subject to risks associated with raw sugar production.

The Company's production of raw sugar is subject to numerous risks that could adversely affect the volume and quality of sugar produced, including:

- weather and natural disasters;
- disease;
- weed control;
- uncontrolled fires, including arson;
- government restrictions on farming practices due to cane burning;
- increases in costs, including, but not limited to fuel, fertilizer, herbicide, and drip tubing;
- water availability (see risk factor above regarding lack of water);
- equipment failures in factory or power plant;
- labor, including labor availability (see risk factor above regarding labor disruptions) and loss of qualified personnel; and
- lack of demand for the Company's production.

Any of these risks has the potential to adversely affect the Company's future Agribusiness operating results.

A reorganization or termination of the Company's sugar business could result in impairment losses and restructuring costs.

If the Company's sugar business is unable to sustain profitability, the Company may reorganize or terminate its sugar operations. The reorganization or termination of sugar operations may result in an impairment loss and restructuring costs that would adversely affect the Company's financial performance.

The Company's power sales contracts could be replaced on less favorable terms or may not be replaced.

The Company's power sales contracts, as described under "Business and Properties – Energy" above, expire at various points in the future and may not be replaced or could be replaced on less favorable terms, which could adversely affect the Company's Agribusiness operations.

The foregoing should not be construed as an exhaustive list of all factors that could cause actual results to differ materially from those expressed in forward-looking statements made by the Company or on its behalf.

The market for power sales in Hawaii is limited.

The power distribution systems in Hawaii are small and island-specific; currently, there is no ability to move power generated on one island to any other island. In addition, Hawaii law limits the ability of independent power producers, such as the Company's Agribusiness operations, to sell its output to firms other than the local utilities on each island. Further, any sales of electricity by the Company to the utilities on each island must be done under long term agreements subject to the approval of the State Public Utilities Commission. Unlike some areas in the Mainland, Hawaii's independent power producers have no ability to use utility infrastructure to transfer power to other locations.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 3. LEGAL PROCEEDINGS

See "Business and Properties - Transportation - Rate Regulation" above for a discussion of rate and other regulatory matters in which Matson is routinely involved.

A&B owns 16,000 acres of watershed lands in East Maui that supply a significant portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the last ten years have supplied approximately 58 percent of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. If the Company is not permitted to utilize sufficient quantities of stream waters from State lands in East Maui, it could have a material adverse effect on the Company's sugar-growing operations.

In addition, on May 24, 2001, petitions were filed by a third party, requesting that the Commission on Water Resource Management of the State of Hawaii ("Water Commission") amend established interim instream flow standards ("IIFS") in 27 East Maui streams that feed the Company's irrigation system. On September 25, 2008, the Water Commission took action on eight of the petitions, resulting in some quantity of water being returned to the streams rather than being utilized for irrigation purposes. In May 2010, the Water Commission took action on the remaining 19 petitions resulting in additional water being returned to the streams. A petition requesting a contested case hearing to challenge the Water Commission's decisions was filed with the Commission by the opposing third party. On October 18, 2010, the Water Commission denied the petitioner's request for a contested case hearing. On November 17, 2010, the petitioner filed an appeal of the Commission's denial to the Hawaii Intermediate Court of Appeals. On August 31, 2011, the Intermediate Court of Appeals dismissed the petitioner's appeal. On November 29, 2011, the petitioner appealed the Intermediate Court of Appeals' dismissal to the Hawaii Supreme Court. On January 11, 2012, the Hawaii Supreme Court vacated the Intermediate Court of Appeals' dismissal of the petitioner's appeal and remanded the appeal back to the Intermediate Court of Appeals.

On June 25, 2004, two organizations filed with the Water Commission a petition to amend established IIFS for four streams in West Maui to increase the amount of water to be returned to these streams. The West Maui irrigation system provided approximately 14 percent of the irrigation water used by HC&S over the last ten years. The Water Commission issued a decision in June 2010, which required the return of water in two of the four streams. In July 2010, the two organizations appealed the Water Commission's decision to the Hawaii Intermediate Court of Appeals. On June 23, 2011, the case was transferred to the Hawaii Supreme Court.

The loss of East Maui and West Maui water as a result of the Water Commission's decisions will impose challenges to the Company's sugar growing operations. While the resulting water loss does not immediately threaten near-term sugar production, it will result in a future suppression of sugar yields and will have an impact on the Company that will only be quantifiable over time. Accordingly, the Company is unable to predict, at this time, the outcome or financial impact of the water proceedings.

On April 21, 2008, Matson was served with a grand jury subpoena from the U.S. District Court for the Middle District of Florida for documents and information relating to water carriage in connection with the Department of Justice's investigation into the pricing and other competitive practices of carriers operating in the domestic trades. Matson understands that while the investigation originally was focused primarily on the Puerto Rico trade, it also includes pricing and other competitive practices in connection with all domestic trades, including the Alaska, Hawaii and Guam trades. Matson does not operate vessels in the Puerto Rico and Alaska trades. It does operate vessels in the Hawaii and Guam trades. Matson has cooperated, and will continue to cooperate, fully with the Department of Justice. If the Department of Justice believes that any violations have occurred on the part of Matson or the Company, it could seek civil or criminal sanctions, including monetary fines. The Company is unable to predict, at this time, the outcome or financial impact, if any, of this investigation.

ITEM 6. SELECTED FINANCIAL DATA

The following should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except shareholders of record and per-share amounts):

	2011	2010	2009	2008	2007
Revenue:					
Transportation:					
Ocean transportation	$ **1,077.6**	$ 1,016.5	$ 888.6	$ 1,023.7	$ 1,006.9
Logistics services	**386.4**	355.6	320.9	436.0	433.5
Real Estate:					
Leasing	**100.1**	94.4	103.2	107.8	108.5
Sales	**66.2**	136.1	125.6	350.2	117.8
Less amounts reported in discontinued operations [1]	**(47.5)**	(126.7)	(136.6)	(164.6)	(142.6)
Agribusiness[5]	**161.7**	163.9	107.0	124.3	123.7
Reconciling Items[2]	**(22.1)**	(26.3)	(16.3)	(10.7)	(9.2)
Total Revenue	$ **1,722.4**	$ 1,613.5	$ 1,392.4	$ 1,866.7	$ 1,638.6
Operating Profit:					
Transportation:					
Ocean transportation[3]	$ **74.1**	$ 118.7	$ 58.3	$ 105.8	$ 126.5
Logistics services	**5.0**	7.2	6.7	18.5	21.8
Real Estate:					
Leasing	**39.3**	35.3	43.2	47.8	51.6
Sales[3]	**15.5**	50.1	39.1	95.6	74.4
Less amounts reported in discontinued operations [1]	**(23.8)**	(54.5)	(59.2)	(77.1)	(78.4)
Agribusiness[5]	**22.2**	6.1	(27.8)	(12.9)	0.2
Total operating profit	**132.3**	162.9	60.3	177.7	196.1
Interest expense, net[4]	**(24.8)**	(25.5)	(25.9)	(23.7)	(18.8)
General corporate expenses	**(20.3)**	(23.3)	(21.8)	(21.0)	(27.3)
Income from continuing operations before income taxes	**87.2**	114.1	12.6	133.0	150.0
Income taxes	**32.3**	44.7	5.0	48.2	56.6
Income from continuing operations	**54.9**	69.4	7.6	84.8	93.4
Income (loss) from discontinued operations	**(20.7)**	22.7	36.6	47.6	48.8
Net Income	$ **34.2**	$ 92.1	$ 44.2	$ 132.4	$ 142.2

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $8.6 million, $12.8 million, $6.2 million, $5.2 million, and $10.7 million of equity in earnings from its investment in SSAT for 2011, 2010, 2009, 2008, and 2007, respectively. The Real Estate Sales segment includes approximately ($7.9) million, $2.0 million, $9.0 million, and $22.6 million in equity in (loss) earnings from its various real estate joint ventures for 2011, 2010, 2008, and 2007, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] Includes Ocean Transportation interest expense of $7.7 million for 2011, $8.2 million for 2010, $9.0 million for 2009, $11.6 million for 2008, and $13.9 million for 2007. Substantially all other interest expense was incurred at the parent company.

[5] Includes a $4.9 million gain in 2010 related to an agriculture disaster relief payment for drought experienced in prior years and a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

SELECTED FINANCIAL DATA (CONTINUED)

	2011	2010	2009	2008	2007
Identifiable Assets:					
Transportation:					
Ocean transportation[6]	**$ 1,082.6**	$ 1,095.5	$ 1,095.2	$ 1,153.9	$ 1,215.0
Logistics services	**76.8**	73.8	72.4	74.2	58.6
Real Estate:					
Leasing	**770.9**	739.4	627.4	590.2	595.4
Sales[6]	**451.4**	420.8	415.6	344.6	408.9
Agribusiness	**157.8**	150.3	156.8	172.2	174.6
Other	**4.8**	14.8	12.2	15.1	26.6
Total assets	**$ 2,544.3**	$ 2,494.6	$ 2,379.6	$ 2,350.2	$ 2,479.1
Capital Expenditures:					
Transportation:					
Ocean transportation	**$ 44.2**	$ 69.4	$ 12.7	$ 35.5	$ 65.8
Logistics services[7]	**3.0**	1.8	0.6	2.4	2.0
Real Estate:					
Leasing[8]	**43.6**	164.7	108.8	100.2	124.5
Sales[9]	**5.2**	0.1	0.1	0.6	0.3
Agribusiness	**10.5**	6.8	3.4	15.2	20.5
Other	**–**	0.3	0.3	0.8	0.3
Total capital expenditures	**$ 106.5**	$ 243.1	$ 125.9	$ 154.7	$ 213.4
Depreciation and Amortization:					
Transportation:					
Ocean transportation	**$ 70.6**	$ 69.0	$ 67.1	$ 66.1	$ 63.2
Logistics services	**3.2**	3.2	3.5	2.3	1.5
Real Estate:					
Leasing[1]	**21.6**	20.3	19.5	17.9	15.7
Sales	**0.2**	0.2	0.3	0.2	0.2
Agribusiness	**11.9**	12.7	11.9	11.5	10.7
Other	**1.1**	1.9	3.1	2.7	1.3
Total depreciation and amortization	**$ 108.6**	$ 107.3	$ 105.4	$ 100.7	$ 92.6

[6] The Ocean Transportation segment includes approximately $56.5 million, $52.9 million, $47.2 million, $44.6 million, and $48.6 million related to its investment in SSAT as of December 31, 2011, 2010, 2009, 2008, and 2007, respectively. The Real Estate Sales segment includes approximately $290.1 million, $274.8 million, $193.3 million, $162.1 million, and $134.1 million related to its investment in various real estate joint ventures as of December 31, 2011, 2010, 2009, 2008, and 2007, respectively.

[7] Excludes expenditures related to Matson Logistics' acquisitions, which are classified as acquisition of businesses in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

[8] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[9] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for expenditures related to real estate developments were $14 million, $22 million, $6 million, $39 million, and $110 million for 2011, 2010, 2009, 2008, and 2007, respectively.

SELECTED FINANCIAL DATA (CONTINUED)

	2011	2010	2009	2008	2007
Earnings per share:					
From continuing operations:					
Basic	**$ 1.32**	$ 1.68	$ 0.19	$ 2.05	$ 2.20
Diluted	**$ 1.31**	$ 1.67	$ 0.19	$ 2.04	$ 2.17
Net income:					
Basic	**$ 0.82**	$ 2.23	$ 1.08	$ 3.21	$ 3.34
Diluted	**$ 0.81**	$ 2.22	$ 1.08	$ 3.19	$ 3.30
Return on beginning equity	**3.0%**	8.5%	4.1%	11.7%	13.8%
Cash dividends per share	**$ 1.26**	$ 1.26	$ 1.26	$ 1.235	$ 1.12
At Year End					
Shareholders of record	**2,923**	3,079	3,197	3,269	3,381
Shares outstanding	**41.7**	41.3	41.0	41.0	42.4
Long-term debt – non-current	**$ 507**	$ 386	$ 406	$ 452	$ 452

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

The Company, from time to time, may make or may have made certain forward-looking statements, whether orally or in writing, such as forecasts and projections of the Company's future performance or statements of management's plans and objectives. These statements are "forward-looking" statements as that term is defined in the Private Securities Litigation Reform Act of 1995. Such forward-looking statements may be contained in, among other things, SEC filings, such as the Forms 10-K, 10-Q and 8-K, the Annual Report to Shareholders, press releases made by the Company, the Company's Internet Web sites (including Web sites of its subsidiaries), and oral statements made by the officers of the Company. Except for historical information contained in these written or oral communications, such communications contain forward-looking statements. These include, for example, all references to 2012 or future years. New risk factors emerge from time to time and it is not possible for the Company to predict all such risk factors, nor can it assess the impact of all such risk factors on the Company's business or the extent to which any factor, or combination of factors, may cause actual results to differ materially from those contained in any forward-looking statements. Accordingly, forward-looking statements cannot be relied upon as a guarantee of future results and involve a number of risks and uncertainties that could cause actual results to differ materially from those projected in the statements, including, but not limited to the factors that are described in Part I, Item 1A under the caption of "Risk Factors" of this Form 10-K, which section is incorporated herein by reference. The Company is not required, and undertakes no obligation, to revise or update forward-looking statements or any factors that may affect actual results, whether as a result of new information, future events, or circumstances occurring after the date of this report.

OVERVIEW

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is designed to provide a discussion of the Company's financial condition, results of operations, liquidity and certain other factors that may affect its future results from the perspective of management. The discussion that follows is intended to provide information that will assist in understanding the changes in the Company's financial statements from year to year, the primary factors that accounted for those changes, and how certain accounting principles, policies and estimates affect the Company's financial statements. MD&A is provided as a supplement to, and should be read in conjunction with, the consolidated financial statements and the accompanying notes to the financial statements. MD&A is presented in the following sections:

- Business Overview
- Separation Transaction
- Critical Accounting Estimates
- Consolidated Results of Operations
- Analysis of Operating Revenue and Profit by Segment
- Liquidity and Capital Resources
- Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements
- Business Outlook
- Other Matters

BUSINESS OVERVIEW

Alexander & Baldwin, Inc. ("A&B" or the "Company"), founded in 1870, is a multi-industry corporation headquartered in Honolulu that operates in five segments in three industries—Transportation, Real Estate, and Agribusiness.

Transportation: The Transportation Industry consists of Ocean Transportation and Logistics Services segments. The Ocean Transportation segment, which is conducted through Matson Navigation Company, Inc. ("Matson"), a wholly-owned subsidiary of A&B, is an asset-based business that derives its revenue primarily through the carriage of containerized freight between various U.S. Pacific Coast, Hawaii, Guam, China and other Pacific island ports. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities.

The Logistics Services segment, which is conducted through Matson Logistics, Inc. ("ML"), a wholly-owned subsidiary of Matson, is a non-asset based business that is a provider of domestic and international rail intermodal service ("Intermodal"), long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited/air freight services, and warehousing and distribution services (collectively "Highway"). Warehousing, packaging and distribution services are provided by Matson Logistics Warehousing, Inc. ("MLW"), a wholly-owned subsidiary of ML.

Real Estate: The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the U.S. Mainland. The Real Estate Sales segment generates its revenues through the development and sale of land and commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. Real estate activities are conducted through A&B Properties, Inc. and various other wholly-owned subsidiaries of A&B.

Agribusiness: Agribusiness, which contains one segment, produces bulk raw sugar, specialty food grade sugars, and molasses; markets and distributes specialty food-grade sugars; provides general trucking services, mobile equipment maintenance, and repair services in Hawaii; and generates and sells, to the extent not used in the Company's Agribusiness operations, electricity. The Company also is the sole member in Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services.

In March 2011, the Company executed an agreement to lease land and sell coffee inventory and certain assets used in a coffee business it previously operated to Massimo Zanetti Beverage USA, Inc. ("MZB"), including intangible assets. The coffee inventory and assets were sold for approximately $14 million. There was no material gain or loss on the transaction. The Company retained fee simple ownership of the land, buildings, power generation, and power distribution assets, but no longer operates the coffee plantation.

SEPARATION TRANSACTION

On December 1, 2011, the Company announced that its Board of Directors unanimously approved a plan to pursue the separation of the Company to create two independent, publicly traded companies:

- A Hawaii-based land company with interests in real estate development, commercial real estate and agriculture (composed of the Real Estate and Agribusiness segments described above), which will retain the Alexander & Baldwin, Inc. name; and

- An ocean transportation company serving the U.S. West Coast, Hawaii, Guam, Micronesia and China, and a domestic logistics company under the Matson name (composed of the businesses in the Transportation segment described above).

The separation is expected to be completed in the second half of 2012.

On February 13, 2012, the Company entered into an Agreement and Plan of Merger to reorganize itself as a holding company incorporated in Hawaii. The holding company structure will help facilitate the separation by allowing the Company to organize and segregate the assets of its different businesses in an efficient manner prior to the separation and facilitate the third party and governmental consent and approval process. In addition, the holding company reorganization will help preserve the Company's status as a U.S. citizen under certain U.S. maritime and vessel documentation laws (popularly referred to as the Jones Act) by, among other things, limiting the percentage of outstanding shares of common stock in the holding company that may be owned (of record or beneficially) or controlled in the aggregate by non-U.S. citizens (as defined by the Jones Act) to a maximum permitted percentage of 22%. For more information on the Jones Act and its effect on the Company, see "Description of Business and Properties – Transportation – Jones Act."

- Retirement rates
- Mortality rates
- Expected contributions

Actual results that differ from the assumptions made with respect to the above factors could materially affect the Company's financial condition or its future operating results. The effects of changing assumptions are included in unamortized net gains and losses, which directly affect accumulated other comprehensive income. Additionally, these unamortized gains and losses are amortized and reclassified to income (loss) over future periods.

The 2011 net periodic costs for qualified pension and post-retirement plans were determined using a discount rate of 5.75 percent. The benefit obligations for qualified pension and post-retirement plans, as of December 31, 2011, were determined using a discount rate of 4.80 percent and 4.90 percent, respectively. For the Company's non-qualified benefit plans, the 2011 net periodic cost was determined using a discount rate of 4.50 percent and the December 31, 2011 obligation was determined using a discount rate of 3.90 percent. The discount rate used for determining the year-end benefit plan obligation was generally calculated using a weighting of expected benefit payments and rates associated with high-quality U.S. corporate bonds for each year of expected payment to derive a single estimated rate at which the benefits could be effectively settled at December 31, 2011.

The estimated return on plan assets of 8.25 percent was based on historical trends combined with long-term expectations, the mix of plan assets, asset class returns, and long-term inflation assumptions. One-, three-, and five-year pension returns (losses) were (4.2) percent, 8.8 percent, and (0.3) percent, respectively. The Company's long-term rate of return (since inception in 1989) was 8.0 percent.

As of December 31, 2011, the Company's post-retirement obligations were measured using an initial 9 percent health care cost trend rate, decreasing by 1 percent annually until the ultimate rate of 5 percent is reached in 2016.

Lowering the expected long-term rate of return on the Company's qualified plan assets by one-half of one percent would have increased pre-tax pension expense for 2011 by approximately $1.4 million. Lowering the discount rate assumption by one-half of one percentage point would have increased pre-tax pension expense by approximately $2.4 million. Additional information about the Company's benefit plans is included in Note 10 to the Consolidated Financial Statements.

As of December 31, 2011, the market value of the Company's defined benefit plan assets totaled approximately $257 million, compared with $285 million as of December 31, 2010. The recorded net pension liability was approximately $109 million as of December 31, 2011 and approximately $70 million as of December 31, 2010. The Company expects to make contributions totaling $21 million to certain of its defined benefit pension plans in 2012. The Company's contributions to its pension plans were approximately $5 million in 2011 and $6 million in 2010.

Income Taxes: The Company makes certain estimates and judgments in determining income tax expense for financial statement purposes. These estimates and judgments are applied in the calculation of tax credits, tax benefits and deductions, and in the calculation of certain deferred tax assets and liabilities, which arise from differences in the timing of recognition of revenue and expense for tax and financial statement purposes. Significant changes to these estimates may result in an increase or decrease to the Company's tax provision in a subsequent period.

In addition, the calculation of tax liabilities involves significant judgment in estimating the impact of uncertain tax positions taken or expected to be taken with respect to the application of complex tax laws. Resolution of these uncertainties in a manner inconsistent with management's expectations could materially affect the Company's financial condition or its future operating results.

Recent Accounting Pronouncements: See Note 1 to the Consolidated Financial Statements for a full description of the impact of recently issued accounting standards, which is incorporated herein by reference, including the expected dates of adoption and estimated effects on the Company's results of operations and financial condition.

CONSOLIDATED RESULTS OF OPERATIONS

The following analysis of the consolidated financial condition and results of operations of Alexander & Baldwin, Inc. and its subsidiaries (collectively, the "Company") should be read in conjunction with the consolidated financial statements and related notes thereto. Amounts in this narrative are rounded to millions, but per-share calculations and percentages were calculated based on thousands. Accordingly, a recalculation of some per-share amounts and percentages, if based on the reported data, may be slightly different than the more accurate amounts included herein.

(dollars in millions, except per-share amounts)	**2011**	Chg.	2010	Chg.	2009
Operating Revenue	**$ 1,722**	7%	$ 1,614	16%	$ 1,392
Operating Costs and Expenses	**1,608**	8%	1,488	10%	1,358
Operating Income	**114**	-10%	126	4X	34
Other Income and (Expense)	**(27)**	2X	(12)	-45%	(22)
Income Taxes	**32**	-29%	45	9X	5
Income From Continuing Operations	**55**	-20%	69	10X	7
Discontinued Operations (net of taxes)	**(21)**	NM	23	-38%	37
Net Income	**$ 34**	-63%	$ 92	2X	$ 44
Basic Earnings Per Share	**$ 0.82**	-63%	$ 2.23	2X	$ 1.08
Diluted Earnings Per Share	**$ 0.81**	-64%	$ 2.22	2X	$ 1.08

2011 vs. 2010

Operating Revenue for 2011 increased 7 percent, or $108 million, to $1,722 million. Ocean Transportation revenue increased 6 percent, principally due to higher fuel surcharge revenues resulting from higher fuel prices. Logistics Services revenue increased 9 percent, principally due to higher Intermodal and Highway volumes. Real Estate Leasing revenue increased 15 percent in 2011 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to acquisitions and higher mainland occupancies. Agribusiness revenue decreased 2 percent, primarily due to lower coffee revenue as a result of the sale of the assets of the coffee operations in the first quarter of 2011. The reasons for business- and segment-specific year-to-year fluctuations in revenue growth are further described below in the Analysis of Operating Revenue and Profit by Segment.

Because of the recurring nature of property sales, the Company views changes in Real Estate Sales and Real Estate Leasing revenues on a year-over-year basis before the reclassification of revenue to discontinued operations to be more meaningful in assessing segment performance. Additionally, due to the timing of sales for development properties and the mix of properties sold, management believes performance is more appropriately assessed over a multi-year period. Year-over-year comparisons of revenue are also not complete without the consideration of results from the Company's investment in its real estate joint ventures, which are not included in consolidated operating revenue, but are included in segment operating profit. The Analysis of Operating Revenue and Profit by Segment that follows, provides additional information on changes in Real Estate Sales revenue and operating profit before reclassifications to discontinued operations.

Operating Costs and Expenses for 2011 increased by 8 percent, or $120 million, to $1,608 million. Ocean Transportation costs increased 13 percent, primarily due to higher vessel operating expenses and higher terminal handling costs. Logistics Services cost increased 11 percent due primarily to higher purchased transportation costs. Real Estate Sales and Leasing costs increased by 12 percent, primarily due to property acquisitions. These increases were offset by Agribusiness costs, which decreased 13 percent due principally to a lower volume of sugar sold, combined with higher production levels. Selling, General and Administrative costs ("SG&A") decreased 3 percent due principally to higher non-qualified benefits paid in 2010 related to the retirement of certain senior executives. The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Other Income and Expense: Other expense in 2011 increased $15 million, compared with 2010, due primarily to $8 million in joint venture losses, a $4 million gain in 2010 related to the settlement of a non-performing mortgage note acquired as an investment, a $5 million payment received in 2010 for agriculture disaster relief, and a $2 million decrease in interest income in 2011, partially offset by $1 million in lower interest expenses.

Income Taxes were lower in 2011 compared with 2010 on an absolute basis due principally to lower income. The effective tax rate in 2011 was lower than the rate in 2010 due principally to deductible expenses in both periods that had a greater impact on the 2011 effective rate because of the lower income relative to 2010.

2010 vs. 2009

Operating Revenue for 2010 increased 16 percent, or $222 million, to $1,614 million. Ocean Transportation revenue increased 14 percent, principally due to higher overall volumes and yields, principally in the China trade, as well as higher fuel surcharge revenues resulting from higher fuel prices. Agribusiness revenue increased 57 percent, primarily due to higher sugar prices and higher sales volume. Logistics Services revenue increased 11 percent, principally due to higher Intermodal and Highway volumes. Real Estate Leasing revenue increased 14 percent in 2010 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to acquisitions, partially offset by lower mainland renewal rents. Real Estate Sales revenue decreased 14 percent in 2010 (after subtracting revenue from discontinued operations) due principally to lower property sales. The reasons for business- and segment-specific year-to-year fluctuations in revenue growth are further described below in the Analysis of Operating Revenue and Profit by Segment.

Operating Costs and Expenses for 2010 increased by 10 percent, or $130 million, to $1,488 million. Ocean Transportation costs increased 9 percent, primarily due to higher vessel operating expenses and higher terminal handling costs. Logistics Services cost increased 12 percent due primarily to higher purchased transportation costs. Agribusiness costs increased 15 percent due principally to a higher volume of sugar sold. Real Estate Sales and Leasing costs increased by 11 percent, primarily due to property acquisitions. Selling, General and Administrative costs ("SG&A") increased 3 percent due principally to higher non-qualified benefit expenses related to the retirement of certain senior executives. The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Other Income and Expense: Other expense in 2010 decreased $10 million, compared with 2009, due primarily to a $5 million agriculture disaster relief payment for drought experienced in prior years, a $4 million gain related to the settlement of a non-performing mortgage note acquired as an investment, $2 million in higher real estate joint venture income, and a $2 million increase in interest income in 2010. The decrease in other expense was partially offset by a $5 million gain recorded in 2009 upon consolidation of HS&TC.

Income Taxes were higher in 2010 compared with 2009 on an absolute basis due principally to higher income. The effective tax rate in 2010 was lower than the rate in 2009 due principally to non-deductible expenses in both periods that had a lesser impact on the 2010 effective rate because of the higher income relative to 2009.

ANALYSIS OF OPERATING REVENUE AND PROFIT BY SEGMENT

Additional detailed information related to the operations and financial performance of the Company's Industry Segments is included in Part II Item 6 and Note 14 to the Consolidated Financial Statements. The following information should be read in relation to the information contained in those sections.

Transportation Industry

***Ocean Transportation**: 2011 compared with 2010*

(dollars in millions)	**2011**	2010	Change
Revenue	**$ 1,077.6**	$ 1,016.5	6%
Operating profit	**$ 74.1**	$ 118.7	-38%
Operating profit margin	**6.9%**	11.7%	
Volume* (units):			

Hawaii containers	**140,000**	136,700	2%
Hawaii automobiles	**81,000**	81,800	-1%
China containers – CLX1	**59,000**	60,000	-2%
Guam containers	**15,200**	15,200	--%

* Container volumes included for the period are based on the voyage departure date, but revenue and operating profit are adjusted to reflect the percentage of revenue and operating profit earned during the reporting period for voyages that straddle the beginning or end of the reporting period.

Ocean Transportation revenue increased $61.1 million, or 6 percent, in 2011 compared to 2010. This increase was principally due to $73.2 million in higher fuel surcharges, due to increased fuel prices, as well as $9.6 million in net volume growth, principally in Hawaii. These increases were partially offset by $21.8 million in lower yields and cargo mix primarily in the China trade.

Total Hawaii container volume increased 2 percent in 2011 compared with 2010, due to a new connecting carrier agreement with a large international carrier that commenced at the end of 2010 and other customer gains, partially offset by one less week in 2011 compared to 2010. Matson's Hawaii automobile volume for the year was 1 percent lower than 2010, due principally to the timing of automobile rental fleet replacement activity. China container volume decreased 2 percent in 2011, compared with 2010, principally due to increased competition from excess capacity in the trade. Guam container volumes were relatively flat as weaker market conditions were offset by fourth quarter gains related to the departure of a competitor from the trade in mid-November.

Operating profit (which includes $7.1 million of CLX2 shutdown expenses) decreased $44.6 million, or 38 percent, in 2011 compared to 2010. The decrease in operating profit was principally due to $21.8 million in lower yields and cargo mix primarily related to the China trade. Additionally, terminal handling costs increased $10.0 million due primarily to higher rates, and outside transportation costs increased $3.9 million due to higher volume. Operations overhead costs increased $1.5 million due to additional equipment repositioning costs, partially offset lower equipment lease expenses, and also vessel operating expenses were $1.2 million higher, due to the increased contractual labor costs and generally higher costs. The lower yields and increases in costs were partially offset by $5.4 million in higher overall cargo volume. Operating profit was also impacted by $4.2 million in lower SSAT joint venture earnings due to reduced volume.

Discontinued Operations: The revenue, operating profit, and after-tax effects of discontinued operations for 2011, 2010 and 2009 were as follows (in millions, except per-share amounts):

		2011		2010		2009
Real Estate Sales Revenue*	**$**	**45.5**	$	117.1	$	109.6
Real Estate Leasing Revenue		**2.0**		9.6		27.0
CLX2 Revenue		**92.7**		28.5		--
Real Estate Sales Operating Profit*	**$**	**22.5**	$	48.6	$	44.3
Real Estate Leasing Operating Profit		**1.3**		5.9		14.9
CLX2 Loss from Operations		**(56.6)**		(19.3)		--
Total Operating Profit (Loss) Before Taxes		**(32.8)**		35.2		59.2
Income Tax Expense (Benefit)		**(12.1)**		12.5		22.6
Income (Loss) from Discontinued Operations	**$**	**(20.7)**	$	22.7	$	36.6
Basic Earnings Per Share	**$**	**(0.50)**	$	0.55	$	0.89
Diluted Earnings Per Share	**$**	**(0.50)**	$	0.55	$	0.89

* Represents the sales proceeds and the gain on sale of income producing properties that are classified as discontinued operations.

2011: In the third quarter of 2011, the Company finalized a decision to terminate Matson's second China string ("CLX2") due to the longer-term outlook for sustained high fuel prices and increasingly volatile Transpacific rates. In connection with the termination of this service, the results of operation for the CLX2 component have been reclassified from the Transportation segment to discontinued operations for all periods presented. Additionally, the revenue and expenses of Arbor Park Shopping Center, a retail property in Texas, Wakea Business Center II, a commercial facility on Maui, and a leased Maui property have been classified as discontinued operations.

2010: The revenue and expenses of Ontario Distribution Center, an industrial property in California, Valley Freeway Corporate Park, an industrial facility in Washington, Mililani Shopping Center, a retail center in Hawaii, Kele Shopping Center on Maui, and various Maui parcels have been classified as discontinued operations. Additionally, a retail property on Maui that was held for sale at year-end was classified as discontinued operations.

2009: The revenue and expenses of Hawaii Business Park, an industrial property on Oahu, Southbank II, an office building in Arizona, San Jose Avenue Warehouse, an industrial property in California, Pacific Guardian Tower, an office property on Oahu, Village at Indian Wells, an office property in California, and various parcels on Maui have been classified as discontinued operations. Additionally, a retail property on Oahu was classified as discontinued operations.

Agribusiness

Agribusiness: 2011 compared with 2010

(dollars in millions)		**2011**		2010	Change
Revenue	**$**	**161.7**	$	163.9	-1%
Operating profit (loss)	**$**	**22.2**	$	6.1	4X
Operating profit margin		**13.8%**		3.7%	
Tons sugar produced		**182,800**		171,800	6%
Tons sugar sold		**163,100**		176,700	-8%

Agribusiness revenue decreased $2.2 million in 2011 compared with 2010. The decrease was primarily due to $8.2 million in lower coffee revenue as a result of the sale of the assets of the coffee operation in the first quarter of 2011, the absence of a $4.9 million agriculture disaster relief payment for drought received in 2010, and $2.7 million in lower sugar revenue, due to lower sugar sales volume. These decreases were partially offset by a $5.4 million increase in power revenue, $3.0 million higher in molasses revenue due to higher volumes and prices, and $2.4 million higher outside charter revenue.

Operating profit increased $16.1 million in 2011 compared with 2010. The increase in operating profit was primarily due to a $6.1 million improvement in power margins and a $5.2 million increase in raw and specialty sugar margins. The improvements in raw and specialty sugar margins are principally the result of higher sugar prices and an increase in the volume of sugar production over which costs are allocated, resulting in lower per unit costs. Molasses margins also increased $3.2 million due to higher sales volumes and prices. The increase in operating profit was partially offset by the aforementioned agriculture disaster relief payment for drought received in 2010.

Sugar production in 2011 was 6 percent higher than in 2010 due principally to higher average yields per acre. The higher yields in 2011 were principally the result of improved growing conditions and factory enhancements. The average revenue per ton of sugar for 2011 was $605 or 5 percent higher than the average revenue per ton of $575 in 2010.

Agribusiness: 2010 compared with 2009

(dollars in millions)		**2010**		2009	Change
Revenue	**$**	**163.9**	$	107.0	53%
Operating profit (loss)	**$**	**6.1**	$	(27.8)	NM
Operating profit margin		**3.7%**		-26.0%	
Tons sugar produced		**171,800**		126,800	35%

Tons sugar sold	**176,700**	124,000	43%

Beginning December 1, 2009, the Company consolidated the results of the Hawaiian Sugar & Transportation Cooperative ("HS&TC") because the Company was the sole member. Since HS&TC is a wholly-owned consolidated subsidiary, revenue recognition on raw sugar and molasses sales occurs when HS&TC delivers the sugar and molasses to the Company's third-party customers on the U.S. mainland. Prior to consolidation, the Company recognized revenue when the raw sugar was delivered to HS&TC, which occurred as sugar was produced and delivered to the sugar warehouse on Maui, where title and risk of loss passed. As a result of the HS&TC consolidation, the timing of revenue recognition differs between 2009 and 2010 and results in year-over-year variances.

Agribusiness revenue increased $56.9 million in 2010 compared with 2009. The increase was primarily due to $62.8 million in higher bulk raw sugar revenue that was the result of higher sugar prices and higher sales volume, as well as $3.3 million in higher coffee revenues related to higher volume and prices. These increases were partially offset by a $7.1 million reduction in specialty sugar revenue due to lower sales volume.

Operating profit was $6.1 million in 2010 compared with an operating loss of $27.8 million in 2009. The improvement in operating profit was primarily due to a $33.4 million improvement in raw sugar margins. The improvement in raw sugar margins is principally the result of higher sugar prices and an increase in the volume of sugar production over which costs are allocated, resulting in lower per unit costs. Operating profit also benefited from a $7.9 million increase in specialty sugar margins, due primarily to lower per unit production costs previously described. The increase in operating profit was partially offset by a $3.0 million reduction in coffee results, principally due to a $1.9 million lower of cost or market adjustment to coffee inventory in the first quarter of 2010, as well as a $2.8 million reduction in molasses margins due principally to higher delivery costs and lower sales volume.

Sugar production in 2010 was 35 percent higher than in 2009 due principally to higher average yields per acre. The higher yields in 2010 were principally the result of improved growing conditions and factory enhancements. The average revenue per ton of sugar for 2010 was $575 or 63 percent higher than the average revenue per ton of $352 in 2009.

CONTRACTUAL OBLIGATIONS, COMMITMENTS, CONTINGENCIES AND OFF-BALANCE SHEET ARRANGEMENTS

Contractual Obligations: At December 31, 2011, the Company had the following estimated contractual obligations (in millions):

Contractual Obligations		Total	2012	Payment due by period 2013-2014	2015-2016	Thereafter
Long-term debt obligations (including current portion)	(a)	$ 559	$ 52	$ 99	$ 251	$ 157
Estimated interest on debt	(b)	110	23	35	24	28
Purchase obligations	(c)	39	39	--	--	--
Post-retirement obligations	(d)	34	3	6	7	18
Non-qualified benefit obligations	(e)	14	4	2	6	2
Operating lease obligations	(f)	91	26	32	17	16
Total		$ 847	$ 147	$ 174	$ 305	$ 221

(a) Long-term debt obligations (including current portion) include principal repayments of short-term and long-term debt for the respective period(s) described (see Note 7 to the Consolidated Financial Statements for principal repayments for each of the next five years). Short-term debt includes amounts borrowed under revolving credit facilities and have been reflected as payments due in 2012.

(b) Estimated cash paid for interest on debt is determined based on (1) the stated interest rate for fixed debt and (2) the rate in effect on December 31, 2011 for variable rate debt. Because the Company's variable rate date may be rolled over, actual interest may be greater or less than the amounts indicated.

(c) Purchase obligations include only non-cancellable contractual obligations for the purchases of goods and services. Arrangements are considered purchase obligations if a contract specifies all significant terms, including fixed or minimum quantities to be purchased, a pricing structure and approximate timing of the transaction. Any amounts reflected on the consolidated balance sheet as accounts payable and accrued liabilities are excluded from the table above.

(d) Post-retirement obligations include expected payments to medical service providers in connection with providing benefits to the Company's employees and retirees. The $18 million noted in the column labeled "Thereafter" comprises estimated benefit payments for 2017 through 2021. Post-retirement obligations are described further in Note 10 to the Consolidated Financial Statements. The obligation for pensions reflected on the Company's consolidated balance sheet is excluded from the table above because the Company is unable to reliably estimate the timing and amount of contributions.

(e) Non-qualified benefit obligations include estimated payments to executives and directors under the Company's four non-qualified plans. The $2 million noted in the column labeled "Thereafter" comprises estimated benefit payments for 2017 through 2021. Additional information about the Company's non-qualified plans is included in Note 10 to the Consolidated Financial Statements.

(f) Operating lease obligations include principally land, office and terminal facilities, containers and equipment under non-cancelable, long-term lease arrangements that do not transfer the rights and risks of ownership to the Company. These amounts are further described in Note 8 to the Consolidated Financial Statements.

The Company has not provided a detailed estimate of the timing and amount of payments related to uncertain tax position liabilities due to the uncertainty of when the related tax settlements are due. At December 31, 2011, the Company's uncertain tax position liabilities totaled approximately $6 million.

Other Commitments and Contingencies: A description of other commitments, contingencies, and off-balance sheet arrangements, and incorporated herein by reference, is described in Note 13 to the Consolidated Financial Statements of Item 8 in this Form 10-K

BUSINESS OUTLOOK

The following discussion provides the Company's preliminary outlook for 2012. All of the forward-looking statements made herein are qualified by the inherent risks of the Company's operations and the markets it serves, as more fully described on pages 17-25 of this Form 10-K.

The Company's overall outlook assumes modest growth for the U.S. and Hawaii economies. In Hawaii, increases in visitor arrivals and expenditures are expected to remain the principal drivers of growth. The State's visitor industry performed well in 2011. Visitor expenditures were $12.5 billion, up 16 percent compared to 2010, second only to 2007's record expenditures of $12.6 billion. Strength in tourism performance came primarily from Mainland U.S. and non-Japanese international visitors, including visitors from Canada, Australia and China.

There are two primary sources of periodic economic forecasts and data for the State of Hawaii: The University of Hawaii Economic Research Organization (UHERO) and the State's Department of Business, Economic Development and Tourism (DBEDT). Economic information included herein has been derived from economic reports available on UHERO's and DBEDT's websites that provide more complete information about the status of and forecast for the Hawaii economy.

Ocean Transportation: Ocean Transportation's performance continues to be highly dependent on the future performance of the national and Hawaii economies, fuel prices, Transpacific freight rates, and other factors that cannot be predicted with certainty.

The Company expects stable performance for the Hawaii trade lane, due to continued strength in tourism expenditures. More meaningful growth in the Hawaii trade, however, is predicated on growth in the Hawaii construction sector, which has yet to recover. In the Transpacific, the Company expects to run its CLX1 ships at full or near full capacity, but freight rates are expected to remain at the suppressed levels experienced in 2011. Any improvement in Transpacific freight rates is primarily dependent on carrier management of capacity and strength in the U.S. economy. Improved performance in Guam is projected due to increased container volume resulting from Horizon Line's exit from the trade; such improvement is expected to be sustained until a new carrier enters this market.

Logistics Services: The Company will focus on customer retention and expansion at its warehouse facilities and organic growth in its intermodal and highway businesses and expects modest overall financial improvement. Performance will be dependent upon improvement in the Mainland economy, as well as competitive dynamics in the freight brokerage business, cargo mix, available capacity in the market and reliability of the underlying carriers.

Real Estate Leasing: In Real Estate Leasing, the Company expects both Mainland and Hawaii rents and occupancy to remain stable, and while quarter-to-quarter variability will occur, the Company expect modest overall full-year improvement in this segment as well.

Real Estate Development and Sales: Real estate sales are opportunistic and episodic by nature and, therefore, difficult to predict with certainty. The Company expects to pursue its usual wide range of property sales, except that in 2011, the Company made the strategic decision to refocus its commercial portfolio back to Hawaii over time. Accordingly, the pace of sales from its income portfolio will increasingly be dictated by the availability of acquisition opportunities in Hawaii. The Company expects to be in a position to provide greater clarity on Real Estate Sales as the year progresses.

Agribusiness: Agribusiness is expected to continue to perform well based on forecasted sugar production and pricing that has already been locked in for over half of the 2012 crop.

OTHER MATTERS

Management Changes: The following management changes were effective between January 1, 2011 and February 15, 2012.

On February 11, 2011, the Company announced the retirement of Norbert M. Buelsing, president of A&B Properties, Inc. and the appointment of Christopher J. Benjamin, senior vice president, chief financial officer and treasurer of A&B and general manager of Hawaiian Commercial & Sugar Company (HC&S), to president of the A&B Land Group and president of A&B Properties, Inc. Mr. Benjamin's appointment to his new role was effective on September 1, 2011.

On July 6, 2011, the Company announced the appointment of Joel Wine as senior vice president, chief financial officer and treasurer of A&B, which became effective September 1, 2011.

Rick Volner, Jr., senior vice president, Agricultural Operations of HC&S, was promoted to general manager of HC&S, effective April 1, 2011.

Wendy M. Ludwig was promoted to A&B vice president, tax, effective April 26, 2011.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31, 2011	2010	2009
Operating Revenue:			
Ocean transportation	$ 1,074	$ 1,012	$ 887
Logistics services	386	355	321
Real estate leasing	93	81	71
Real estate sales	14	14	16
Agribusiness	155	152	97
Total operating revenue	1,722	1,614	1,392
Operating Costs and Expenses:			
Cost of ocean transportation services	908	806	740
Cost of logistics services	348	314	280
Cost of real estate sales and leasing	67	60	54
Cost of agribusiness goods and services	131	150	130
Selling, general and administrative	154	158	154
Total operating costs and expenses	1,608	1,488	1,358
Operating Income	114	126	34
Other Income and (Expense):			
Gain on insurance settlement	–	2	--
Agriculture disaster relief payment	–	5	--
Gain on consolidation of HS&TC	–	--	5
Income (loss) related to real estate joint ventures	(2)	5	(2)
Interest income	–	2	--
Interest expense	(25)	(26)	(25)
Income From Continuing Operations Before Income Taxes	87	114	12
Income taxes	32	45	5
Income From Continuing Operations	55	69	7
Income from discontinued operations, net of income taxes (Note 2)	(21)	23	37
Net Income	$ 34	$ 92	$ 44
Basic Earnings per Share of Common Stock:			
Continuing operations	$ 1.32	$ 1.68	$ 0.19
Discontinued operations	(0.50)	0.55	0.89
Net income	$ 0.82	$ 2.23	$ 1.08
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ 1.31	$ 1.67	$ 0.19
Discontinued operations	(0.50)	0.55	0.89
Net income	$ 0.81	$ 2.22	$ 1.08
Weighted Average Number of Shares Outstanding:			
Basic	41.6	41.2	41.0
Diluted	42.0	41.5	41.1

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31, 2011	2010	2009
Cash Flows from Operating Activities:			
Net income	$ 34	$ 92	$ 44
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	109	107	105
Deferred income taxes	(5)	5	1
Gains on asset transactions, net of impairment losses	(34)	(51)	(51)
Gain from receipt of insurance proceeds	–	(1)	--
Gain on consolidation of HS&TC	–	--	(5)
Share-based expense	8	8	9
Equity in (income) loss of affiliates, net of distributions	5	(8)	(1)
Changes in operating assets and liabilities:			
Accounts and notes receivable	(13)	8	(16)
Inventories	(6)	6	(6)
Prepaid expenses and other assets	(4)	(18)	(5)
Deferred dry-docking costs	(13)	9	10
Liability for employee benefit plans	11	15	--
Accounts and income taxes payable	14	9	20
Other liabilities	(12)	(15)	11
Real estate developments held for sale:			
Real estate inventory sales	6	6	5
Expenditures for real estate inventory	(14)	(22)	(6)
Net cash provided by operations	86	150	115
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	(67)	(95)	(31)
Proceeds from disposal of income-producing property, investments and other assets	16	34	32
Deposits into Capital Construction Fund	(4)	(4)	(4)
Withdrawals from Capital Construction Fund	4	4	4
Acquisition of businesses, net of cash acquired	–	--	10
Payments for purchases of investments	(28)	(102)	(48)
Proceeds from investments	8	13	6
Net cash used in investing activities	(71)	(150)	(31)
Cash Flows from Financing Activities:			
Proceeds from issuance of debt	256	245	241
Payments of debt and deferred financing costs	(215)	(198)	(288)
Proceeds from (payments on) line-of-credit agreement, net	(5)	(4)	13
Proceeds from issuance of capital stock and other	10	7	(1)
Dividends paid	(53)	(52)	(52)
Net cash used in financing activities	(7)	(2)	(87)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	8	(2)	(3)
Balance, beginning of year	14	16	19
Balance, end of year	$ 22	$ 14	$ 16
Other Cash Flow Information:			
Interest paid, net of amounts capitalized	$ (24)	$ (25)	$ (24)
Income taxes paid	$ (25)	$ (46)	$ (38)
Non-cash Activities:			
Debt assumed in real estate purchase	$ –	$ 8	$ --
Real estate received in settlement of a mortgage note	$ –	$ 8	$ --
Capital expenditures included in accounts payable and accrued expenses	$ 11	$ 7	$ 5
Tax-deferred property sales	$ 45	$ 120	$ 109
Tax-deferred property purchases	$ (39)	$ (148)	$ (95)

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2011	December 31, 2010
ASSETS		
Current Assets		
Cash and cash equivalents	$ 22	$ 14
Accounts and notes receivable, less allowances of $7 for 2011 and $8 for 2010	173	165
Inventories	40	35
Real estate held for sale	3	8
Deferred income taxes	5	8
Section 1031 exchange proceeds	–	1
Prepaid expenses and other assets	32	33
Total current assets	275	264
Investments in Affiliates	347	329
Real Estate Developments	143	122
Property – net	1,634	1,651
Employee Benefit Plan Assets	1	3
Other Assets	144	126
Total	$ 2,544	$ 2,495
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	$ 52	$ 136
Accounts payable	156	137
Payroll and vacation benefits	20	20
Uninsured claims	8	10
Accrued and other liabilities	42	50
Total current liabilities	278	353
Long-term Liabilities		
Long-term debt	507	386
Deferred income taxes	418	431
Employee benefit plans	168	135
Uninsured claims and other liabilities	50	54
Total long-term liabilities	1,143	1,006
Commitments and Contingencies (Note 13)		
Shareholders' Equity		
Capital stock – common stock without par value; authorized, 150 million shares ($0.75 stated value per share); outstanding, 41.7 million shares in 2011 and 41.3 million shares in 2010	34	34
Additional capital	239	223
Accumulated other comprehensive loss	(92)	(82)
Retained earnings	953	972
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,123	1,136
Total	$ 2,544	$ 2,495

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF SHAREHOLDERS' EQUITY
For the three years ended December 31, 2011
(In millions, except per-share amounts)

	Capital Stock						
	Issued		In Treasury			Accumulated Other Compre-hensive	
	Shares	Stated Value	Shares	Cost	Additional Capital	Loss	Retained Earnings	Total
Balance, December 31, 2008	**44.6**	**$ 33**	**3.6**	**$ (11)**	**$ 204**	**$ (96)**	**$ 942**	**$ 1,072**
Net income	—	—	—	—	—	—	44	44
Other comprehensive income, net of tax*:								
Defined benefit plans:								
Net gain/prior service (cost)	—	—	—	—	—	7	—	7
Less: Amortization of net loss/prior service cost	—	—	—	—	—	8	—	8
Total comprehensive income								59
Excess tax benefit and share withholding	—	—	—	—	(3)	—	—	(3)
Share-based compensation	—	—	—	—	9	—	—	9
Dividends ($1.26 per share)	—	—	—	—	—	—	(52)	(52)
Balance, December 31, 2009	**44.6**	**33**	**3.6**	**$ (11)**	**210**	**(81)**	**934**	**1,085**
Net income	—	—	—	—	—	—	92	92
Other comprehensive income, net of tax*:								
Defined benefit plans:								
Net gain/prior service (cost)	—	—	—	—	—	(13)	—	(13)
Less: Amortization of net loss/prior service cost	—	—	—	—	—	12	—	12
Total comprehensive income								91
Excess tax benefit and share withholding	—	—	—	—	(1)	—	(2)	(3)
Shares issued	0.3	1	—	—	6	—	—	7
Share-based compensation	—	—	—	—	8	—	—	8
Dividends ($1.26 per share)	—	—	—	—	—	—	(52)	(52)
Balance, December 31, 2010	**44.9**	**34**	**3.6**	**(11)**	**223**	**(82**	**972**	**1,136**
Net income	—	—	—	—	—	—	**34**	**34**
Other comprehensive income, net of tax*:								
Defined benefit plans:								
Net gain/prior service (cost)	—	—	—	—	—	**(17)**	—	**(17)**
Less: Amortization of net loss/prior service cost	—	—	—	—	—	**7**	—	**7**
Total comprehensive income								**24**
Excess tax benefit and share withholding	—	—	—	—	—	—	—	—
Shares issued	**0.4**	—	—	—	**8**	—	—	**8**
Share-based compensation	—	—	—	—	**8**	—	—	**8**
Dividends ($1.26 per share)	—	—	—	—	—	—	**(53)**	**(53)**
Balance, December 31, 2011	**45.3**	**$ 34**	**3.6**	**$ (11)**	**$ 239**	**$ (92)**	**$ 953**	**$ 1,123**

* Net of ($10) million and $5 million for 2011, ($10) million and $6 million for 2010, and $5 million each in 2009 for deferred taxes related to net gain/prior service cost and amortization of net loss/prior service cost, respectively.

See notes to consolidated financial statements.

14. INDUSTRY SEGMENTS

Operating segments are components of an enterprise that engage in business activities from which it may earn revenues and incur expenses, whose operating results are regularly reviewed by the chief operating decision maker to make decisions about resources to be allocated to the segment and assess its performance, and for which discrete financial information is available. The Company's chief operating decision maker is its Chief Executive Officer. Based on the foregoing, the Company has five groups of similar products and services that are provided by its five segments that operate in three industries: Transportation, Real Estate and Agribusiness.

The Transportation Industry consists of two segments. Ocean Transportation carries freight between various U.S. Pacific Coast, major Hawaii ports, Guam, China and other Pacific ports and provides terminal, stevedoring and container equipment management services in Hawaii. Additionally, the Ocean Transportation segment has a 35 percent interest in an entity that provides terminal and stevedoring services at U.S. Pacific Coast facilities. Logistics Services arranges domestic and international rail intermodal service, long-haul and regional highway brokerage, specialized hauling, flat-bed and project work, less-than-truckload, expedited freight services, and warehousing and distribution services.

The Real Estate Industry consists of two segments. The Real Estate Sales segment generates its revenues through the development and sale of land, commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties. When property that was previously leased is sold, the sales revenue and operating profit are included with the Real Estate Sales segment.

Agribusiness, which consists of one segment, grows sugar cane; produces bulk raw sugar, specialty food-grade sugars, and molasses; markets and distributes specialty food-grade sugars; provides general trucking services, mobile equipment maintenance and repair services in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

The accounting policies of the operating segments are described in the summary of significant accounting policies. Reportable segments are measured based on operating profit, exclusive of interest expense, general corporate expenses, and income taxes. Transactions between reportable segments are accounted for on the same basis as transactions with unrelated third parties.

Industry segment information for 2011, 2010, and 2009 is summarized below (in millions):

For the Year	2011	2010	2009
Revenue:			
Transportation:			
Ocean transportation	**$ 1,077.6**	$ 1,016.5	$ 888.6
Logistics services	**386.4**	355.6	320.9
Real Estate:			
Leasing	**100.1**	94.4	103.2
Sales	**66.2**	136.1	125.6
Less amounts reported in discontinued operations [1]	**(47.5)**	(126.7)	(136.6)
Agribusiness[5]	**161.7**	163.9	107.0
Reconciling Items [2]	**(22.1)**	(26.3)	(16.3)
Total revenue	**$ 1,722.4**	$ 1,613.5	$ 1,392.4
Operating Profit:			
Transportation:			
Ocean transportation[3]	**$ 74.1**	$ 118.7	$ 58.3
Logistics services	**5.0**	7.2	6.7
Real Estate:			
Leasing	**39.3**	35.3	43.2
Sales[3]	**15.5**	50.1	39.1
Less amounts reported in discontinued operations [1]	**(23.8)**	(54.5)	(59.2)
Agribusiness[5]	**22.2**	6.1	(27.8)
Total operating profit	**132.3**	162.9	60.3
Interest expense, net[4]	**(24.8)**	(25.5)	(25.9)
General corporate expenses	**(20.3)**	(23.3)	(21.8)
Income from continuing operations before income taxes	**87.2**	114.1	12.6
Income taxes	**32.3**	44.7	5.0
Income from continuing operations	**54.9**	69.4	7.6
Discontinued operations	**(20.7)**	22.7	36.6
Net income	**$ 34.2**	$ 92.1	$ 44.2

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

[3] The Ocean Transportation segment includes approximately $8.6 million, $12.8 million, and $6.2 million of equity in earnings from its investment in SSAT for 2011, 2010, and 2009, respectively. The Real Estate Sales segment includes approximately $7.9 million equity in loss and $2.0 million in equity in earnings from its various real estate joint ventures for 2011 and 2010, respectively. Equity in earnings from joint ventures in 2009 was negligible.

[4] Includes Ocean Transportation interest expense of $7.7 million, $8.2 million, and $9.0 million for 2011, 2010, and 2009, respectively. Substantially all other interest expense was at the parent company.

[5] Includes a $4.9 million gain in 2010 related to an agriculture disaster relief payment for drought experienced in prior years and a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

INDUSTRY SEGMENTS (CONTINUED)

As of December 31:	2011	2010	2009
Identifiable Assets:			
Ocean transportation[6]	$ 1,082.6	$ 1,095.5	$ 1,095.2
Logistics services	76.8	73.8	72.4
Real estate leasing	770.9	739.4	627.4
Real estate sales[6]	451.4	420.8	415.6
Agribusiness	157.8	150.3	156.8
Other	4.8	14.8	12.2
Total assets	$ 2,544.3	$ 2,494.6	$ 2,379.6
Capital Expenditures:			
Ocean transportation	$ 44.2	$ 69.4	$ 12.7
Logistics services[7]	3.0	1.8	0.6
Real estate leasing[8]	43.6	164.7	108.8
Real estate sales[9]	5.2	0.1	0.1
Agribusiness	10.5	6.8	3.4
Other	--	0.3	0.3
Total capital expenditures	$ 106.5	$ 243.1	$ 125.9
Depreciation and Amortization:			
Ocean transportation	$ 70.6	$ 69.0	$ 67.1
Logistics services	3.2	3.2	3.5
Real estate leasing[1]	21.6	20.3	19.5
Real estate sales	0.2	0.2	0.3
Agribusiness	11.9	12.7	11.9
Other	1.1	1.9	3.1
Total depreciation and amortization	$ 108.6	$ 107.3	$ 105.4

[6] The Ocean Transportation segment includes approximately $56.5 million, $52.9 million, and $47.2 million related to its investment in SSAT as of December 31, 2011, 2010, and 2009, respectively. The Real Estate Sales segment includes approximately $290.1 million, $274.8 million, and $193.3 million related to its investment in various real estate joint ventures as of December 31, 2011, 2010, and 2009, respectively.

[7] Excludes expenditures related to Matson Logistics' acquisitions, which are classified as acquisition of businesses in Cash Flows from Investing Activities within the Consolidated Statements of Cash Flows.

[8] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[9] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows. Operating cash flows for expenditures related to real estate developments were $14 million, $22 million, and $6 million for 2011, 2010, and 2009, respectively.

15. **QUARTERLY INFORMATION (Unaudited)**

Segment results by quarter for 2011 are listed below (in millions, except per-share amounts):

	2011 Q1	2011 Q2	2011 Q3	2011 Q4
Revenue:				
Transportation:				
Ocean transportation	$ 238.4	$ 274.8	$ 281.8	$ 282.6
Logistics services	91.3	103.1	99.2	92.8
Real Estate:				
Leasing	26.0	25.2	24.5	24.4
Sales	23.4	30.7	9.3	2.8
Less amounts reported in discontinued operations [1]	(15.2)	(23.1)	(8.8)	(0.4)
Agribusiness	16.1	44.7	38.5	62.4
Reconciling Items [2]	(6.5)	(6.9)	(4.3)	(4.4)
Total Revenue	**$ 373.5**	**$ 448.5**	**$ 440.2**	**$ 460.2**
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 5.4	$ 27.1	$ 28.6	$ 13.0
Logistics services	1.5	2.1	2.0	(0.6)
Real Estate:				
Leasing	10.6	10.4	9.2	9.1
Sales	12.0	10.6	3.5	(10.6)
Less amounts reported in discontinued operations [1]	(7.2)	(9.2)	(7.0)	(0.4)
Agribusiness	2.6	8.5	3.8	7.3
Total operating profit	24.9	49.5	40.1	17.8
Interest Expense	(6.2)	(6.1)	(6.3)	(6.2)
General Corporate Expenses	(4.2)	(4.2)	(4.8)	(7.1)
Income From Continuing Operations before Income Taxes	14.5	39.2	29.0	4.5
Income taxes	5.8	15.1	10.6	0.8
Income From Continuing Operations	**8.7**	**24.1**	**18.4**	**3.7**
Discontinued Operations [1]	(3.5)	(5.4)	(9.7)	(2.1)
Net Income	**$ 5.2**	**$ 18.7**	**$ 8.7**	**$ 1.6**
Earnings Per Share:				
Basic	$ 0.13	$ 0.45	$ 0.21	$ 0.04
Diluted	$ 0.12	$ 0.44	$ 0.21	$ 0.04

1 See Note 2 for discussion of discontinued operations.

2 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

Segment results by quarter for 2010 are listed below (in millions, except per-share amounts):

	2010			
	Q1	Q2	Q3	Q4
Revenue:				
Transportation:				
Ocean transportation	$ 229.5	$ 257.2	$ 261.8	$ 268.0
Logistics services	77.1	88.6	92.4	97.5
Real Estate:				
Leasing	23.6	23.2	24.4	23.2
Sales	60.3	22.0	4.3	49.5
Less amounts reported in discontinued operations [1]	(58.4)	(20.7)	(3.3)	(44.3)
Agribusiness[2]	14.2	29.8	60.4	59.5
Reconciling Items [3]	(4.2)	(3.6)	(2.7)	(15.8)
Total Revenue	**$ 342.1**	**$ 396.5**	**$ 437.3**	**$ 437.6**
Operating Profit (Loss):				
Transportation:				
Ocean transportation	$ 10.4	$ 37.0	$ 42.5	$ 28.8
Logistics services	1.9	1.5	1.8	2.0
Real Estate:				
Leasing	9.1	8.5	9.3	8.4
Sales	21.4	8.0	2.9	17.8
Less amounts reported in discontinued operations [1]	(22.8)	(10.6)	(2.1)	(19.0)
Agribusiness[2]	(1.1)	1.8	0.8	4.6
Total operating profit	18.9	46.2	55.2	42.6
Interest Expense	(6.5)	(6.5)	(6.3)	(6.2)
General Corporate Expenses	(6.6)	(4.5)	(7.7)	(4.5)
Income From Continuing Operations before Income Taxes	5.8	35.2	41.2	31.9
Income taxes	3.0	13.1	15.5	13.1
Income From Continuing Operations	**2.8**	**22.1**	**25.7**	**18.8**
Discontinued Operations [1]	14.5	6.8	--	1.4
Net Income	**$ 17.3**	**$ 28.9**	**$ 25.7**	**$ 20.2**
Earnings Per Share:				
Basic	$ 0.42	$ 0.70	$ 0.62	$ 0.49
Diluted	$ 0.42	$ 0.70	$ 0.62	$ 0.48

1 See Note 2 for discussion of discontinued operations.
2 Includes a $4.9 million gain in the fourth quarter of 2010 related to a agriculture disaster relief payment for drought experienced in prior years.
3 Includes inter-segment revenue, interest income, and other income classified as revenue for segment reporting purposes.

16. PARENT COMPANY CONDENSED FINANCIAL INFORMATION

Set forth below are the unconsolidated condensed financial statements of Alexander & Baldwin, Inc. ("Parent Company"). The significant accounting policies used in preparing these financial statements are substantially the same as those used in the preparation of the consolidated financial statements as described in Note 1, except that, for purposes of the tables presented in this footnote, subsidiaries are carried under the equity method.

The following table presents the Parent Company's condensed balance sheets as of December 31, 2011 and 2010 (in millions):

	2011	2010
ASSETS		
Current Assets:		
Cash and cash equivalents	$ 1	$ -
Accounts and other receivables, net	3	5
Inventories	24	16
Real estate held for sale	–	3
Prepaid expenses and other	5	6
Total current assets	33	30
Investments:		
Subsidiaries consolidated, at equity	1,313	1,299
Property, at Cost	518	501
Less accumulated depreciation and amortization	237	225
Property – net	281	276
Other Assets	16	17
Total	$ 1,643	$ 1,622
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 34	$ 108
Accounts payable	6	8
Income taxes payable	22	2
Non-qualified benefit plans	1	1
Other	17	17
Total current liabilities	80	136
Long-term Debt	308	230
Employee Benefit Plans	41	27
Non-qualified Benefit Plans	8	10
Other Long-term Liabilities	19	11
Deferred Income Taxes	50	50
Due to Subsidiaries	14	22
Shareholders' Equity:		
Capital stock	34	34
Additional capital	239	223
Accumulated other comprehensive loss	(92)	(82)
Retained earnings	953	972
Cost of treasury stock	(11)	(11)
Total shareholders' equity	1,123	1,136
Total	$ 1,643	$ 1,622

The following table presents the Parent Company's condensed statements of income for the years ended December 31, 2011, 2010, and 2009 (in millions):

	2011	2010	2009
Revenue:			
Agribusiness	$ 128	$ 117	$ 73
Real estate leasing	24	16	13
Real estate sales	15	2	8
Interest and other	3	6	2
Total revenue	170	141	96
Costs and Expenses:			
Cost of agribusiness goods and services	113	114	109
Cost of real estate sales and leasing	21	11	9
Selling, general and administrative	21	24	21
Interest and other	16	16	16
Income tax benefit (expense)	2	(12)	(22)
Total costs and expenses	173	153	133
Loss from Continuing Operations	(3)	(12)	(37)
Discontinued Operations, net of income taxes	2	24	11
Income (Loss) Before Equity in Income of Subsidiaries Consolidated	(1)	12	(26)
Equity in Income from Continuing Operations of Subsidiaries Consolidated	58	81	44
Equity in Income (Loss) from Discontinued Operations of Subsidiaries Consolidated	(23)	(1)	26
Net Income	34	92	44
Other Comprehensive Income (Loss), net of income taxes	(10)	(1)	15
Comprehensive Income	$ 24	$ 91	$ 59

The following table presents the Parent Company's condensed statements of cash flows for the years ended December 31, 2011, 2010, and 2009 (in millions):

	2011	2010	2009
Cash Flows from Operations (including dividends received from subsidiaries)	$ 96	$ 37	$ 90
Cash Flows from Investing Activities:			
Capital expenditures	(10)	(14)	(6)
Purchase of investments	(58)	(67)	(96)
Proceeds from disposal of property and sale of investments	12	36	28
Net cash used in investing activities	(55)	(45)	(74)
Cash Flows from Financing Activities:			
Change in intercompany payables/receivables	--	--	(13)
Proceeds from (repayments of) long-term debt, net	3	52	51
Proceeds from issuance of capital stock and other	10	7	(1)
Repurchases of capital stock	--	--	--
Dividends paid	(53)	(52)	(52)
Net cash used in financing activities	(40)	7	(15)
Cash and Cash Equivalents:			
Net increase (decrease) for the year	1	(1)	1
Balance, beginning of year	--	1	--
Balance, end of year	$ 1	$ --	$ 1
Other Cash Flow Information:			
Interest paid	$ (16)	$ (15)	$ (13)
Income taxes paid, net of refunds	$ (25)	$ (46)	$ (38)
Other Non-cash Information:			
Depreciation expense	$ 16	$ 16	$ 17
Tax-deferred property sales	$ 16	$ 65	$ 29
Tax-deferred property purchases	$ (12)	$ (78)	$ (40)

General Information: The Parent Company is headquartered in Honolulu, Hawaii and is engaged in the operations that are generally described in Note 14, "Industry Segments." Additional information related to the Parent Company is described in the foregoing notes to the consolidated financial statements.

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UNITED STATES
SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

FORM 10-K

☒ ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2012

OR

[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF
THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _______ to _______

Commission file number 001-35492

ALEXANDER & BALDWIN, INC.

(Exact name of registrant as specified in its charter)

Hawaii (State or other jurisdiction of incorporation or organization)	**45-4849780** (I.R.S. Employer Identification No.)

822 Bishop Street
Post Office Box 3440, Honolulu, Hawaii 96801
(Address of principal executive offices and zip code)

808-525-6611
(Registrant's telephone number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Name of each exchange on which registered
Common Stock, without par value	NYSE

Securities registered pursuant to Section 12(g) of the Act:
None

Number of shares of Common Stock outstanding at February 15, 2013:
43,017,144

Aggregate market value of Common Stock held by non-affiliates at June 30, 2012:
$1,057,054,900

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes ☒ No ☐

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes ☐ No ☒

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes ☒ No ☐

Indicate by check mark whether the registrant has submitted electronically and posted on its corporate Web site, if any, every Interactive Data File required to be submitted and posted pursuant to Rule 405 of Regulation S-T during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). Yes ☒ No ☐

Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K is not contained herein, and will not be contained, to the best of registrant's knowledge, in definitive proxy or information statements incorporated by reference in Part III of this Form 10-K or any amendment to this Form 10-K. ☒

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, or a smaller reporting company. See definition of "large accelerated filer," "accelerated filer" and "smaller reporting company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer ☒	Accelerated filer ☐
Non-accelerated filer ☐ (Do not check if a smaller reporting company)	Smaller reporting company ☐

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ☐ No ☒

Documents Incorporated By Reference
Portions of Registrant's Proxy Statement for the 2013 Annual Meeting of Shareholders (Part III of Form 10-K)

Exhibit E-R6

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PART II

ALEXANDER & BALDWIN, INC.

FORM 10-K

Annual Report for the Fiscal Year
Ended December 31, 2012

PART I

ITEMS 1 & 2. BUSINESS AND PROPERTIES

Overview

Alexander & Baldwin, Inc. ("A&B" or the "Company") is a premier Hawaii-focused land company with interests in real estate development, real estate leasing and agribusiness. A&B's assets include approximately 87,000 acres of land in Hawaii, nearly 8.0 million square feet of high-quality retail, office and industrial properties in Hawaii and on the Mainland, and a real estate development portfolio encompassing residential and commercial projects across Hawaii. Its landholdings, primarily on Maui and Kauai, make it the fourth largest private landowner in the state. A&B, whose history in Hawaii dates back to 1870, is Hawaii's largest farmer with 36,000 acres in productive sugar cane cultivation. A&B also plays a key role as a major provider of renewable energy on Maui and Kauai, supplying approximately six percent of the power consumed on each island.

Prior to June 29, 2012, A&B's businesses included Matson Navigation Company Inc. ("Matson Navigation"), a wholly owned subsidiary, that provided ocean transportation, truck brokerage and intermodal services. As part of a strategic initiative designed to allow A&B to independently execute its strategies and to best enhance and maximize its earnings, growth prospects and shareholder value, A&B made a decision to separate the transportation businesses from the Hawaii real estate and agriculture businesses. In preparation for the separation, A&B modified its legal-entity structure and became a wholly owned subsidiary of a newly created entity, Alexander & Baldwin Holdings, Inc. ("Holdings"). On June 29, 2012, Holdings distributed to its shareholders all of the shares of A&B stock in a tax-free distribution (the "Separation"). Holders of Holdings common stock continued to own the transportation businesses, but also received one share of A&B common stock for each share of Holdings common stock held at the close of business on June 18, 2012, the record date. Following the Separation, Holdings changed its name to Matson, Inc. ("Matson"). On July 2, 2012, A&B began regular trading on the New York Stock Exchange under the ticker symbol "ALEX" as an independent, public company.

A&B is headquartered in Honolulu and operates in three segments in two industries—Real Estate and Agribusiness. The business industries of A&B are generally as follows:

A. *Real Estate* - The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the Mainland. The Real Estate Industry engages in real estate development and ownership activities, including planning, zoning, financing, constructing, purchasing, managing and leasing, selling and exchanging, and investing in real property. Real estate activities are conducted through A&B Properties, Inc. and other wholly owned subsidiaries of A&B.

- *Real Estate Development and Sales segment* - generates its revenues and creates value through an active and comprehensive program of land stewardship, planning, entitlement, development and sale of land and commercial and residential properties, principally in Hawaii.

- *Real Estate Leasing segment* - owns, operates, and manages a large portfolio of high-quality retail, office, and industrial properties in Hawaii and on the Mainland. The Company also leases land in Hawaii. The significant recurring cash flow generated by this portfolio serves as an important source of funding for A&B's real estate development and sales activities.

B. *Agribusiness* - Agribusiness, which contains one segment, produces bulk raw sugar, specialty food grade sugars, and molasses; markets and distributes specialty food-grade sugars; provides general trucking services, mobile equipment maintenance, and repair services in Hawaii; leases agricultural land to third parties; and generates and sells electricity to the extent not used in A&B's Agribusiness operations. A&B also is the member of Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services.

The following table contains key information regarding each of the Company's segments. Since the purchase and sale of real estate is considered an ongoing and recurring core activity of its real estate businesses, Real Estate Development Sales and Real Estate Leasing segment revenue and segment operating profit are analyzed before subtracting amounts related to discontinued operations. This is consistent with how the Company generates earnings and how A&B's management evaluates performance and makes decisions regarding capital allocation for A&B's real estate businesses.

Segment	2012 Revenue (in millions)	Percentage of Total 2012 Revenue	2012 Operating Profit (in millions)	Percentage of Total 2012 Operating Profit	Key Facts
Real Estate Leasing	$100.6	32%	$41.6	72%	High-quality commercial portfolio consisting of 45 improved properties in Hawaii and 8 Mainland states totaling nearly 8.0 million square feet.
Real Estate Sales*	$32.2	10%	$(4.4)	(8)%	Hawaii-focused, experienced developer with a large development pipeline encompassing over a dozen projects entitled for approximately 1,700 resort residential, 600 primary residential and 200 commercial units. Fourth largest private landowner in Hawaii with approximately 87,000 acres.
Agribusiness	$182.3	58%	$20.8	36%	Largest farmer in Hawaii and only producer of raw sugar in Hawaii, producing nearly 180,000 tons of sugar in 2012, and provider of approximately 6 percent of renewable energy on both Maui and Kauai.
Total	$315.1	100%	$58.0	100%	

* Revenue includes $8.3 million on the sale of a 286-acre agricultural parcel in the third quarter of 2012 classified as "Gain on sale of agricultural parcel" in the consolidated statements of income, but reflected as

revenue for segment reporting purposes. Additionally, operating profit includes impairment and equity losses of $9.8 million related to the Company's change to its development strategy to focus on development projects in Hawaii.

Further information about the revenue, operating profits and identifiable assets of A&B's industry segments for the three years ended December 31, 2012 are contained in Note 14 ("Operating Segments") to A&B's financial statements in Item 8 of Part II below.

Strategy

A&B strives to create value through superior investments in Hawaii by leveraging its extensive asset base, market knowledge and development expertise to create shareholder value through the entire spectrum of land stewardship and development, including land planning, entitlement, permitting, development and sales. A&B has a long track record of successfully investing in residential and commercial projects on both its legacy landholdings and non-legacy holdings. A&B believes that Hawaii has attractive near- and long-term growth prospects and intends to position its development and investment activities to capitalize on this growth.

A&B is committed to the highest and best use of its agricultural land assets through continued improvements in sugar production and renewable energy generation, and will continue to explore opportunities for conversion to a bio-energy generating model. Additional details regarding A&B's key strategies across its lands, commercial properties, investments, and agriculture assets are as follows:

Land:

- *Employing lands at their highest and best use:* A&B strives to employ the land it owns at its highest and best use, to the benefit of shareholders, employees, our communities and other key stakeholder groups. For a significant portion of A&B's substantial Hawaii landholdings, this implies a wide range of non-development uses, ranging from conservation/watershed to pasture to active farming. While a material portion of A&B's landholdings has limited or no long-term urban development potential, these landholdings remain valuable for other reasons, for example, providing access to natural resources or hydro-electric generation capability.

- *Focus on entitlement and development of core Hawaii lands:* A&B intends to focus on development of a portion of its core landholdings in Hawaii, pursuing appropriate entitlement and development projects that respond to market demand while meeting community needs.

Commercial Properties:

- *Optimize returns of A&B's diversified commercial portfolio:* A&B has a track record of increasing the value of its commercial property portfolio through active management of a comprehensive program designed to increase occupancy, secure quality tenants, and reduce costs, thereby maximizing the financial performance of these properties. Periodically, when A&B believes it has maximized the value of a select asset, it may market the asset for sale. Upon sale, A&B will seek to redeploy the proceeds on a 1031 tax-deferred basis into a new asset with a higher return potential, with a focus on opportunistically migrating the portfolio to Hawaii over time, while ensuring that the portfolio continues to serve as a stable source of cash flow for A&B's investment activities.

Real Estate Investment:

- *Invest in high-returning real estate opportunities in Hawaii:* In addition to development of its own lands, A&B will continue to invest in attractive real estate opportunities elsewhere in Hawaii where it can leverage its market knowledge, relationships and financial strength to create significant value and, at the same time, diversify its current portfolio and pipeline.

- *Build a pipeline of development projects scaled to market opportunities and designed to optimize risk-adjusted returns:* A&B owns a valuable pipeline of development projects encompassing a wide-range of product types, from resort residential real estate, to industrial, to primary residential housing. A&B employs a disciplined approach to its investments and prudently invests capital to position select projects with ready inventory to meet market demand. A&B also will pursue joint ventures, where appropriate, to supplement its in-house capabilities, access third-party capital, gain access to new opportunities in the Hawaii market, diversify its pipeline, and optimize risk-adjusted returns.

Agriculture:

- *De-risk agricultural operations:* A&B continuously seeks to stabilize and de-risk its agricultural operations. For example, the sale of A&B's Kauai Coffee Company, Inc. assets to a global coffee manufacturer removed operational cost and product marketing risks and replaced volatile financial results with a stable lease income stream. In addition, A&B has enhanced the management of field and factory at its sugar operations, resulting in a greater than 40 percent increase in sugar yields per acre over the past three years. A&B intends to continue its focus on maximizing its returns from agricultural activities and assets while mitigating the volatility of those returns. To meet this objective, A&B employs a variety of risk-mitigation measures, including forward pricing of sugar sales and fixed-rate contracts for key inputs. Refer to the Company's "Outlook" on page 51 for an updated discussion on the Company's sugar pricing.

- *Grow renewable energy operations:* Due to the high cost of transporting fossil fuels to a remote island community, the economics of renewable energy in Hawaii are more favorable relative to other U.S. locations. In fact, Hawaii has mandated a shift to 40 percent clean energy by the year 2030. As a result, A&B expects to evaluate and further capitalize on opportunities to add additional renewable energy capacity to its portfolio through new projects, and to continue research on possible cultivation and conversion of feedstock from A&B's sugar plantation for use in bio-fuel production.

Seek New Hawaii Opportunities:

- A&B has a successful long-term track record of expanding into lines of businesses that complement its core land and agribusiness operations. Looking forward, A&B expects to continue its evaluation of Hawaii-centric business opportunities that complement its core land stewardship, agribusiness, property development and property management activities in the state, and leverage A&B's competitive strengths and the long-term prospects for growth in Hawaii.

Competitive Strengths

Irreplaceable Hawaii Real Estate Assets:

- *Extensive and irreplaceable landholdings:* A&B is the fourth largest private landowner in Hawaii, with approximately 87,000 acres, primarily on Maui and Kauai, including 750 acres fully entitled for urban use.

- *High-quality commercial real estate portfolio producing strong free cash flow:* A&B owns and manages a high-quality commercial portfolio of 45 properties in Hawaii and eight Mainland states that totals nearly 8.0 million square feet, which provides significant, stable, recurring cash flows that support A&B's real estate

The Company's schedule of lease expirations for its Hawaii and U.S. Mainland commercial portfolio is as follows:

Year of expiration	Number of leases	Sq. ft. of expiring leases	Percentage of total leased GLA(1)	Annual gross rent expiring(2) ($ in millions)	Percentage of total annual gross rent(2)
2013	109	699,317	9.9%	7.4	10.5%
2014	111	477,349	6.7%	6.9	9.8%
2015	129	1,197,584	16.9%	12.3	17.7%
2016	78	974,963	13.8%	10.6	15.1%
2017	72	2,007,353	28.3%	14.8	21.2%
2018	26	469,888	6.6%	3.7	5.2%
2019	9	125,870	1.8%	2.0	2.8%
2020	15	197,154	2.8%	2.9	4.2%
2021	6	161,607	2.3%	1.5	2.2%
2022	11	97,839	1.4%	2.0	2.8%
2023	4	20,861	0.3%	0.4	0.6%
Thereafter	21	652,965	9.2%	5.5	7.9%
Total	591	7,082,750	100.0%	70.0	100.0%

(1) Gross leasable area

(2) Annual gross rent means the annualized base rent amounts of expiring leases and includes improved properties only.

C. Agribusiness

(1) Production

A&B has been engaged in the production of cane sugar in Hawaii since 1870. A&B's current agribusiness and related operations consist of: (1) a sugar plantation on the island of Maui, operated by its Hawaiian Commercial & Sugar Company ("HC&S") division, (2) renewable energy operations on the island of Kauai, operated by its McBryde Resources, Inc. ("McBryde") subsidiary, (3) its Kahului Trucking & Storage, Inc. ("KT&S") and Kauai Commercial Company, Incorporated ("KCC") subsidiaries, which provide several types of trucking services, including sugar and molasses hauling on Maui, mobile equipment maintenance and repair services on Maui, Kauai, and the Big Island, and self-service storage facilities on Maui and Kauai, and (4) Hawaiian Sugar & Transportation Cooperative ("HS&TC"), an agricultural cooperative that provides raw sugar marketing and transportation services solely to HC&S. HS&TC owns the MV Moku Pahu, a Jones Act qualified integrated tug barge bulk dry carrier, which is used to transport raw sugar from Hawaii to the U.S. West Coast and coal from the U.S. West Coast to Hawaii.

HC&S is Hawaii's only producer of raw sugar, producing approximately 178,300 tons of raw sugar in 2012 (compared with 182,800 tons in 2011). The primary reasons for the decrease in production were lower yields on the plantation due to an increase in fields harvested as green cane, which suppresses yields, and drier conditions resulting in lower water deliveries to the crop. HC&S harvested 15,900 acres of sugar cane in 2012 (compared with 15,063 in 2011). Yields averaged 11.3 tons of sugar per acre in 2012 (compared to 12.1 in 2011). As a by-product of sugar production, HC&S also produced approximately 50,500 tons of molasses in 2012 (compared to 53,100 in 2011).

In 2012, approximately 15,600 tons of sugar (compared to 18,700 tons in 2011) were processed by HC&S into specialty food-grade sugars under HC&S's Maui Brand® trademark or repackaged by distributors under their own labels. This decrease in production was due to planned lower levels to meet customer commitment levels and limited availability of the highest quality syrup to process the specialty sugars.

HC&S and McBryde produce electricity for internal use and for sale to the local electric utility companies. HC&S's power is produced by burning bagasse (the residual fiber of the sugar cane plant), by hydroelectric power generation and, when necessary, by burning fossil fuels. McBryde produces power through hydroelectric and solar generation. The price for the power sold by HC&S is equal to the utility companies' "avoided cost" of not producing such power themselves. In addition, HC&S receives a capacity payment to provide a guaranteed power generation capacity to the local utility. The price for the power sold by McBryde is based on fixed prices that vary along a sliding scale tied to volume. See "Energy" below for power production and sales data.

(2) Marketing of Sugar

Approximately 90 percent of the bulk raw sugar produced by HC&S in 2012 was purchased by C&H Sugar Company, Inc. ("C&H"). C&H processes the raw cane sugar at its refinery at Crockett, California and markets the refined products primarily in the western and central United States.

The remaining 10 percent of the raw sugar was used by HC&S to produce specialty food-grade sugars, which are sold by HC&S to food and beverage producers and to retail stores under its Maui Brand® label, and to distributors that repackage the sugars under their own labels. HC&S's largest food-grade sugar customers are Cumberland Packing Corp. and Sugar Foods Corporation, which repackage HC&S's turbinado sugar for their "Sugar in the Raw" product line.

HS&TC, a sugar grower cooperative in Hawaii (of which HC&S is the member), has a supply contract with C&H ending in December 2014. Pursuant to the supply contract, the cooperative sells raw sugar to C&H at a price equal to the New York No. 16 Contract settlement price, less a volume-based discount.

(3) Sugar Competition and Legislation

Hawaii has traditionally produced more sugar per acre than most other major producing areas of the world, but that advantage is offset by Hawaii's high labor costs and the distance to the Mainland market. Hawaiian refined sugar is marketed primarily west of Chicago, Illinois. The region near Chicago is also the largest beet sugar growing and processing area and, as a result, the only market area in the United States that produces more sugar than it consumes. Sugar from sugar beets is the greatest source of competition in the refined sugar market for the Hawaiian sugar industry.

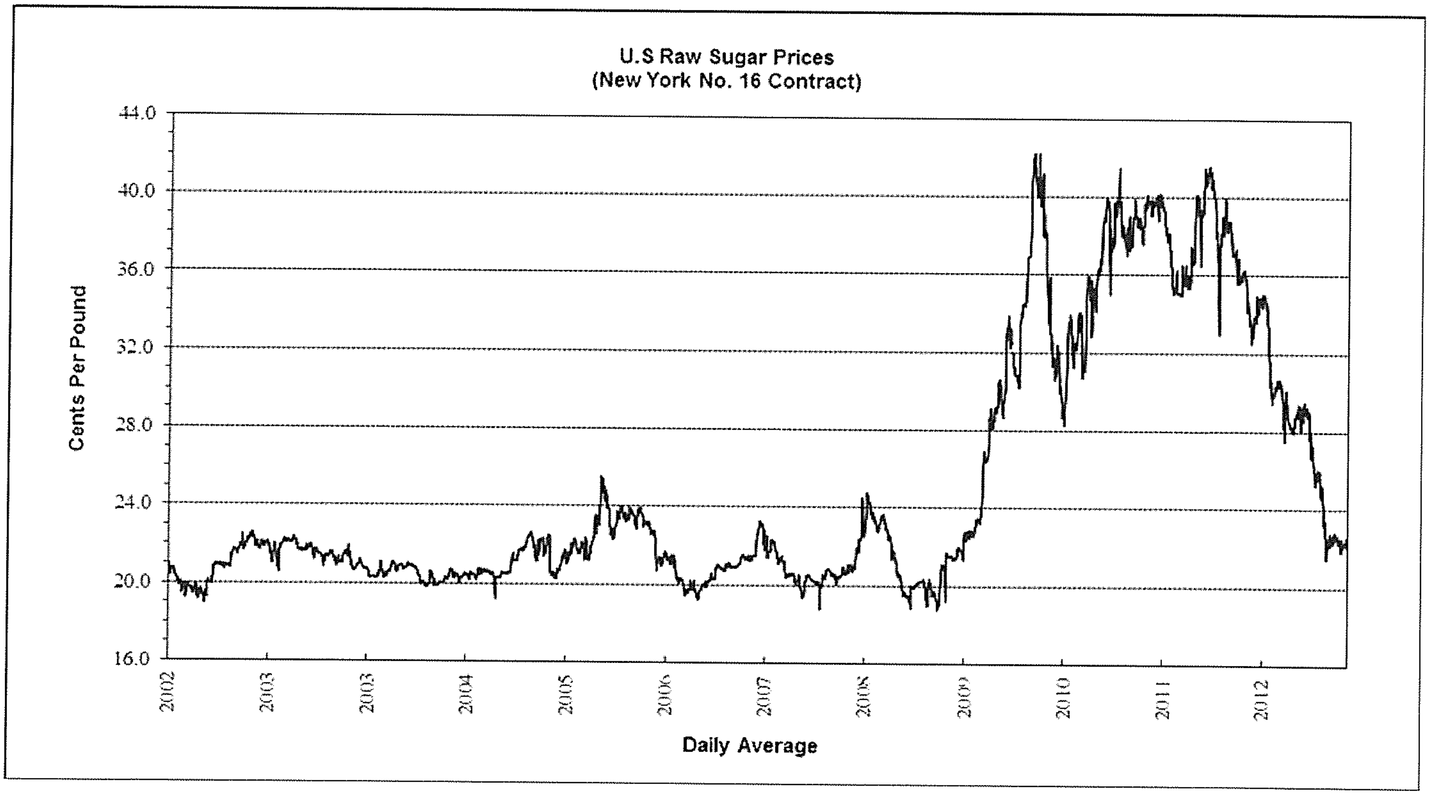
The U.S. Congress historically has sought, through legislation, to assure a reliable domestic supply of sugar at stable and reasonable prices. The current legislation is the Food Conservation and Energy Act of 2008, which was set to expire on December 31, 2012 ("2008 Farm Bill"), but was extended one year during the national "fiscal cliff" negotiations. The two main elements of U.S. sugar policy are the tariff-rate quota ("TRQ") import system and the price support loan program. The TRQ system limits imports from countries other than Canada and Mexico by allowing only a quota amount to enter the U.S. after payment of a relatively low tariff. A higher, over-quota tariff is imposed for imported quantities above the quota amount. Also, a new but limited sucrose ethanol program was added in 2008, which allows sugar to be diverted into ethanol production when the market is deemed to be oversupplied.

The 2008 Farm Bill reauthorized the sugar price support loan program, which supports the U.S. price of sugar by providing for commodity-secured loans to producers. A loan rate (support price) of 18.50 cents per pound ("¢/lb") for raw cane sugar was in effect for the 2010 and 2011 crops. The loan rate increases to 18.75 ¢/lb for the 2012 and 2013 crops (the last year of the bill). The U.S. rates are adjusted by region to reflect the cost of transportation. The 2012 adjusted crop loan rate in Hawaii is 17.57¢/lb. A&B does not currently participate in the sugar price support loan program.

In 2005, the U.S. approved a trade pact with Central America and the Dominican Republic, known as the Central America-Dominican Republic-United States Free Trade Agreement. In 2006, the first year of the agreement, additional sugar market access for participating countries amounted to about 1.2 percent of current U.S. sugar consumption (107,000 metric tons), which will grow to about 1.7 percent (151,000 metric tons) in its fifteenth year.

Implementation of the North American Free Trade Agreement (NAFTA) began in 1994. This agreement removed most barriers to trade and investment among the U.S., Canada and Mexico. Under NAFTA, all non-tariff barriers to agricultural trade between the U.S. and Mexico were eliminated. In addition, many tariffs were eliminated immediately or phased out. Starting in 2008, Mexico was permitted to ship an unlimited quantity of sugar duty-free to the U.S. each year.

U.S. raw sugar prices remained relatively stable and flat for over thirty years. The full implementation of NAFTA in 2008, which unified the U.S. and Mexican sugar markets, increased price volatility. In 2009, a tight NAFTA supply/demand outlook and a soaring world raw sugar market combined to push U.S. raw sugar prices to 29-year highs. Prices have since steadily declined in 2012 due to a recent NAFTA and world market surplus. A chronological chart of the average U.S. domestic raw sugar prices, based on the average daily New York No. 16 Contract settlement price for domestic raw sugar, is shown below (not adjusted for inflation):



(4) **Land Designations and Water**

The HC&S sugar plantation, the only remaining sugar plantation in Hawaii, consists of 43,300 acres, with approximately 36,000 acres under active sugar cane cultivation.

On Kauai, approximately 3,000 acres are cultivated in coffee by Massimo Zanetti Beverage USA, Inc., which leases the land from A&B. Additional acreage is cultivated in seed corn and used for pasture purposes.

The Hawaii Legislature, in 2005, passed Important Agricultural Lands ("IAL") legislation to fulfill the state constitutional mandate to protect agricultural lands, promote diversified agriculture, increase the state's agricultural self-sufficiency, and assure the availability of agriculturally suitable lands. In 2008, the Legislature passed a package of incentives, which is necessary to trigger the IAL system of land designation. In 2009, A&B received approval from the State Land Use Commission for the designation of over 27,000 acres on Maui and over 3,700 acres on Kauai as IAL. These designations were the result of voluntary petitions filed by A&B.

It is crucial for HC&S to have access to reliable sources of water supply and efficient irrigation systems. HC&S conserves water by using "drip" irrigation systems that distribute water to the roots through small holes in plastic tubes. All but a small area of the cultivated cane land farmed by HC&S is drip irrigated.

A&B owns 16,000 acres of watershed lands in East Maui, which supply a portion of the irrigation water used by HC&S. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui, which over the last ten years have supplied approximately 58 percent of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. A&B also holds rights to an irrigation system in West Maui, which provided approximately 14 percent of the irrigation water used by HC&S over the last ten years. For information regarding legal proceedings involving A&B's irrigation systems, see "Legal Proceedings" below.

(5) **Energy**

As has been the practice with sugar plantations throughout Hawaii, HC&S uses bagasse, the residual fiber of the sugar cane plant, as a fuel to generate steam for the production of most of the electrical power for sugar milling and irrigation pumping operations. In addition to bagasse, HC&S uses coal, diesel, fuel oil, and recycled motor oil to generate power during factory shutdown periods when bagasse is not being produced or during periods when bagasse is not produced in sufficient quantities. HC&S also generates a limited amount of hydroelectric power. To the extent it is not used in A&B's factory and farming operations, HC&S sells electricity. In 2012, HC&S produced and sold, respectively, approximately 182,100 megawatt hours (MWH) and 58,200 MWH of electric power (compared with 191,300 MWH produced and 64,900 MWH sold in 2011). The decrease in power sold was due to increased power used for irrigation pumps to improve soil moisture levels and yields and mechanical problems with one of the boilers at HC&S in the first half of 2012. Hydroelectric generation was depressed during the year due to extended drought conditions on Maui. HC&S's use of oil in 2012 of 17,600,barrels was 81 percent more than the 9,700 barrels used in 2011. Coal used for power generation was 51,000 short tons, about 7,600 tons less than that used in 2011. Less coal was required because of the higher bagasse production from the fields, lower power deliveries described above, and the higher oil consumption.

In 2012, McBryde produced approximately 30,500 MWH of hydroelectric power (compared with approximately 29,800 MWH in 2011). To the extent it is not used in A&B-related operations, McBryde sells electricity to Kauai Island Utility Cooperative ("KIUC"). Power sales in 2012 amounted to approximately 24,100 MWH (compared with 22,100 MWH in 2011). In December 2012, McBryde placed into service a 6 MW photovoltaic solar power generation facility. The Company expects to sell approximately 10,000 MWH of solar power per annum to KIUC.

Employees and Labor Relations

As of December 31, 2012, A&B and its subsidiaries had 946 regular full-time employees. The Agribusiness segment employed 846 regular full-time employees, the real estate segment employed 43 regular full-time employees, and the remaining employees were employed in administration. Approximately 73 percent were covered by collective bargaining agreements with unions.

Bargaining unit employees of HC&S are covered by two collective bargaining agreements with the International Longshore and Warehouse Union ("ILWU"). The agreements with the HC&S production unit employees and clerical and technical employees bargaining units cover approximately 640 workers and expire on January 31, 2014. The bargaining unit employees at KT&S also are covered by two collective bargaining agreements with the ILWU. The bulk sugar employees' agreement expires on June 30, 2014 and the agreement with all other employees expires on March 31, 2015. There are two collective bargaining agreements with Kauai Commercial Company employees represented by the ILWU. These agreements expired on February 28, 2013, with renegotiations underway.

Available Information

A&B files reports with the Securities and Exchange Commission (the "SEC"). The reports and other information filed include: annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and other reports and information filed under the Securities Exchange Act of 1934 (the "Exchange Act").

The public may read and copy any materials A&B files with the SEC at the SEC's Public Reference Room at 100 F Street, NE, Washington, DC 20549. The public may obtain information on the operation of the Public Reference Room by calling the SEC at 1-800-SEC-0330. The SEC maintains an Internet website that contains reports, proxy and information statements, and other information regarding A&B and other issuers that file electronically with the SEC. The address of that website is www.sec.gov.

A&B makes available, free of charge on or through its Internet website, A&B's annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act as soon as reasonably practicable after it electronically files such material with, or furnishes it to, the SEC. The address of A&B's Internet website is www.alexanderbaldwin.com.

ITEM 1A. RISK FACTORS

A&B's business and its common stock are subject to a number of risks and uncertainties. You should carefully consider the risks and uncertainties described below, together with all of the other information in this Form 10-K and the Company's filings with the U.S. Securities and Exchange Commission. Based on information currently known, A&B believes that the following information identifies the most significant risk factors affecting A&B's business and its common stock. However, the risks and uncertainties faced by A&B are not limited to those described below, nor are they listed in order of significance. Additional risks and uncertainties not presently known to A&B or that it currently believes to be immaterial may also materially adversely affect A&B's business, liquidity, financial condition, results of operation and cash flows. This Form 10-K also contains forward-looking statements that involve risks and uncertainties.

If any of the following events occur, A&B's business, liquidity, financial condition, results of operations, and cash flows could be materially adversely affected, and the trading price of A&B common stock could materially decline.

Risks Relating to A&B's Business

Changes in economic conditions that result in a decrease in consumer confidence or market demand for A&B's real estate assets in Hawaii and the Mainland may adversely affect A&B's financial position, results of operations, liquidity, or cash flows.

A weakening of economic drivers in Hawaii, which include tourism, military spending, construction starts, personal income growth, and employment, or the weakening of consumer confidence, market demand, or economic conditions the Mainland, may adversely affect the demand for or sale of Hawaii real estate and the level of real estate leasing activity in Hawaii and on the Mainland.

A&B may face new or increased competition.

There are numerous other developers, buyers, managers and owners of commercial and residential real estate and undeveloped land that compete or may compete with A&B for management and leasing revenues, land for development, properties for acquisition and disposition, and for tenants and purchasers for properties. Increased vacancies, decreased rents, sales prices or sales volume, or lack of development opportunities may lead to a deterioration in results from A&B's real estate businesses.

A&B may face potential difficulties in obtaining operating and development capital.

The successful execution of A&B's strategy requires substantial amounts of operating and development capital both initially and over time. Sources of such capital could include banks, life insurance companies, public and private offerings of debt or equity, including rights offerings, sale of certain assets and joint venture partners. If A&B's credit profile deteriorates significantly, its access to the debt capital markets or its ability to renew its committed lines of credit may become restricted, the cost to borrow may increase, or A&B may not be able to refinance debt at the same levels or on the same terms. Because A&B will rely on its ability to obtain and draw on a revolving credit facility to support its operations, any volatility in the credit and financial markets or deterioration in A&B's credit profile that prevents A&B from accessing funds could have an adverse effect on

A&B's financial condition and cash flows. There is no assurance that any capital will be available on terms acceptable to A&B or at all in order to satisfy A&B's short or long-term cash needs.

A&B may increase its debt level or raise additional capital in the future, which could affect its financial health and may decrease its profitability.

To execute its business strategy, A&B may require additional capital. If A&B incurs additional debt or raises equity through the issuance of preferred stock, the terms of the debt or preferred stock issued may give the holders rights, preferences and privileges senior to those of holders of A&B common stock, particularly in the event of liquidation. The terms of any new debt may also impose additional and more stringent restrictions on A&B's operations than currently in place. If A&B issues additional common equity, either through public or private offerings or rights offerings, your percentage ownership in A&B would decline if you do not participate on a ratable basis. If A&B is unable to raise additional capital when required, it could affect A&B's liquidity, financial condition, results of operations and cash flows.

Failure to comply with certain restrictive financial covenants contained in A&B's credit facilities could impose restrictions on A&B's business segments, capital availability, the ability to pursue other activities or otherwise adversely affect A&B.

A&B's credit facilities contain certain restrictive financial covenants. If A&B breaches any of the covenants and such breach is not cured timely or waived by the lenders, and results in default, A&B's access to credit may be limited or terminated and the lenders could declare any outstanding amounts immediately due and payable.

A rapid increase in interest rates may increase A&B's overall interest rate expense.

A rapid increase in interest rates could have an immediate adverse impact on A&B due to its outstanding floating-rate debt. In the event of an increase in interest rates, A&B may be unable to refinance maturing debt with new debt at equal or better interest rates.

A&B's significant operating agreements and leases could be replaced on less favorable terms or may not be replaced.

The significant operating agreements and leases of A&B in its various businesses expire at various points in the future and may not be replaced or could be replaced on less favorable terms, thereby adversely affecting A&B's future financial position, results of operations and cash flows.

An increase in fuel prices may adversely affect A&B's profits.

Fuel prices are a significant factor that has a direct impact on the health of the Hawaii economy. The price and supply of fuel are unpredictable and fluctuate based on events beyond A&B's control. Increases in the price of fuel may result in higher transportation costs to Hawaii and adversely affect visitor counts and the cost to ship goods into Hawaii, thereby affecting the strength of the Hawaii economy and its consumers. Increases in fuel costs also can lead to other direct expense increases to A&B through, for example, increased costs of energy and petroleum-based raw materials. Increases in energy costs for A&B's leased real estate portfolio are typically recovered from lessees, although A&B's share of energy costs increases as a result of lower occupancies, and higher operating cost reimbursements impact the ability to increase underlying rents. Rising fuel prices also may increase the cost of construction, including delivery costs to Hawaii, and the cost of materials that are petroleum-based, thus affecting A&B's real estate development projects. Finally, rising fuel prices will impact the cost of producing and transporting sugar.

Noncompliance with, or changes to, federal, state or local law or regulations, including passage of climate change legislation or regulation, may adversely affect A&B's business.

A&B is subject to federal, state and local laws and regulations, including government rate regulations, land use regulations, tax regulations and federal government administration of the U.S. sugar program. Noncompliance with, or changes to, the laws and regulations governing A&B's business could impose significant additional costs on A&B and adversely affect A&B's financial condition and results of operations. For example, the real estate segments are subject to numerous federal, state and local laws and regulations, which, if changed, or not complied with may adversely affect A&B's business. The Agribusiness segment is subject to the federal government's administration of the U.S. sugar program, such as the 2008 Farm Bill, and the Hawaii Public Utilities Commission's regulation of agreements between A&B and Hawaii's utilities regarding the sale of electric power. Further changes to these laws and regulations could adversely affect A&B. Climate change legislation, such as limiting and reducing greenhouse gas emissions through a "cap and trade" system of allowances and credits, if enacted, may have an adverse effect on A&B's business.

Work stoppages or other labor disruptions by the unionized employees of A&B or other companies in related industries may adversely affect A&B's operations.

As of December 31, 2012, A&B had 946 regular full-time employees, of which approximately 73 percent were covered by collective bargaining agreements with unions. A&B's Real Estate and Agribusiness segments may be adversely affected by actions taken by employees of A&B or other companies in related industries against efforts by management to control labor costs, restrain wage or benefits increases or modify work practices. Strikes and disruptions may occur as a result of the failure of A&B or other companies in its industry to negotiate collective bargaining agreements with such unions successfully. For example, in its Real Estate Sales segment, A&B may be unable to complete construction of its projects if building materials or labor are unavailable due to labor disruptions in the relevant trade groups.

The loss of or damage to key vendor and customer relationships may adversely affect A&B's business.

A&B's business is dependent on its relationships with key vendors, customers and tenants. For example, in A&B's Agribusiness segment, HC&S's relationship with C&H Sugar Company, Inc., the primary buyer of HC&S's raw sugar, is critical. The loss of or damage to any of these key relationships may affect A&B's business adversely.

Interruption or failure of A&B's information technology and communications systems could impair A&B's ability to operate and adversely affect its business.

A&B is highly dependent on information technology systems. All information technology and communication systems are subject to reliability issues, integration and compatibility concerns, and security-threatening intrusions. A&B may experience failures caused by the occurrence of a natural disaster, or other unanticipated problems at A&B's facilities. Any failure of A&B's systems could result in interruptions in its service or production, reductions in its revenue and profits and damage to its reputation.

A&B is susceptible to weather and natural disasters.

A&B's real estate operations are vulnerable to natural disasters, such as hurricanes, earthquakes, tsunamis, floods, fires, tornados and unusually heavy or prolonged rain, which could damage its real estate holdings and which could result in substantial repair or replacement costs to the extent not covered by insurance, a reduction in property values, or a loss of revenue, and could have an adverse effect on its ability to develop, lease and sell properties. The occurrence of natural disasters could also cause increases in property insurance rates and deductibles, which could reduce demand for, or increase the cost of owning or developing, A&B's properties.

For the Agribusiness segment, drought, greater than normal rainfall, hurricanes, low-wind conditions, earthquakes, tsunamis, floods, fires, other natural disasters or agricultural pestilence may have an adverse effect on the sugar planting, harvesting and production, electricity generation and sales, and the Agribusiness segment's facilities, including dams and reservoirs.

A&B maintains casualty insurance under policies it believes to be adequate and appropriate. These policies are generally subject to large retentions and deductibles. Some types of losses, such as losses resulting from physical damage to dams or crop damage, generally are not insured. In some cases A&B retains the entire risk of loss because it is not economically prudent to purchase insurance coverage or because of the perceived remoteness of the risk. Other risks are uninsured because insurance coverage may not be commercially available. Finally, A&B retains all risk of loss that exceeds the limits of its insurance.

Heightened security measures, war, actual or threatened terrorist attacks, efforts to combat terrorism and other acts of violence may adversely impact A&B's operations and profitability.

War, terrorist attacks and other acts of violence may cause consumer confidence and spending to decrease, or may affect the ability or willingness of tourists to travel to Hawaii, thereby adversely affecting Hawaii's economy and A&B. Additionally, future terrorist attacks could increase the volatility in the U.S. and worldwide financial markets.

Loss of A&B's key personnel could adversely affect its business.

A&B's future success will depend, in significant part, upon the continued services of its key personnel, including its senior management and skilled employees. The loss of the services of key personnel could adversely affect its future operating results because of such employee's experience and knowledge of its business and customer relationships. If key employees depart, A&B may have to incur significant costs to replace them, and A&B's ability to execute its business model could be impaired if it cannot replace them in a timely manner. A&B does not expect to maintain key person insurance on any of its key personnel.

A&B is subject to, and may in the future be subject to, disputes, legal or other proceedings, or government inquiries or investigations, that could have an adverse effect on A&B.

The nature of A&B's business exposes it to the potential for disputes, legal or other proceedings, or government inquiries or investigations, relating to labor and employment matters, personal injury and property damage, environmental matters, construction litigation, and other matters, as discussed in the other risk factors disclosed in this section. These disputes, individually or collectively, could harm A&B's business by distracting its management from the operation of its business. If these disputes develop into proceedings, these proceedings, individually or collectively, could involve or result in significant expenditures or losses by A&B, which could have an adverse effect on A&B's future operating results, including profitability, cash flows, and financial condition. For more information, see Item 3 entitled "Legal Proceedings." As a real estate developer, A&B may face warranty and construction defect claims, as described below under "—Risks Related to A&B's Real Estate Segments."

Changes in the value of pension assets, or a change in pension law or key assumptions, may adversely affect A&B's financial performance.

The amount of A&B's employee pension and postretirement benefit costs and obligations are calculated on assumptions used in the relevant actuarial calculations. Adverse changes in any of these assumptions due to economic or other factors, changes in discount rates, higher health care costs, or lower actual or expected returns on plan assets, may adversely affect A&B's operating results, cash flows, and financial condition. In addition, a change in federal law, including changes to the Employee Retirement Income Security Act and Pension Benefit Guaranty Corporation premiums, may adversely affect A&B's single-employer pension plans and plan funding. These factors, as well as a decline in the fair value of pension plan assets, may put upward pressure on the cost of providing pension and medical benefits and may increase future pension expense and required funding contributions. Although A&B has actively sought to control increases in these costs, there can be no assurance that it will be successful in limiting future cost and expense increases, and continued upward pressure in costs and expenses could further reduce the profitability of A&B's businesses.

Risks Relating to A&B's Real Estate Segments

A&B is subject to risks associated with real estate construction and development.

A&B's development projects are subject to risks relating to A&B's ability to complete its projects on time and on budget. Factors that may result in a development project exceeding budget or being prevented from completion include, but are not limited to:

- an inability of A&B or buyers to secure sufficient financing or insurance on favorable terms, or at all;
- construction delays, defects, or cost overruns, which may increase project development costs;
- an increase in commodity or construction costs, including labor costs;
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues;
- an inability to obtain, or significant delay in obtaining, zoning, construction, occupancy and other required governmental permits and authorizations;
- difficulty in complying with local, city, county and state rules and regulations regarding permitting, zoning, subdivision, utilities, affordable housing, and water quality as well as federal rules and regulations regarding air and water quality and protection of endangered species and their habitats;
- an inability to have access to sufficient and reliable sources of water or to secure water service or meters for its projects;
- an inability to secure tenants or buyers necessary to support the project or maintain compliance with debt covenants;
- failure to achieve or sustain anticipated occupancy or sales levels;
- buyer defaults, including defaults under executed or binding contracts;
- condemnation of all or parts of development or operating properties, which could adversely affect the value or viability of such projects; and
- an inability to sell A&B's constructed inventory.

Any of these risks has the potential to adversely affect A&B's operating results.

The reduction in availability of mortgage financing may adversely affect A&B's real estate business.

As a result of the financial crisis of 2008 - 2009, the financial industry experienced significant instability due to, among other things, declining property values and increasing defaults on loans. This led to tightened credit requirements, reduced liquidity and increased credit risk premiums for virtually all borrowers. Fewer loan products and strict loan qualifications make it more difficult for borrowers to finance the purchase of units in A&B's projects. Additionally, the stringent requirements to obtain financing for buyers of commercial properties make it significantly more difficult for A&B to sell commercial properties and may negatively impact the sales prices and other terms of such sales.

The stringent credit environment may also impact A&B in other ways, including the credit or solvency of customers, vendors, tenants, or joint venture partners, and the ability of partners to fund their financial obligations to joint ventures.

A decline in leasing rental income could adversely affect A&B.

A&B owns a portfolio of commercial income properties. Factors that may adversely affect the portfolio's profitability include, but are not limited to:

- a significant number of A&B's tenants are unable to meet their obligations;
- increases in non-recoverable operating and ownership costs;
- A&B is unable to lease space at its properties when the space becomes available;
- the rental rates upon a renewal or a new lease are significantly lower than prior rents or do not increase sufficiently to cover increases in operating and ownership costs;
- the providing of lease concessions, such as free or discounted rents and tenant improvement allowances; and
- the discovery of hazardous or toxic substances, or other environmental, culturally-sensitive, or related issues at the property.

The bankruptcy of key tenants may adversely affect A&B's revenues and profitability.

A&B may derive significant revenues and earnings from certain key tenants. If one or more of these tenants declare bankruptcy or voluntarily vacates from the leased premise and A&B is unable to re-lease such space or to re-lease it on comparable or more favorable terms, A&B's liquidity, financial position, results of operations and cash flows may be adversely impacted. Additionally, A&B's results of operations may be further adversely impacted by an impairment or "write-down" of intangible assets, such as lease-in-place value or a deferred asset related to straight-line lease rent, associated with a tenant bankruptcy or vacancy.

Governmental entities have adopted or may adopt regulatory requirements that may restrict A&B's development activity.

A&B is subject to extensive and complex laws and regulations that affect the land development process, including laws and regulations related to zoning and permitted land uses. Government entities have adopted or may approve regulations or laws that could negatively impact the availability of land and development opportunities within those areas. It is possible that increasingly stringent requirements will be imposed on developers in the future that could adversely affect A&B's ability to develop projects in the affected markets or could require that A&B satisfy additional administrative and regulatory requirements, which could delay development progress or increase the development costs to A&B. Any such delays or costs could have an adverse effect on A&B's revenues, earnings and cash flows.

Real estate development projects are subject to warranty and construction defect claims in the ordinary course of business that can be significant.

As a developer, A&B is subject to warranty and construction defect claims arising in the ordinary course of business. The amounts payable under these claims, both in legal fees and remedying any construction defects, can be significant and exceed the profits made from the project. As a consequence, A&B may maintain liability insurance, obtain indemnities and certificates of insurance from contractors generally covering claims related to workmanship and materials, and create warranty and other reserves for projects based on historical experience and qualitative risks associated with the type of project built. Because of the uncertainties inherent to these matters, A&B cannot provide any assurance that its insurance coverage, contractor arrangements and reserves will be adequate to address some or all of A&B's warranty and construction defect claims in the future. For example, contractual indemnities may be difficult to enforce, A&B may be responsible for applicable self-insured retentions, and certain claims may not be covered by insurance or may exceed applicable coverage limits. Additionally, the coverage offered and the availability of liability insurance for construction defects could be limited or costly. Accordingly, A&B cannot provide any assurance that such coverage will be adequate, available at an acceptable cost, or available at all.

A&B is involved in joint ventures and is subject to risks associated with joint venture relationships.

A&B is involved in joint venture relationships, and may initiate future joint venture projects. A joint venture involves certain risks such as, among others:

- A&B may not have voting control over the joint venture;
- A&B may not be able to maintain good relationships with its venture partners;
- the venture partner at any time may have economic or business interests that are inconsistent with A&B's economic or business interests;
- the venture partner may fail to fund its share of capital for operations and development activities, or to fulfill its other commitments, including providing accurate and timely accounting and financial information to A&B;
- the joint venture or venture partner could lose key personnel; and
- the venture partner could become insolvent, requiring A&B to assume all risks and capital requirements related to the joint venture project, and any resulting bankruptcy proceedings could have an adverse impact on the operation of the project or the joint venture.

In connection with its real estate joint ventures, A&B may be asked to guarantee completion of a joint venture's construction and development of a project, to guarantee joint venture indebtedness, or to indemnify a third party serving as surety for a joint venture's bonds for such completion. If A&B were to agree to become obligated to perform under such arrangements, A&B may be adversely affected.

A&B's financial results are significantly influenced by the economic growth and strength of Hawaii.

Virtually all of A&B's real estate development activity is conducted in Hawaii. Consequently, the growth and strength of Hawaii's economy has a significant impact on the demand for A&B's real estate development projects. As a result, any adverse change to the growth or health of Hawaii's economy could adversely affect A&B's financial condition and results of operations.

The value of A&B's development projects and its commercial properties are affected by a number of factors.

The Company has significant investments in various commercial real estate properties, development projects, and joint venture investments. For example, the Company has invested more than $250 million in its Kukui'ula joint venture, including the value of the land. Further weakness in the real estate sector, difficulty in obtaining or renewing project-level financing, and changes in A&B's investment and development strategy, among other factors, may affect the fair value of these real estate assets owned by A&B or by its joint ventures. If the fair value of A&B's joint venture development projects were to decline below the carrying value of those assets, and that decline was other-than-temporary, A&B would be required to recognize an impairment loss. Additionally, if the undiscounted cash flows of its commercial properties or development projects were to decline below the carrying value of those assets, A&B would be required to recognize an impairment loss if the fair value of those assets were below their carrying value. Such impairment losses would have an adverse effect on A&B's financial position and results of operations.

Risks Relating to A&B's Agribusiness Segment

The lack of water for agricultural irrigation could adversely affect A&B.

It is crucial for A&B's Agribusiness segment to have access to reliable sources of water for the irrigation of sugar cane. As further described in "Legal Proceedings," there are regulatory and legal challenges to A&B's ability to divert water from streams in Maui. In addition, A&B's access to water is subject to weather patterns that cannot be reliably predicted. If A&B is limited in its ability to divert stream waters for its use or there is insufficient rainfall on an extended basis, it would have an adverse effect on A&B's sugar operations, including possible cessation of operations, and energy production.

Low raw sugar prices will adversely affect A&B's business.

The business and results of operations of A&B's Agribusiness segment are substantially affected by market factors, particularly the domestic prices for raw cane sugar. These market factors are influenced by a variety of forces, including prices of competing crops and suppliers, weather conditions, and United States farm and trade policies. A&B has forward priced approximately 78 percent of its 2013 crop at favorable levels. However, sugar prices have since declined below 25 cents a pound. If the price for sugar does not recover before A&B is required to price its remaining sugar deliveries in the medium- to long-term, A&B's Agribusiness segment would be adversely affected, including possible cessation of operations.

A&B is subject to risks associated with raw sugar production.

A&B's production of raw sugar is subject to numerous risks that could adversely affect the volume and quality of sugar produced. Any of these risks has the potential to adversely affect A&B's sugar operations, including possible cessation of operations. These risks include, but are not limited to:

- equipment accidents or failures in the factory or the power plant, particularly where equipment is old and difficult to repair or replace;
- government restrictions on farming practices, including cane burning;
- loss of A&B's major customer;
- weather and natural disasters;
- increases in costs, including, but not limited to fuel, fertilizer, herbicide, and drip tubing;
- labor, including labor availability (see risk factor above regarding labor disruptions) and loss of qualified personnel;
- lack of demand for A&B's production;
- disease;
- uncontrolled fires, including arson;
- and weed control.

A&B's power sales contracts could be replaced on less favorable terms or may not be replaced.

A&B's power sales contracts expire at various points in the future and may not be replaced or could be replaced on less favorable terms, which could adversely affect A&B's agribusiness operations. Recently, the State of Hawaii has approved power sales contracts with third parties that use a fixed price, rather than an avoided cost formula. Such a change in A&B's power sales contracts may adversely affect power revenue and provide less protection against internal power generation costs in a rising oil price market.

The market for power sales in Hawaii is limited.

The power distribution systems in Hawaii are small and island-specific; currently, there is no ability to move power generated on one island to any other island. In addition, Hawaii law limits the ability of independent power producers, such as A&B's agribusiness operations, to sell their output to firms other than the respective utilities on each island, without themselves becoming utilities and subject to the State's Public Utilities Commission (PUC) regulation. Further, any sales of electricity by A&B to the utilities on each island are subject to the approval of the PUC. Unlike some areas in the Mainland, Hawaii's independent power producers have no ability to use utility infrastructure to transfer power to other locations.

A&B has limited options for carriage of sugar to domestic markets.

In order to directly ship bulk or partially processed food-grade sugar from Maui to markets on the U.S. West coast, or any alternate U.S. domestic port, A&B must utilize vessels that are subject to the restrictions delineated in Section 27 of the Merchant Marine Act, 1920, commonly referred to as the Jones Act. A&B currently owns a bulk sugar transportation vessel, the MV Moku Pahu, and therefore, A&B itself is also subject to the restrictions of the Jones Act. Under the Jones Act, all vessels transporting cargo between covered U.S. ports must, subject to limited exceptions, be built in the U.S., registered under the U.S. flag, manned by predominantly U.S. crews, and owned and operated by U.S.-organized companies that are controlled and 75 percent owned by U.S. citizens. U.S.-flagged vessels are generally required to be maintained at higher standards than foreign-flagged vessels and are supervised by, as well as subject to rigorous inspections by, or on behalf of, the U.S. Coast Guard, which requires appropriate certifications and background checks of the crew members. Because of these restrictions, A&B would have limited options for carriage of sugar to domestic markets if the MV Moku Pahu no longer qualified under the Jones Act or were taken out of service due to its age.

Risks Relating to the Separation

If the Separation were to fail to qualify as tax-free for U.S. federal income tax purposes, then A&B, Matson and the shareholders who received their shares of A&B common stock in the Separation could be subject to significant tax liability or tax indemnity obligations.

Matson received a private letter ruling from the IRS (which we refer to as the IRS Ruling) that, for U.S. federal income tax purposes, (i) certain transactions to be effected in connection with the Separation qualify as a reorganization under Sections 355 and/or 368 of the Internal Revenue Code of 1986, as amended (which we refer to as the Code), or as a complete liquidation under Section 332(a) of the Code and (ii) the Separation qualifies as a transaction under Section 355 of the Code. In addition to obtaining the IRS Ruling, Matson received a tax opinion (which we refer to as the Tax Opinion) from the law firm of Skadden, Arps, Slate, Meagher & Flom LLP (which Tax Opinion relies on the effectiveness of the IRS Ruling) substantially to the effect that, for U.S. federal income tax purposes, the Separation and certain related transactions qualify as a reorganization under Section 368 of the Code. The IRS Ruling and Tax Opinion rely on certain facts and assumptions, and certain representations from A&B and Matson regarding the past and future conduct of their respective businesses and other matters. Notwithstanding the IRS Ruling and Tax Opinion, the IRS could determine on audit that the Separation and related transactions should be treated as a taxable transaction if it determines that any of these facts, assumptions, representations or undertakings is not correct or has been violated, or that the Separation and related transactions should be taxable for other reasons, including as a result of a significant change in stock or asset ownership after the Separation or if the IRS were to disagree with the conclusions in the Tax Opinion that are not covered by the IRS Ruling. If the Separation and related transactions ultimately were determined to be taxable, the distribution of our stock in the Separation could be treated as taxable for U.S. federal income tax purposes to the shareholders who received their shares of A&B common stock in the Separation, and such shareholders could incur significant U.S. federal income tax liabilities. In addition, Matson would recognize gain in an amount equal to the excess of the fair market value of the shares of A&B common stock distributed to Matson's shareholders on the Separation date over Matson tax basis in such shares.

In addition, under the terms of the Tax Sharing Agreement that A&B entered into with Matson, A&B also generally is responsible for any taxes imposed on Matson that arise from the failure of the Separation and certain related transactions to qualify as tax-free for U.S. federal income tax purposes within the meaning of Sections 355 and 368 of the Code, to the extent such failure to qualify is attributable to actions, events or transactions relating to A&B's stock, assets or business, or a breach of the relevant representations or covenants made by A&B and its subsidiaries in the Tax Sharing Agreement, the materials submitted to the IRS in connection with the request for the IRS Ruling or the representation letter provided to counsel in connection with the Tax Opinion. The amounts of any such taxes could be significant.

A&B is subject to continuing contingent liabilities of Matson following the Separation.

After the Separation, there are several significant areas where the liabilities of Matson may become A&B's obligations. For example, under the Code and the related rules and regulations, each corporation that was a member of the Matson consolidated tax reporting group during any taxable period or portion of any taxable period ending on or before the effective time of the Separation is severally liable for the U.S. federal income tax liability of the entire Matson consolidated tax reporting group for such taxable period. In connection with the Separation and related transactions, A&B entered into a Tax Sharing Agreement with Matson that allocates the responsibility for prior period taxes of the Matson consolidated tax reporting group between A&B and Matson. If Matson were unable to pay any prior period taxes for which it is responsible, however, A&B could be required to pay the entire amount of such taxes, and such amounts could be significant. Other provisions of U.S. federal, state, local, or foreign law may establish similar liability for other matters, including laws governing tax-qualified pension plans as well as other contingent liabilities.

A&B might not be able to engage in desirable strategic transactions and equity issuances following the Separation because of certain restrictions relating to requirements for tax-free distributions.

A&B's ability to engage in significant equity transactions could be limited or restricted after the Separation in order to preserve, for U.S. federal income tax purposes, the tax-free nature of the Separation to Matson. Even if the Separation otherwise qualifies for tax-free treatment under Section 355 of the Code, the Separation may result in corporate-level taxable gain to Matson under Section 355(e) of the Code if 50% or more, by vote or value, of the shares of A&B's stock or Matson's stock are treated as acquired or issued as part of a plan or series of related transactions that includes the Separation . The process for determining whether an acquisition or issuance triggering these provisions has occurred is complex, inherently factual and subject to interpretation of the facts and circumstances of a particular case. Any acquisitions or issuances of A&B's stock or Matson's stock within two years after the Separation generally are presumed to be part of such a plan, although A&B or Matson, as applicable, may be able to rebut that presumption.

To preserve the tax-free treatment of the Separation to Matson, under the Tax Sharing Agreement that A&B entered into with Matson, A&B may be prohibited from taking or failing to take certain actions that could prevent the Separation or certain related transactions from being tax-free under the Code. Further, for the two-year period following the Separation, A&B may be prohibited from:

- issuing equity securities to satisfy financing needs if the equity securities issued would represent a 50% or greater interest in A&B;
- acquiring businesses or assets with equity securities if the equity securities issued would represent a 50% or greater interest in A&B; or
- engaging in mergers or asset transfers that could jeopardize the tax-free status of the Separation or certain related transactions.

These restrictions may limit our ability to pursue strategic transactions or engage in new business or other transactions that may maximize the value of our business.

A court could require that we assume responsibility for obligations allocated to Matson under the Separation and Distribution Agreement.

Under the Separation and Distribution Agreement entered into with Matson, we and Matson are each responsible for the debts, liabilities and other obligations related to the businesses which each company owns and operates following the consummation of the Separation. A court, however, could disregard the allocation agreed to between the parties in the Separation and Distribution Agreement, and require that we assume responsibility for obligations allocated to Matson, particularly if Matson were to refuse or were unable to pay or perform the allocated obligations.

Potential indemnification liabilities to Matson pursuant to the Separation and Distribution Agreement could materially adversely affect our company.

Among other things, the Separation and Distribution Agreement provides for indemnification obligations designed to make our company financially responsible for substantially all liabilities that may exist relating to our business activities, whether incurred prior to or after the Separation. If we are required to indemnify Matson under the circumstances set forth in the Separation and Distribution Agreement, we may be subject to substantial liabilities.

In connection with the Separation, Matson is required to indemnify us for certain liabilities. However, there can be no assurance that the indemnity will be sufficient to insure us against the full amount of such liabilities, or that Matson's ability to satisfy its indemnification obligation will not be impaired in the future.

Pursuant to the Separation and Distribution Agreement, Matson is required to indemnify us for substantially all liabilities that may exist relating to Matson's business activities, whether incurred prior to or after the Separation. However, third parties could seek to hold us responsible for any of the liabilities that Matson agrees to retain, and there can be no assurance that the indemnity from Matson will be sufficient to protect us against the full amount of such liabilities, or that Matson will be able to fully satisfy its indemnification obligations. Moreover, even if we ultimately succeed in recovering from Matson any amounts for which we are held liable, we may be temporarily required to bear these losses.

The Separation may expose us to potential liabilities arising out of state and federal fraudulent conveyance laws.

The Separation is subject to review under various state and federal fraudulent conveyance laws. Fraudulent conveyance laws generally provide that an entity engages in a constructive fraudulent conveyance when (i) the entity transfers assets and does not receive fair consideration or reasonably equivalent value in return and (ii) the entity (a) is insolvent at the time of the transfer or is rendered insolvent by the transfer, (b) has unreasonably small capital with which to carry on its business or (c) intends to incur or believes it will incur debts beyond its ability to repay its debts as they mature. An unpaid creditor or an entity acting on behalf of a creditor (including without limitation a trustee or debtorin-possession in a bankruptcy by us or Matson or any of our respective subsidiaries) may bring a lawsuit alleging that the Separation or any of the related transactions constituted a constructive fraudulent conveyance. If a court accepts these allegations, it could impose a number of remedies, including without limitation, requiring our shareholders to return to Matson some or all of the shares of our common stock distributed in the distribution.

ITEM 1B. UNRESOLVED STAFF COMMENTS

None.

ITEM 3. LEGAL PROCEEDINGS

A&B owns 16,000 acres of watershed lands in East Maui that supply a significant portion of the irrigation water used by Hawaiian Commercial & Sugar Company ("HC&S"), a division of A&B that produces raw sugar. A&B also held four water licenses to another 30,000 acres owned by the State of Hawaii in East Maui which, over the last ten years, have supplied approximately 58 percent of the irrigation water used by HC&S. The last of these water license agreements expired in 1986, and all four agreements were then extended as revocable permits that were renewed annually. In 2001, a request was made to the State Board of Land and Natural Resources (the "BLNR") to replace these revocable permits with a long-term water lease. Pending the conclusion by the BLNR of this contested case hearing on the request for the long-term lease, the BLNR has renewed the existing permits on a holdover basis. If the Company is not permitted to utilize sufficient quantities of stream waters from State lands in East Maui, it could have a material adverse effect on the Company's sugar-growing operations.

In addition, on May 24, 2001, petitions were filed by a third party, requesting that the Commission on Water Resource Management of the State of Hawaii ("Water Commission") establish interim instream flow standards ("IIFS") in 27 East Maui streams that feed the Company's irrigation system. On September 25, 2008, the Water Commission took action on eight of the petitions, resulting in some quantity of water being returned to the streams rather than being utilized for irrigation purposes. In May 2010, the Water Commission took action on the remaining 19 petitions resulting in additional water being returned to the streams. A petition requesting a contested case hearing to challenge the Water Commission's decisions was filed with the Commission by the opposing third party. On October 18, 2010, the Water Commission denied the petitioner's request for a contested case hearing. On November 17, 2010, the petitioner filed an appeal of the Water Commission's denial to the Hawaii Intermediate Court of Appeals. On August 31, 2011, the Intermediate Court of Appeals dismissed the petitioner's appeal. On November 29, 2011, the petitioner appealed the Intermediate Court of Appeals' dismissal to the Hawaii Supreme Court. On January 11, 2012, the Hawaii Supreme Court vacated the Intermediate Court of Appeals' dismissal of the petitioner's appeal and remanded the appeal back to the Intermediate Court of Appeals. On November 30, 2012, the Intermediate Court of Appeals remanded the case back to the Water Commission, ordering the Commission to grant the petitioner's request for a contested case hearing.

On June 25, 2004, two organizations filed a petition with the Water Commission to establish IIFS for four streams in West Maui to increase the amount of water to be returned to these streams. The West Maui irrigation system provided approximately 15 percent of the irrigation water used by HC&S over the last ten years. The Water Commission issued a decision in June 2010, which required the return of water in two of the four streams. In July 2010, the two organizations appealed the Water Commission's decision to the Hawaii Intermediate Court of Appeals. On June 23, 2011, the case was transferred to the Hawaii Supreme Court. On August 15, 2012, the Hawaii Supreme Court overturned the Water Commission's decision and remanded the case to the Water Commission for further consideration in connection with the establishment of the IIFS.

The loss of East Maui and West Maui water as a result of the Water Commission's decisions imposes challenges to the Company's sugar growing operations. While the resulting water loss does not immediately threaten near-term sugar production, it will result in a future suppression of sugar yields and will have an impact on the Company that will only be quantifiable over time. Accordingly, the Company is unable to predict, at this time, the outcome or financial impact of the water proceedings.

In March 2011, the Environmental Protection Agency ("EPA") published nationwide standards for controlling hazardous air pollutant emissions from industrial, commercial, institutional boilers and process heaters (the "Boiler MACT" rule), which would apply to HC&S's three boilers at the Puunene Sugar Mill. The EPA subsequently reconsidered the March 2011 rule, and on December 21, 2012, EPA announced that it had finalized a revised Boiler MACT rule; the final rule was published in the Federal Register on January 31, 2013. The effective date of the rule is April 1, 2013, with compliance required by April 1, 2016.

The Company is currently evaluating the final rule and assessing its compliance options. Based on a preliminary review, EPA has made significant revisions from the March 2011 final rule addressing two of industry's primary concerns: technical achievability and compliance time. As a result, the Puunene Mill boilers are capable of meeting most of the emissions limits specified in the final rule and will not require expensive upgrades to the existing particulate matter controls. However, the boilers are not currently able to consistently meet new limits on carbon monoxide emissions during bagasse firing. This is due in large part to the highly variable nature of bagasse fuel. As a result, at minimum improvements to combustion controls and monitoring will be required on all three boilers.

The Company has begun the process of assessing current carbon monoxide emissions during bagasse firing, and will need to complete an engineering evaluation in order to develop a plan for coming into compliance with the new rule. The compliance deadline for this rule will be three years from the date of publication of the final rule in the Federal Register (i.e., April 1, 2016), with the option for states to grant a one-year extension. A rough estimate of anticipated compliance costs based on currently available information is in the range of $1 to $5 million. This estimate will be refined as the engineering evaluation proceeds.

In June 2011, the Equal Employment Opportunity Commission ("EEOC") served McBryde Resources, Inc., formerly known as Kauai Coffee Company, Inc. ("McBryde Resources") with a lawsuit, which alleged that McBryde Resources and five other farms were complicit in illegal acts by Global Horizons Inc., a company that had hired Thai workers for the farms. The lawsuit was filed in the U.S. District Court for the District of Hawaii. In July 2011, the EEOC amended the lawsuit to name Alexander & Baldwin, LLC (formerly known as Alexander & Baldwin, Inc.), a wholly-owned subsidiary of the Company, as a defendant. After motions to dismiss the complaint, and amended complaints, certain claims against the defendants remain and McBryde Resources and Alexander & Baldwin, LLC are defending the lawsuit. Discovery is ongoing. The Company is unable to predict, at this time, the outcome or financial impact, if any, of the lawsuit.

A&B and its subsidiaries are parties to, or may be contingently liable in connection with, other legal actions arising in the normal conduct of its businesses, the outcomes of which, in the opinion of management after consultation with counsel, would not have a material effect on A&B's consolidated financial statements as a whole.

ITEM 4. MINE SAFETY DISCLOSURES

Not Applicable.

ITEM 6. SELECTED FINANCIAL DATA

The following should be read in conjunction with Item 8, "Financial Statements and Supplementary Data," and Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations" (dollars and shares in millions, except shareholders of record and per-share amounts):

	2012	2011	2010	2009	2008
Revenue:					
Real Estate:					
Leasing	$ **100.6**	$ 99.7	$ 93.8	$ 102.5	$ 107.0
Development and Sales	**32.2**	59.8	131.0	125.5	350.0
Less amounts reported in discontinued operations[1]	**(10.1)**	(49.3)	(128.6)	(137.0)	(164.7)
Agribusiness[2]	**182.3**	157.5	165.6	99.6	121.6
Reconciling Items[3]	**(8.3)**	—	—	—	—
Total Revenue	$ **296.7**	$ 267.7	$ 261.8	190.5	$ 413.9
Operating Profit:					
Real Estate:					
Leasing	$ **41.6**	$ 39.3	$ 35.3	$ 43.2	$ 47.8
Development and Sales[4]	**(4.4)**	15.5	50.1	39.1	95.6
Less amounts reported in discontinued operations[1]	**(4.7)**	(24.8)	(55.5)	(59.5)	(77.2)
Agribusiness[2]	**20.8**	22.2	6.1	(27.8)	(12.9)
Total operating profit (loss)	**53.3**	52.2	36.0	(5.0)	53.3
Interest expense, net	**(14.9)**	(17.1)	(17.3)	(17.0)	(12.5)
General corporate expenses	**(15.1)**	(19.9)	(22.7)	(21.0)	(20.5)
Separation costs	**(6.8)**	—	—	—	—
Income (loss) from continuing operations before income taxes	**16.5**	15.2	(4.0)	(43.0)	20.3
Income tax expense (benefit)	**(1.2)**	6.6	(1.7)	(17.2)	8.1
Income (loss) from continuing operations	**17.7**	8.6	(2.3)	(25.8)	12.2
Income from discontinued operations	**2.8**	14.9	35.4	36.7	47.7
Net Income	$ **20.5**	$ 23.5	$ 33.1	$ 10.9	$ 59.9

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes a $4.9 million gain in 2010 related to an agriculture disaster relief payment for drought experienced in prior years and a $5.4 million gain recorded upon consolidation of HS&TC in 2009.

[3] Represents the sale of a 286-acre agricultural parcel in the third quarter of 2012 classified as "Gain on sale of agricultural parcel" in the consolidated statements of income, but reflected as revenue for segment reporting purposes.

[4] The Real Estate Development and Sales segment includes approximately $(8.3) million, ($7.9) million, $2.0 million, and $9.0 million in equity in (loss) earnings from its various real estate joint ventures for 2012, 2011, 2010, and 2008, respectively. Equity in earnings from joint ventures in 2009 was negligible. Included in operating profit are noncash impairment and equity losses of $9.8 million (Bakersfield joint venture and Santa Barbara real estate project) in 2012 and $6.4 million (Waiawa real estate joint venture) in 2011.

SELECTED FINANCIAL DATA (CONTINUED)

	2012	2011	2010	2009	2008
Identifiable Assets:					
Real Estate:					
Leasing	$ 771.3	$ 772.0	$ 761.3	$ 686.9	$ 621.2
Development and Sales[5]	504.8	451.5	420.3	349.0	347.4
Agribusiness	149.9	157.8	153.3	169.6	196.2
Other	11.3	5.3	6.6	30.2	10.8
Total assets	$ 1,437.3	$ 1,386.6	$ 1,341.5	$ 1,235.7	$ 1,175.6
Capital Expenditures:					
Real Estate:					
Leasing[6]	$ 23.1	43.6	$ 164.7	$ 108.8	$ 100.2
Development and Sales[7]	—	5.2	0.1	0.1	0.6
Agribusiness[8]	31.7	10.5	6.8	3.4	15.2
Other	—	—	0.3	0.3	2.7
Total capital expenditures[9]	$ 54.8	$ 59.3	$ 171.9	$ 112.6	$ 118.7
Depreciation and Amortization:					
Real Estate:					
Leasing[1]	$ 22.0	$ 21.6	$ 20.3	$ 19.5	$ 17.9
Development and Sales	0.2	0.2	0.2	0.3	0.2
Agribusiness	11.6	11.9	12.7	11.9	11.5
Other	1.3	1.1	2.0	3.1	3.2
Total depreciation and amortization	$ 35.1	$ 34.8	$ 35.2	$ 34.8	$ 32.8

[5] The Real Estate Development and Sales segment includes approximately $319.7 million, $290.1 million, $274.8 million, $193.3 million, and $162.1 million related to its investment in various real estate joint ventures as of December 31, 2012, 2011, 2010, 2009, and 2008, respectively.

[6] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows

[7] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows and excludes investment in joint ventures classified as Cash Flows from Investing Activities. Operating cash flows for expenditures related to real estate developments were $37.2 million, $13.8 million, $21.6 million, $6.2 million, and $38.8 million for 2012, 2011, 2010, 2009, and 2008, respectively. Investments in joint ventures were $17.4 million, $27.9 million, $100.5 million, $46.4 million and $40.6 million in 2012, 2011, 2010, 2009, and 2008, respectively.

[8] Includes $21.8 million of capital related to the Company's Port Allen solar project before tax credits.

[9] Total capital expenditures for segment disclosure purposes includes tax-deferred property purchases of $9.4 million, $39.1 million, $148.4 million, $94.1 million and $46.1 million for the years ended 2012, 2011, 2010, 2009, and 2008, respectively, that are treated as non-cash transactions, and therefore, not included in Capital Expenditures for properties and developments on the Consolidated Statements of Cash Flows.

SELECTED FINANCIAL DATA (CONTINUED)

	2012	2011	2010	2009	2008
Earnings (loss) per share:[1]					
Basic:					
Continuing operations	**$ 0.41**	$ 0.20	$ (0.05)	$ (0.61)	$ 0.29
Discontinued operations	**0.07**	0.35	0.83	0.87	1.12
Basic earnings per share	**$ 0.48**	$ 0.55	$ 0.78	$ 0.26	$ 1.41
Diluted:					
Continuing operations	**$ 0.41**	$ 0.20	$ (0.05)	$ (0.61)	$ 0.29
Discontinued operations	**0.07**	0.35	0.83	0.87	1.12
Diluted earnings per share	**$ 0.48**	$ 0.55	$ 0.78	$ 0.26	$ 1.41
Balance sheet data (in millions):					
Investment in real estate and joint ventures	**$ 1,203.4**	$ 1,165.0	$ 1,123.8	$ 916.8	$ 841.2
Total assets	**1,437.3**	1,386.6	1,341.5	1,231.3	1,175.7
Total liabilities	**522.9**	660.8	652.9	584.5	562.2
Long-term debt – non-current	**220.0**	327.2	249.6	258.3	219.8
Shareholders' equity	**914.4**	725.8	688.6	646.8	613.5

1 The computation of basic and diluted earnings per common share for all periods prior to Separation is calculated using 42.4 million, the number of shares of A&B common stock outstanding on July 2, 2012, which was the first day of trading following the June 29, 2012 distribution of A&B common stock to Holdings shareholders, as if those shares were outstanding for those periods. For all periods prior to Separation, there were no dilutive shares because no actual A&B shares or share-based awards were outstanding prior to the Separation.

ITEM 7. MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS

FORWARD-LOOKING STATEMENTS AND RISK FACTORS

We have made or incorporated by reference forward-looking statements in this Form 10-K that are based on our management's beliefs and assumptions and on information currently available to our management. Forward-looking statements include the information concerning our possible or assumed future results of operations, business strategies, financing plans, competitive position, potential growth opportunities, potential operating performance improvements, the effects of competition and the effects of future legislation or regulations. Forward-looking statements include all statements that are not historical facts and can be identified by the use of forward-looking terminology such as the words "believe," "expect," "plan," "intend," "anticipate," "estimate," "predict," "potential," "continue," "may," "might," "should," "could" or the negative of these terms or similar expressions.

Forward-looking statements involve risks, uncertainties and assumptions. Actual results may differ materially from those expressed in these forward-looking statements. You should not put undue reliance on any forward-looking statements in this Form 10-K. We do not have any intention or obligation to update forward-looking statements after we file this Form 10-K.

The risk factors discussed in "Risk Factors" could cause our results to differ materially from those expressed in forward-looking statements. There may be other risks and uncertainties that we are unable to predict at this time or that we currently do not expect to have a material adverse effect on our financial position, results of operations or cash flows. Any such risks could cause our results to differ materially from those expressed in forward-looking statements.

Introduction

Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A") is a supplement to the accompanying consolidated financial statements and provides additional information about A&B's business, recent developments, financial condition, liquidity and capital resources, cash flows, results of operations and how certain accounting principles, policies and estimates affect A&B's financial statements. MD&A is organized as follows:

- *Basis of Presentation:* This section provides a discussion of the basis on which A&B's consolidated financial statements were prepared, including A&B's historical results of operations.
- *Business Overview:* This section provides a general description of A&B's business, as well as recent developments that A&B believes are important in understanding its results of operations and financial condition or in understanding anticipated future trends.
- *Critical Accounting Estimates:* This section identifies and summarizes those accounting policies that significantly impact A&B's reported results of operations and financial condition and require significant judgment or estimates on the part of management in their application.
- *Consolidated Results of Operations:* This section provides an analysis of A&B's results of operations for the three years ended December 31, 2012, 2011 and 2010.
- *Analysis of Operating Revenue and Profit by Segment:* This section provides an analysis of A&B's results of operations by business segment.
- *Liquidity and Capital Resources:* This section provides a discussion of A&B's financial condition and an analysis of A&B's cash flows for the years ended December 31, 2012, 2011, and 2010, as well as a discussion of A&B's ability to fund the its future commitments and ongoing operating activities through internal and external sources of capital.
- *Contractual Obligations, Commitments, Contingencies and Off-Balance-Sheet Arrangements:* This section provides a discussion of A&B's contractual obligations and other commitments and contingencies that existed at December 31, 2012.
- *Quantitative and Qualitative Disclosures about Market Risk:* This section discusses how A&B monitors and manages exposure to potential gains and losses associated with changes in interest rates.
- *Outlook:* This section provides a discussion of management's general outlook about its markets and A&B's competitive position.

Basis of Presentation

Prior to June 29, 2012, A&B's businesses included Matson Navigation, a wholly owned subsidiary, that provided ocean transportation, truck brokerage and intermodal services. As part of a strategic initiative designed to allow A&B to independently execute its strategies and to best enhance and maximize its earnings, growth prospects and shareholder value, A&B made a decision to separate the transportation businesses from the Hawaii real estate and agriculture businesses. In preparation for the separation, A&B modified its legal-entity structure and became a wholly owned subsidiary of Holdings. On June 29, 2012, Holdings distributed to its shareholders all of the shares of A&B stock in the Separation. Holders of Holdings common stock continued to own the transportation businesses, but also received one share of A&B common stock for each share of Holdings common stock held at the close of business on June 18, 2012, the record date. Following the Separation, Holdings changed its name to Matson, Inc. On July 2, 2012, A&B began regular trading on the New York Stock Exchange under the ticker symbol "ALEX" as an independent, public company.

The financial statements and related financial information pertaining to the periods preceding the Separation have been presented on a combined basis and reflect the financial position, results of operations and cash flows of the real estate and agriculture businesses and corporate functions of Alexander & Baldwin, Inc., all of which were under common ownership and common management prior to the Separation. The financial statements and related financial information pertaining to the period subsequent to the Separation have been presented on a consolidated basis. The financial statements for periods prior to the Separation included herein may not necessarily reflect A&B's results of operations, financial position and cash flows in the future or what its results of operations, financial position and cash flows would have been had A&B been a stand-alone company during the periods presented.

Business Overview

A&B, whose history dates back to 1870, is headquartered in Honolulu and operates in three segments in two industries—Real Estate and Agribusiness.

Real Estate

The Real Estate Industry consists of two segments, both of which have operations in Hawaii and on the Mainland. The Real Estate Development and Sales segment generates its revenues through the investment in and development and sale of land and commercial and residential properties. The Real Estate Leasing segment owns, operates, and manages retail, office, and industrial properties in Hawaii and on the Mainland. The Real Estate Leasing segment also leases land in Hawaii. Real estate activities are conducted through A&B Properties, Inc. and various other wholly owned subsidiaries of A&B.

Agribusiness

Agribusiness, which contains one segment, produces bulk raw sugar, specialty food grade sugars, and molasses; markets and distributes specialty food-grade sugars; provides general trucking services, mobile equipment maintenance, and repair services in Hawaii; leases agricultural land to third parties; and generates and sells electricity, to the extent not used in the Company's Agribusiness operations. A&B is the member in Hawaiian Sugar & Transportation Cooperative ("HS&TC"), a cooperative that provides raw sugar marketing and transportation services.

Critical Accounting Estimates

A&B's significant accounting policies are described in Note 2 to the Consolidated Financial Statements. The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America, upon which the MD&A is based, requires that management exercise judgment when making estimates and assumptions about future events that may affect the amounts reported in the financial statements and accompanying notes. Future events and their effects cannot be determined with certainty and actual results will, inevitably, differ from those critical accounting estimates. These differences could be material.

A&B considers an accounting estimate to be critical if: (i)(a) the accounting estimate requires A&B to make assumptions that are difficult or subjective about matters that were highly uncertain at the time that the accounting estimate was made, (b) changes in the estimate are reasonably likely to occur in periods subsequent to the period in which the estimate was made, or (c) use of different estimates by A&B could have been used, and (ii) changes in those assumptions or estimates would have had a material impact on the financial condition or results of operations of A&B. The critical accounting estimates inherent in the preparation of A&B's financial statements are described below.

Principles of Consolidation

The consolidated financial statements include the accounts of Alexander & Baldwin, Inc. and all wholly owned and controlled subsidiaries, after elimination of significant intercompany amounts. Significant investments in businesses, partnerships, and limited liability companies in which the Company does not have a controlling financial interest, but has the ability to exercise significant influence, are accounted for under the equity method. A controlling financial interest is one in which the Company has a majority voting interest or one in which the Company is the primary beneficiary of a variable interest entity. In determining whether the Company is the primary beneficiary of a variable interest entity in which it has an interest, the Company is required to make significant judgments with respect to various factors including, but not limited to, the Company's ability to direct the activities that most significantly impact the entity's economic performance, the rights and ability of other investors to participate in decisions affecting the economic performance of the entity, and kick-out rights, among others. Activities that significantly affect the economic performance of the entities in which the Company has an interest include, but are not limited to, establishing and modifying detailed business, development, marketing and sales plans, approving and modifying the project budget, approving design changes and associated overruns, if any, and approving project financing, among others. The Company has not consolidated any variable interest entity because it has determined that it is not the primary beneficiary since decisions to direct the activities that most significantly impact the entity's performance are shared by the joint venture partners, and therefore, the Company has determined that it does not have a controlling financial interest in any variable interest entity.

Impairment of Long-Lived Assets and Finite-Lived Intangible Assets

A&B's long-lived assets, including finite-lived intangible assets, are reviewed for possible impairment when events or circumstances indicate that the carrying value may not be recoverable. In such an evaluation, the estimated future undiscounted cash flows generated by the asset are compared with the amount recorded for the asset to determine if its carrying value is not recoverable. If this review determines that the recorded value will not be recovered, the amount recorded for the asset is reduced to estimated fair value. A&B has evaluated certain long-lived assets, including intangible assets, for impairment. During the second quarter of 2012, A&B recorded a non-cash impairment charge of $5.1 million related to its Santa Barbara real estate landholdings in California. The impairment loss recorded to reduce the carrying amount to the estimated fair value reflects the change in the Company's development strategy, following Separation, to focus on development projects in Hawaii, and therefore, its related decision not to proceed with the development of Santa Barbara landholdings in the near term. The impairment of the Santa Barbara landholdings are classified within *Operating costs and expenses* in the consolidated statements of income. No impairment charges were recorded in 2011, or 2010. These asset impairment analyses are highly subjective because they require management to make assumptions and apply considerable judgments to, among others, estimates of the timing and amount of future cash flows, expected useful lives of the assets, uncertainty about future events, including changes in economic conditions, changes in operating performance, changes in the use of the assets, and ongoing costs of maintenance and improvements of the assets, and thus, the accounting estimates may change from period to period. If management uses different assumptions or if different conditions occur in future periods, A&B's financial condition or its future operating results could be materially impacted.

Impairment of Investments

A&B's investments in unconsolidated affiliates are reviewed for impairment whenever there is evidence that fair value may be below carrying cost. An investment is written down to fair value if fair value is below carrying cost and the impairment is other-than-temporary. In evaluating the fair value of an investment and whether any identified impairment is other-than-temporary, significant estimates and considerable judgments are involved. These estimates and judgments are based, in part, on A&B's current and future evaluation of economic conditions in general, as well as a joint venture's current and future plans. Additionally, these impairment calculations are highly subjective because they also require management to make assumptions and apply judgments to estimates regarding the timing and amount of future cash flows, probabilities related to various cash flow scenarios, and appropriate discount rates based on the perceived risks, among others. In evaluating whether an impairment is other-than-temporary, A&B considers all available information, including the length of time and extent of the impairment, the financial condition and near-term prospects of the affiliate, A&B's ability and intent to hold the investment for a period of time sufficient to allow for any anticipated recovery in market value, and projected industry and economic trends, among others. Changes in these and other assumptions could affect the projected operational results and fair value of the unconsolidated affiliates, and accordingly, may require valuation adjustments to A&B's investments that may materially impact A&B's financial condition or its future operating results. For example, if current market conditions deteriorate significantly or a joint venture's plans change materially, impairment charges may be required in future periods, and those charges could be material.

In 2012, A&B recorded an impairment loss and equity losses totaling $4.7 million related to its joint venture investment in Bakersfield (CA) for a commercial development. The recognition of the impairment loss reduced the carrying amount of the investment to its estimated fair value and reflected the change in the Company's development strategy to focus on development projects in Hawaii, and therefore, its related decision not to proceed with the development of California real estate assets in the near term. The impairment loss and equity losses of the Company's investment in its Bakersfield joint venture is classified as *Impairment and equity losses related to Bakersfield joint venture* in the consolidated statements of income. In 2011, A&B recorded a $6.4 million reduction in the carrying value of its investment in Waiawa, a residential joint venture on Oahu, due to the joint venture's termination of its development plans. In 2010, A&B recorded an impairment loss of approximately $1.9 million related to its Santa Barbara investment.

Continued weakness in the real estate sector, difficulty in obtaining or renewing project-level financing, and changes in A&B's development strategy, among other factors, may affect the value or feasibility of certain development projects owned by A&B or by its joint ventures and could lead to additional impairment charges in the future.

Legal Contingencies

A&B's results of operations could be affected by significant litigation adverse to A&B, including, but not limited to, liability claims and construction defect claims. A&B records accruals for legal matters when the information available indicates that it is probable that a liability has been incurred and the amount of the loss can be reasonably estimated. Management makes adjustments to these accruals to reflect the impact and status of negotiations, settlements, rulings, advice of counsel and other information and

2012 vs. 2011

Operating Revenue for 2012 increased 11 percent, or $29.0 million, to $296.7 million. Agribusiness revenue increased $24.8 million, primarily due to higher prices on sugar sold. Real Estate Leasing revenue increased $3.5 million in 2012 (excluding revenue from discontinued operations), primarily due to acquisitions and overall higher mainland occupancies. The reasons for business- and segment-specific year-to-year fluctuations in revenue are further described below in the Analysis of Operating Revenue and Profit by Segment.

Because of the recurring nature of property sales, the Company views changes in Real Estate Sales and Real Estate Leasing revenues on a year-over-year basis before the reclassification of revenue to discontinued operations to be more meaningful in assessing segment performance. Additionally, due to the timing of sales for development properties and the mix of properties sold, management believes performance is more appropriately assessed over a multi-year period. Year-over-year comparisons of revenue are also not complete without the consideration of results from the Company's investment in its real estate joint ventures, which are not included in consolidated operating revenue, but are included in segment operating profit. The Analysis of Operating Revenue and Profit by Segment that follows, provides additional information on changes in Real Estate Sales revenue and operating profit before reclassifications to discontinued operations.

Operating Costs and Expenses for 2012 increased by 10 percent, or $22.4 million, due principally to $26.0 million in higher Agribusiness costs, $6.8 million in higher professional fees related to the Separation, which included $1.2 in share-based compensation related to the exchange of existing employee options with replacement options in the new company as part of the Separation, and a $5.1 million impairment of the Company's Santa Barbara landholdings that resulted from the Company's change in its development strategy to focus on development projects in Hawaii, partially offset by a $7.3 million gain on the sale of an agricultural parcel and $3.5 million in lower Real Estate Development and Sales costs (after excluding costs from discontinued operations). The Company also recognized a $9.4 million gain on land recognized at fair value in connection with its donation to a Maui not-for-profit. The gain was fully offset by an equal amount representing the cost of the charitable donation, which is included in selling, general and administrative expenses. The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Other Income and Expense: Other income (expense) was ($23.9) million in 2012 compared with ($18.6) million in 2011. The change in other income (expense) was due to $4.7 million in impairment and equity losses related to the Company's Bakersfield joint venture development project in California, resulting from the Company's change in its development strategy to focus on development projects in Hawaii, and $4.4 million in real estate joint venture losses in 2012. The higher expenses were partially offset by a $2.2 million reduction in interest expenses as a result of lower average debt levels.

Income Taxes and the effective rate were lower in 2012 compared with 2011 due principally to the Company's solar project on Kauai and a land donation and charitable donations, partially offset by certain non-deductible separation expenses. The Company expects that its effective tax rate in 2013 will return to a combined statutory rate of approximately 39 percent.

2011 vs. 2010

Operating Revenue for 2011 increased 2 percent, or $5.9 million, to $267.7 million. Real Estate Leasing revenue increased 16 percent in 2011 (after subtracting leasing revenue from assets classified as discontinued operations), primarily due to acquisitions and higher mainland occupancies. Agribusiness revenue decreased 5 percent, primarily due to lower coffee revenue as a result of the sale of the assets of the coffee operations in the first quarter of 2011. The reasons for business- and segment-specific year-to-year fluctuations in revenue growth are further described below in the Analysis of Operating Revenue and Profit by Segment.

Operating Costs and Expenses for 2011 decreased by 10 percent, or $26.8 million, to $233.9 million. Real Estate Sales and Leasing costs increased by 12 percent, primarily due to property acquisitions. This increase was offset by Agribusiness costs, which decreased 18 percent due principally to a lower volume of sugar sold, combined with higher production levels. Additionally, Selling, General and Administrative costs ("SG&A") decreased 12 percent due principally to higher non-qualified benefits paid in 2010 related to the retirement of certain senior executives and lower performance-based compensation. The reasons for changes in business- and segment-specific year-to-year fluctuations in operating costs, which affect segment operating profit, are more fully described below in the Analysis of Operating Revenue and Profit by Segment.

Other Income and Expense: Other expense in 2011 increased $13.5 million, compared with 2010, due primarily to $7.9 million in joint venture losses, a $4.9 million payment received in 2010 for agriculture disaster relief, $3.4 million gain in 2010 related to the settlement of a non-performing mortgage note acquired as an investment, and a $1.7 million decrease in interest income in 2011.

Income Taxes in 2011 were higher compared with 2010 due to higher income from continuing operations. The effective tax rate in 2011 was lower than the rate in 2010 due principally to tax benefits that were more significant in relation to the nominal loss from continuing operations in 2010.

ANALYSIS OF OPERATING REVENUE AND PROFIT BY SEGMENT

Additional detailed information related to the operations and financial performance of the Company's Operating Segments is included in Part II Item 6 and Note 14 to the Consolidated Financial Statements. The following information should be read in relation to the information contained in those sections.

Real Estate Industry

Real Estate Leasing and Real Estate Development and Sales revenue and operating profit are analyzed before subtracting amounts related to discontinued operations. This is consistent with how the Company's management evaluates performance and makes decisions regarding capital allocation for the Company's real estate businesses. A discussion of discontinued operations for the real estate business is included separately.

Effect of Property Sales Mix on Operating Results: Direct year-over-year comparison of the real estate development and sales results may not provide a consistent, measurable indicator of future performance because results from period to period are significantly affected by the mix and timing of property sales. Operating results, by virtue of each project's asset class, geography, and timing, are inherently episodic. Earnings from joint venture investments are not included in segment revenue, but are included in operating profit. The mix of real estate sales in any year or quarter can be diverse and can include developed residential real estate, commercial properties, developable subdivision lots, undeveloped land, and property sold under threat of condemnation. The sale of undeveloped land and vacant parcels in Hawaii generally provides higher margins than does the sale of developed and commercial property, due to the low historical-cost basis of the Company's Hawaii land. Consequently, real estate development and sales revenue trends, cash flows from the sales of real estate, and the amount of real estate held for sale on the balance sheets do not necessarily indicate future profitability trends for this segment. Additionally, the operating profit reported in each quarter does not necessarily follow a percentage of sales trend because the cost basis of property sold can differ significantly between transactions.

***Real Estate Leasing**: 2012 compared with 2011*

(dollars in millions)	**2012**	2011	Change

Real estate leasing segment revenue	$ 100.6	$ 99.7	1%
Real estate leasing operating costs and expenses	57.2	58.7	-3%
Selling, general and administrative expenses	1.7	1.8	-6%
Other segment expense (income)	0.1	(0.1)	NM
Segment operating profit	41.6	39.3	6%
Operating profit margin	41.4%	39.4%	
Average Occupancy Rates:			
Mainland	93%	92%	
Hawaii	92%	91%	
Leasable Space (million sq. ft.) - Improved			
Mainland	6.5	6.5	—%
Hawaii	1.4	1.4	—%

Real Estate Leasing revenue for 2012 was one percent higher than the amount reported for 2011. The increase was principally due to the revenue impact resulting from the acquisitions of Union Bank Office Building (June 2011), Issaquah Office Center (September 2011), Gateway at Mililani Mauka (December 2011) and Gateway at Mililani Mauka South (June 2012) and a reversal of deferred rent in 2011 related to a tenant bankruptcy, partially offset by the dispositions of Apex Building (January 2011), Arbor Park Shopping Center (June 2011), Wakea Business Center (September 2011) and Firestone Boulevard Building (March 2012).

Same store average revenue decreased to $13.45 per square foot in 2012 from $13.63 per square foot in 2011, as higher revenue from a mainland retail property and industrial property was more than offset by lower revenue from two mainland office properties, a mainland retail property and the Hawaii retail property.

Same store occupancy increased to 93 percent in 2012, compared to 92 percent for 2011, due primarily to increased occupancy in the mainland industrial properties.

Operating profit was six percent higher in 2012, compared with 2011, principally due to the higher revenue and occupancies in the Hawaii and Mainland portfolios, lower expenses related to the previously mentioned tenant bankruptcy in 2011, and the favorable impact from the timing of acquisitions and dispositions. Depreciation expense was two percent higher year-over-year, as proceeds from leased property sales under 1031 exchange transactions are reinvested in commercial properties at a higher relative book basis than the property replaced.

Leasable space remained essentially unchanged at 7.9 million square feet in 2012 compared with 2011, principally due to the following activity:

Dispositions			Acquisitions		
Date	Property	Leasable sq. ft	Date	Property	Leasable sq. ft
3-12	Firestone Boulevard Building (CA)	28,100	6-12	Gateway at Mililani Mauka South (HI)	18,700
	Total Dispositions	28,100		Total Acquisitions	18,700

Real Estate Leasing: 2011 compared with 2010

(dollars in millions)	2011	2010	Change
Real estate leasing segment revenue	$ 99.7	$ 93.8	6%
Real estate leasing operating costs and expenses	58.7	56.6	4%
Selling, general and administrative expenses	1.8	2.1	-14%
Other segment income (expense)	0.1	0.2	-50%
Segment operating profit	39.3	35.3	11%
Operating profit margin	39.4%	37.6%	
Average Occupancy Rates:			
Mainland	92%	85%	
Hawaii	91%	92%	
Leasable Space (million sq. ft.) - Improved			
Mainland	6.5	6.4	2%
Hawaii	1.4	1.5	-7%

Real Estate Leasing revenue for 2011 was 6 percent higher than the amount reported for 2010. The increase was principally due to the timing of acquisitions and dispositions, but was also due to higher Mainland occupancy.

Same store average revenue decreased to $12.29 per square foot in 2011 from $13.23 per square foot in 2010, as higher mainland office and industrial revenue was more than offset by lower revenue from a California office property and a tenant bankruptcy at a Mainland industrial property.

Same store occupancy increased to 93 percent in 2011, compared to 85 percent for 2010, due primarily to increased occupancy in the Mainland industrial properties.

Operating profit was 11 percent higher in 2011, compared with 2010, principally due to the same reasons cited for the revenue increase. The higher operating costs and expenses was attributable primarily to higher depreciation expense as proceeds from leased property sales under 1031 exchange transactions are reinvested in commercial properties at a higher relative book basis than the property replaced.

Leasable space increased modestly in 2011 compared with 2010, principally due to the following activity:

Dispositions			Acquisitions		
Date	Property	Leasable sq. ft	Date	Property	Leasable sq. ft
1-11	Apex Building (HI)	28,100	6-11	Union Bank Office Building (WA)	84,000
6-11	Arbor Park Shopping Center (TX)	139,500	9-11	Issaquah Office Center (WA)	146,900
9-11	Wakea Business Center II (HI)	61,500	9-11	Gateway at Mililani Mauka (HI)	5,900

Total Dispositions	229,100	Total Acquisitions	236,800

***Real Estate Development and Sales**: 2012 compared with 2011 and 2010*

(dollars in millions)	2012	2011	2010
Hawaii improved	$ —	$ 22.8	$ 55.2
Mainland improved	5.0	22.4	58.5
Hawaii development sales	8.7	6.7	5.8
Hawaii unimproved/other	18.5	7.9	11.5
Total real estate sales segment revenue	32.2	59.8	131.0
Cost of real estate development and sales	(11.0)	(31.6)	(75.3)
Operating expenses	(11.4)	(11.1)	(11.9)
Impairment of Santa Barbara development project	(5.1)	—	—
Impairment and equity loss related to Bakersfield joint venture	(4.7)	—	—
Earnings (loss) from joint ventures	(4.4)	(7.9)	2.0
Other income (loss)	—	6.3	4.3
Total real estate development and sales operating profit (loss)	$ (4.4)	$ 15.5	$ 50.1
Operating profit margin	NM	25.9%	38.2%

The lower revenue and operating profit results in 2012 were primarily due to fewer improved real estate sales and the impairment of two of the Company's California development investments, Santa Barbara and Bakersfield. The composition of sales is described below.

2012: Revenue from Real Estate Development and Sales, before subtracting amounts presented as discontinued operations, was $32.2 million, principally related to the gain on the sale of 286 acres of agricultural-zoned land on Maui, a 4.1-acre parcel at Maui Business Park II, Firestone Boulevard Building, two leased fee parcels on Maui, three residential units on Oahu, and several non-core land parcels on Maui. Operating profit also included joint venture sales of a parcel, a residential lot and six homes at Kukui'ula, eight residential units at the Company's Ka Milo joint venture development on the island of Hawaii, and two units at Kai Malu, the Company's joint venture Wailea development on Maui. The margin on the sales described above was partially offset by $9.8 million of impairment charges in the second quarter of 2012, related to the Company's Santa Barbara and Bakersfield development projects in California, resulting from the Company's change in its development strategy to focus on development projects in Hawaii, as well as joint venture expenses.

2011: Real Estate Development and Sales revenue and operating profit included the sales of Arbor Park Shopping Center, a retail center in Texas; two commercial properties, an 86-acre industrial parcel, a leased fee parcel and several non-core parcels on the island of Maui; and six residential units and one commercial space at the Company's Keola La'i high-rise development on Oahu. Operating profit also included a loss of $6.4 million on the Company's investment in its Waiawa joint venture due to the joint venture's termination of its development plans, as well as various joint venture expenses, partially offset by a gain on the sale of the Company's interest in the Bridgeport Marketplace joint venture development in Valencia, California, a four-acre commercial parcel at the Company's Kukui'ula joint venture on Kauai, and four units at the Company's Ka Milo joint venture development on the island of Hawaii.

2010: Real Estate Sales revenue and operating profit included the sales of Mililani Shopping Center, a retail center in Hawaii, Ontario Distribution Center, an industrial property in California, Valley Freeway Corporate Park, an industrial facility in Washington, six residential units and one commercial space at the Company's Keola La'i high-rise development on Oahu, a 75-acre agricultural parcel on Kauai, two leased fee parcels and several non-core Maui land parcels. In addition to the aforementioned sales, operating profit included a $3.6 million gain recorded in connection with the acquisition of Lahaina Square, a retail center on Maui that was acquired by the Company in the settlement of a non-performing mortgage loan, which was purchased by the Company in the first quarter of 2010. Operating profit also included $2.0 million of joint venture earnings, principally due to $5.1 million in gains recognized on the settlements of two mortgage loans owed to a project lender under regulatory supervision, partially offset by a $1.9 million impairment loss on the Company's Santa Barbara joint venture investment.

Discontinued Operations: The revenue, operating profit, and after-tax effects of discontinued operations for 2012, 2011 and 2010 were as follows (in millions, except per-share amounts):

	2012	2011	2010
Proceeds from the sale of income-producing properties (Real Estate Sales Segment)	$ 8.9	$ 45.5	$ 117.1
Real Estate Leasing revenue (Real Estate Leasing Segment)	1.2	3.8	11.5
Gain on sale of income-producing properties	$ 4.0	$ 22.5	$ 48.6
Real Estate Leasing operating profit	0.7	2.3	6.9
Total operating profit before taxes	4.7	24.8	55.5
Income tax expense	1.9	9.9	20.1
Income from discontinued operations	$ 2.8	$ 14.9	$ 35.4

2012: The revenue and expenses related to the sales of the Firestone Boulevard Building and Northpoint Industrial, two industrial properties in California, and two leased fee properties in Maui have been classified as discontinued operations. Northpoint Industrial was sold in January 2013, but has been classified as held for sale, as of December 31, 2012, in the consolidated balance sheets. Additionally, the revenues, expenses and operating profit from Northpoint have been classified as discontinued operations for all periods presented.

2011: The revenue and expenses of Arbor Park Shopping Center, a retail property in Texas; Wakea Business Center II, a commercial facility on Maui; and a leased Maui property were classified as discontinued operations.

2010: The revenue and expenses of Ontario Distribution Center, an industrial property in California; Valley Freeway Corporate Park, an industrial facility in Washington; Mililani Shopping Center, a retail center in Hawaii; Kele Shopping Center on Maui; and various Maui parcels were classified as discontinued operations. Additionally, a retail property on Maui that was held for sale at year-end was classified as discontinued operations.

Agribusiness

Agribusiness: 2012 compared with 2011

(dollars in millions)		2012		2011	Change
Revenue	$	**182.3**	$	157.5	16%
Operating profit (loss)	$	**20.8**	$	22.2	-6%
Operating profit margin		11.4%		14.1%	
Tons sugar produced		**178,300**		182,800	-2%
Tons sugar sold		**198,200**		163,100	22%

Agribusiness revenue increased $24.8 million, or 16 percent, in 2012 compared with 2011. The increase was primarily due to $24.3 million in higher raw sugar sales revenue due to 5 sugar shipments in 2012 as compared to 4 sugar shipments in 2011, $1.5 million from higher specialty sugar sales resulting from higher volume and prices, $1.5 million in higher molasses sales due to higher volume and prices, and $1.1 million in higher parts and repair revenue, partially offset by $1.8 million in lower charter revenue.

Operating profit decreased $1.4 million in 2012 compared with 2011. The decrease in operating profit was primarily due to a $3.9 million decrease in raw and specialty sugar margins. The decrease in raw and specialty sugar margins were principally the result of a decrease in the volume of sugar production over which costs are allocated, resulting in higher per unit costs. The lower margin on raw and specialty sugar was partially offset by a $1.9 million improvement due to the sale of the coffee assets in 2011 and higher power margins from hydroelectric production on Kauai, as well as $1 million in lower charitable foundation contribution expenses.

Sugar production in 2012 was 2 percent lower than 2011 due principally to lower yields on the acres harvested, resulting from lower water availability. The average net revenue per ton of sugar for 2012 was $619 or 2 percent higher than the average revenue per ton of $605 in 2011.

Agribusiness: 2011 compared with 2010

(dollars in millions)		2011		2010	Change
Revenue	$	**157.5**	$	165.6	-5%
Operating profit (loss)	$	**22.2**	$	6.1	4X
Operating profit margin		14.1%		3.7%	
Tons sugar produced		**182,800**		171,800	6%
Tons sugar sold		**163,100**		176,700	-8%

Agribusiness revenue decreased $8.1 million in 2011 compared with 2010. The decrease was primarily due to $8.2 million in lower coffee revenue as a result of the sale of the assets of the coffee operation in the first quarter of 2011 and $13.4 million in lower sugar revenue, due to lower sugar sales volume. These decreases were partially offset by a $5.4 million increase in power revenue, $3.0 million in higher molasses revenue due to higher volumes and prices, and $2.4 million higher outside charter revenue.

Operating profit increased $16.1 million in 2011 compared with 2010. The increase in operating profit was primarily due to a $6.1 million improvement in power margins and a $5.2 million increase in raw and specialty sugar margins. The improvements in raw and specialty sugar margins were principally the result of higher sugar prices and an increase in the volume of sugar production over which costs are allocated, resulting in lower per unit costs. Molasses margins also increased $3.2 million due to higher sales volumes and prices. The increase in operating profit was partially offset by the aforementioned agriculture disaster relief payment for drought received in 2010.

Sugar production in 2011 was 6 percent higher than in 2010 due principally to higher average yields per acre. The higher yields in 2011 were principally the result of improved growing conditions and factory enhancements. The average net revenue per ton of sugar for 2011 was $605 or 5 percent higher than the average revenue per ton of $575 in 2010.

LIQUIDITY AND CAPITAL RESOURCES

Overview: A&B's primary liquidity needs have historically been to support working capital requirements and fund capital expenditures and real estate developments. In the future, A&B may have liquidity needs to finance acquisitions or repurchase common stock, when appropriate. Historically, A&B's principal sources of liquidity have been cash flows provided by operating activities, available cash and cash equivalent balances, and its credit facilities.

A&B's operating income is generated by its subsidiaries. There are no restrictions on the ability of A&B's subsidiaries to pay dividends or make other distributions to A&B. A&B regularly evaluates investment opportunities, including development projects, joint venture investments, and other strategic transactions to increase shareholder value. A&B cannot predict whether or when it may enter into acquisitions, joint ventures or dispositions, or what impact any such transactions could have on A&B's results of operations, cash flows or financial condition. A&B's cash flows from operations, borrowing availability and overall liquidity are subject to certain risks and uncertainties, including those described in the section titled "Risk Factors" beginning on page 18.

A&B has a committed revolving bank credit facility with a total capacity of $260 million and a $300 million uncommitted shelf facility. A&B believes its operating cash flow, availability of borrowings under credit agreements and access to capital markets will provide sufficient liquidity to support A&B's financing needs.

Cash Flows: Cash flows provided by operating activities continue to be the Company's most significant source of liquidity. Net cash flows from operating activities totaled $10.9 million for 2012, $10.4 million for 2011, and $1.6 million for 2010. Cash flows for 2012 were comparable to 2011. Excluding expenditures for the Company's real estate development inventory, cash flows from operating activities were $23.9 million higher than 2011, due to lower taxes, lower corporate expenses, lower interest expense and higher earnings in 2012, exclusive of non-cash impairment losses. The increase in 2011 over 2010 was due principally to higher Agribusiness and Real Estate Leasing earnings, as well as lower capital requirements for real estate developments, partially offset by lower Real Estate Sales segment earnings. A&B classifies expenditures for real estate development assets as cash flows from operating activities if A&B intends to develop and sell the real estate.

Net cash flows used in investing activities were $50.1 million for 2012, $26.1 million for 2011, and $58.8 million for 2010. Of the 2012 amount, $45.4 million was for capital expenditures, including $13.7 million related to capital improvements to commercial properties, $21.8 million related to the Port Allen solar project on Kauai, and the balance primarily related to routine replacements for agricultural operations. Other cash flows used in investing activities included $17.5 million, principally related to investments in A&B's Kukui'ula joint venture projects. These cash outflows were partially offset by $2.4 million in cash proceeds received, primarily related to property sales, and $2.9 million related to distributions from joint ventures and other investments. The cash used in investing activities for 2012 excludes $9.4 million of 1031 tax-deferred purchases since A&B did not actually take control of the cash during the exchange period. Additionally, expenditures for real estate held-for-sale are excluded from capital expenditures and are instead included in Cash Flows from

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF INCOME
(In millions, except per-share amounts)

	Year Ended December 31, 2012	2011	2010
Operating Revenue:			
Real estate leasing	$ 99.4	$ 95.9	$ 82.4
Real estate sales	15.0	14.3	13.8
Agribusiness	182.3	157.5	165.6
Total operating revenue	296.7	267.7	261.8
Operating Costs and Expenses:			
Cost of real estate leasing	57.2	57.5	52.4
Cost of real estate sales	5.2	8.7	6.8
Cost of agribusiness goods and services	161.0	135.0	164.2
Selling, general and administrative	37.7	32.7	37.3
Gain on sale of agricultural parcel	(7.3)	—	—
Gain on charitable donation of appreciated land	(9.4)	—	—
Impairment of real estate assets (Santa Barbara)	5.1	—	—
Separation costs	6.8	—	—
Total operating costs and expenses	256.3	233.9	260.7
Operating Income	40.4	33.8	1.1
Other Income and (Expense):			
Agriculture disaster relief payment	—	—	4.9
Income (loss) related to real estate and joint ventures	(4.4)	(1.8)	4.6
Impairment and equity losses related to Bakersfield joint venture	(4.7)	—	—
Interest income and other	0.1	0.3	2.7
Interest expense	(14.9)	(17.1)	(17.3)
Income (Loss) From Continuing Operations Before Income Taxes	16.5	15.2	(4.0)
Income tax expense (benefit)	(1.2)	6.6	(1.7)
Income (Loss) From Continuing Operations	17.7	8.6	(2.3)
Income from discontinued operations, net of income taxes (Note 4)	2.8	14.9	35.4
Net Income	$ 20.5	$ 23.5	$ 33.1
Basic Earnings per Share of Common Stock:			
Continuing operations	$ 0.41	$ 0.20	$ (0.05)
Discontinued operations	0.07	0.35	0.83
Net income	$ 0.48	$ 0.55	$ 0.78
Diluted Earnings per Share of Common Stock:			
Continuing operations	$ 0.41	$ 0.20	$ (0.05)
Discontinued operations	0.07	0.35	0.83
Net income	$ 0.48	$ 0.55	$ 0.78
Weighted Average Number of Shares Outstanding:			
Basic	42.6	42.4	42.4
Diluted	42.9	42.4	42.4

ALEXANDER & BALDWIN, INC.
CONSOLIDATED BALANCE SHEETS
(In millions, except per-share amount)

	December 31, 2012	December 31, 2011
ASSETS		
Current Assets		
Cash and cash equivalents	$ 1.1	$ 11.7
Accounts receivable, less allowances of $1.6 for 2012 and $1.7 for 2011	8.2	6.7
Inventories	23.5	36.3
Real estate held for sale	11.5	2.8
Deferred income taxes	7.8	3.5
Prepaid expenses and other assets	11.3	7.8
Total current assets	63.4	68.8
Investments in Affiliates	319.9	290.8
Real Estate Developments	144.0	143.3
Property – net	838.7	830.6
Other Assets	71.3	53.1
Total Assets	$ 1,437.3	$ 1,386.6
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities		
Notes payable and current portion of long-term debt	$ 15.5	$ 34.5
Accounts payable	26.2	20.8
Income taxes payable	—	2.8
Accrued interest	5.2	3.2
Accrued and other liabilities	22.7	28.7
Total current liabilities	69.6	90.0
Long-term Liabilities		
Long-term debt	220.0	327.2
Deferred income taxes	152.9	164.1
Accrued pension and postretirement benefits	58.9	54.6
Other non-current liabilities	21.5	24.9
Total long-term liabilities	453.3	570.8
Commitments and Contingencies (Note 13)		
Shareholders' Equity		
Common stock – no par value; authorized, 150 million shares; outstanding, 42.9 million shares at December 31, 2012	939.8	—
Preferred stock, no par value; authorized, 15 million shares; none issued or outstanding	—	—
Net investment	—	773.4
Accumulated other comprehensive loss	(47.2)	(47.6)
Retained earnings	21.8	—
Total shareholders' equity	914.4	725.8
Total	$ 1,437.3	$ 1,386.6

See notes to consolidated financial statements.

ALEXANDER & BALDWIN, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(In millions)

	Year Ended December 31, 2012	2011	2010
Cash Flows from Operating Activities:			
Net income	$ 20.5	$ 23.5	$ 33.1
Adjustments to reconcile net income to net cash provided by operations:			
Depreciation and amortization	35.1	34.8	35.2
Deferred income taxes	(6.3)	(0.9)	2.1
Gains on asset transactions, net of impairment losses	(14.8)	(33.2)	(54.4)
Gain from receipt of insurance proceeds	—	—	(1.1)
Share-based expense	5.4	4.8	4.9
Equity in (income) loss of affiliates, net of distributions	8.4	8.4	(2.0)
Changes in operating assets and liabilities:			
Accounts receivable	0.1	3.7	(1.9)
Inventories	12.8	(6.2)	5.9
Prepaid expenses and other assets	(10.0)	(4.3)	(8.2)
Accrued pension and postretirement benefits	4.2	6.4	14.0
Accounts payable	(1.5)	(2.6)	0.3
Accrued and other liabilities	(14.2)	(16.6)	(10.2)
Real estate developments held for sale:			
Real estate inventory sales	8.4	6.4	5.5
Expenditures for real estate inventory	(37.2)	(13.8)	(21.6)
Net cash provided by operations	10.9	10.4	1.6
Cash Flows from Investing Activities:			
Capital expenditures for property and developments	(45.4)	(20.2)	(23.5)
Proceeds from investment tax credits and grants related to renewable energy projects	7.5	—	—
Proceeds from disposal of income-producing property and other assets	2.4	14.2	32.5
Loans to affiliate	—	—	20.0
Payments for purchases of investments in affiliates	(17.5)	(28.0)	(100.7)
Proceeds from investments in affiliates	2.9	7.9	12.9
Net cash used in investing activities	(50.1)	(26.1)	(58.8)
Cash Flows from Financing Activities:			
Proceeds from issuance of long-term debt	134.0	147.0	134.0
Payments of long-term debt and deferred financing costs	(257.2)	(145.9)	(78.7)
Proceeds from (payments on) line-of-credit agreement, net	(6.0)	1.1	(3.6)
Distributions to Alexander & Baldwin Holdings, Inc.(a)	(26.7)	(53.1)	(52.2)
Contributions from Alexander & Baldwin Holdings, Inc.(a)	172.7	72.8	54.2
Proceeds from issuance of capital stock and other	11.8	—	—
Net cash provided by financing activities	28.6	21.9	53.7
Cash and Cash Equivalents:			
Net increase (decrease) for the year	(10.6)	6.2	(3.5)
Balance, beginning of year	11.7	5.5	9.0
Balance, end of year	$ 1.1	$ 11.7	$ 5.5
Other Cash Flow Information:			
Interest paid, net of amounts capitalized	$ 14.9	$ 16.9	$ 16.8
Income taxes paid	$ (2.0)	$ (26.0)	$ (3.8)
Non-cash Activities:			
Contribution of land and development assets to Waihonua joint venture	$ 24.2	$ —	$ —
Debt assumed in real estate purchase	$ —	$ —	$ 6.7
Real estate received in settlement of a mortgage note	$ —	$ —	$ 8.4
Capital expenditures included in accounts payable and accrued expenses	$ 12.2	$ 6.8	$ 4.2
Tax-deferred property sales	$ 18.8	$ 44.7	$ 120.0
Tax-deferred property purchases	$ (9.4)	$ (39.1)	$ (148.4)
Conversion of net investment of A&B Holdings into common stock	$ 926.3	$ —	$ —

(a) Refer to Note 3, "Related Party Transactions."
See notes to consolidated financial statements.

14. OPERATING SEGMENTS

Operating segments are components of an enterprise that engage in business activities from which it may earn revenues and incur expenses, whose operating results are regularly reviewed by the chief operating decision maker to make decisions about resources to be allocated to the segment and assess its performance, and for which discrete financial information is available. The Company's chief operating decision maker is its Chief Executive Officer. Based on the foregoing, the Company has three groups of products and services that are provided by its three segments that operate in two industries: Real Estate and Agribusiness.

The Real Estate Industry consists of two operating segments. The Real Estate Development and Sales segment generates its revenues through the investment in and development and sale of land, commercial and residential properties. The Real Estate Leasing operating segment owns, operates, and manages retail, office, and industrial properties. When property that was previously leased is sold, the sales revenue and operating profit are included with the Real Estate Sales segment.

Agribusiness, which consists of one segment, grows sugar cane; produces bulk raw sugar, specialty food-grade sugars, and molasses; markets and distributes specialty food-grade sugars; provides general trucking services, mobile equipment maintenance and repair services in Hawaii; and generates and sells, to the extent not used in the Company's operations, electricity.

The accounting policies of the operating segments are described in the summary of significant accounting policies. Reportable segments are measured based on operating profit, exclusive of interest expense, general corporate expenses, and income taxes. Transactions between reportable segments are accounted for on the same basis as transactions with unrelated third parties.

Raw sugar revenues from the Company's largest customer, C&H Sugar Company, Inc., exceeded 10 percent of total consolidated revenues and totaled $117.5 million, $93.2 million, and $95.3 million in 2012, 2011, and 2010, respectively.

Operating segment information for 2012, 2011, and 2010 is summarized below (in millions):

For the Year	2012	2011	2010
Revenue:			
Real Estate:			
Leasing	$ 100.6	$ 99.7	$ 93.8
Development and Sales	32.2	59.8	131.0
Less amounts reported in discontinued operations[1]	(10.1)	(49.3)	(128.6)
Agribusiness[2]	182.3	157.5	165.6
Reconciling Items [3]	(8.3)	—	—
Total revenue	$ 296.7	$ 267.7	$ 261.8
Operating Profit:			
Real Estate:			
Leasing	$ 41.6	$ 39.3	$ 35.3
Development and Sales[4]	(4.4)	15.5	50.1
Less amounts reported in discontinued operations[1]	(4.7)	(24.8)	(55.5)
Agribusiness[2]	20.8	22.2	6.1
Total operating profit	53.3	52.2	36.0
Interest expense, net	(14.9)	(17.1)	(17.3)
General corporate expenses	(15.1)	(19.9)	(22.7)
Separation costs	(6.8)	—	—
Income from continuing operations before income taxes	16.5	15.2	(4.0)
Income taxes	(1.2)	6.6	(1.7)
Income from continuing operations	17.7	8.6	(2.3)
Discontinued operations	2.8	14.9	35.4
Net income	$ 20.5	$ 23.5	$ 33.1

[1] Prior year amounts restated for amounts treated as discontinued operations.

[2] Includes a $4.9 million gain in 2010 related to an agriculture disaster relief payment for drought experienced in prior years.

[3] Represent the sale of a 286-acre agricultural parcel in the third quarter of 2012 classified as "Gain on sale of agricultural parcel" in the consolidated statement of income, but reflected as revenue for segment reporting purposes.

[4] The Real Estate Development and Sales segment includes approximately ($8.3) million equity in loss, ($7.9) million equity in loss and $2.0 million in equity in earnings from its various real estate joint ventures for 2012, 2011 and 2010, respectively. Included in operating profit are noncash impairment and equity losses of $9.8 million (Bakersfield joint venture and Santa Barbara real estate project) in 2012 and $6.4 million (Waiawa real estate joint venture) in 2011.

OPERATING SEGMENTS (CONTINUED)

As of December 31:	2012	2011	2010
Identifiable Assets:			
Real Estate:			
Real estate leasing	$ 771.3	$ 772.0	$ 761.3
Real estate development and sales[5]	504.8	451.5	420.3
Agribusiness	149.9	157.8	153.3
Other	11.3	5.3	6.6
Total assets	$ 1,437.3	$ 1,386.6	$ 1,341.5
Capital Expenditures:			
Real Estate:			
Real estate leasing[6]	$ 23.1	$ 43.6	$ 164.7
Real estate development and sales[7]	—	5.2	0.1
Agribusiness[8]	31.7	10.5	6.8
Other	—	—	0.3
Total capital expenditures[9]	$ 54.8	$ 59.3	$ 171.9
Depreciation and Amortization:			
Real Estate:			
Real estate leasing[1]	$ 22.0	$ 21.6	$ 20.3
Real estate development and sales	0.2	0.2	0.2
Agribusiness	11.6	11.9	12.7
Other	1.3	1.1	2.0
Total depreciation and amortization	$ 35.1	$ 34.8	$ 35.2

[5] The Real Estate Development and Sales segment includes approximately $319.7 million, $290.1 million, and $274.8 million related to its investment in various real estate joint ventures as of December 31, 2012, 2011, and 2010, respectively.

[6] Represents gross capital additions to the leasing portfolio, including gross tax-deferred property purchases that are reflected as non-cash transactions in the Consolidated Statements of Cash Flows.

[7] Excludes expenditures for real estate developments held for sale which are classified as Cash Flows from Operating Activities within the Consolidated Statements of Cash Flows and excludes investment in joint ventures classified as Cash Flows from Investing Activities. Operating cash flows for expenditures related to real estate developments were $37.2 million, $13.8 million, and $21.6 million for 2012, 2011, and 2010, respectively. Investments in joint ventures were $17.4 million, $27.9 million, and $100.5 million in 2012, 2011, and 2010, respectively.

[8] Includes $21.8 million of capital related to the Company's Port Allen solar project before tax credits.

[9] Total capital expenditures for segment disclosure purposes includes tax-deferred property purchases of $9.4 million, $39.1 million, and $148.4 million for the years ended 2012, 2011, and 2010, respectively, that are treated as non-cash transactions, and therefore, not included in Capital Expenditures for properties and developments on the Consolidated Statements of Cash Flows.

15. QUARTERLY INFORMATION (Unaudited)

Segment results by quarter for 2012 are listed below (in millions, except per-share amounts):

	2012 Q1	2012 Q2	2012 Q3	2012 Q4
Revenue:				
Real Estate:				
Leasing	$ 25.5	$ 25.5	$ 24.9	$ 24.7
Sales	11.4	7.0	8.4	5.4
Less amounts reported in discontinued operations [1]	(9.3)	(0.3)	(0.3)	(0.2)
Agribusiness	13.6	39.9	67.9	60.9
Reconciling Items [2]	—	—	(8.3)	—
Total Revenue	**$ 41.2**	**$ 72.1**	**$ 92.6**	**$ 90.8**
Operating Profit (Loss):				
Real Estate:				
Leasing	10.7	10.5	10.2	10.2
Sales [3]	0.9	(9.9)	3.3	1.3
Less amounts reported in discontinued operations [1]	(4.1)	(0.2)	(0.2)	(0.2)
Agribusiness	3.5	7.0	9.1	1.2
Total operating profit	11.0	7.4	22.4	12.5
Interest Expense	(4.1)	(4.0)	(3.6)	(3.2)
General Corporate Expenses	(4.7)	(4.0)	(3.0)	(3.4)
Separation costs	(1.7)	(4.4)	(0.7)	—
Income (Loss) From Continuing Operations before Income Taxes	0.5	(5.0)	15.1	5.9
Income tax expense (benefit)	0.2	(0.5)	1.8	(2.7)
Income (Loss) From Continuing Operations	**0.3**	**(4.5)**	**13.3**	**8.6**
Discontinued Operations [1]	2.5	0.1	0.1	0.1
Net Income	**$ 2.8**	**$ (4.4)**	**$ 13.4**	**$ 8.7**
Earnings Per Share:				
Basic	$ 0.07	$ (0.10)	$ 0.31	$ 0.20
Diluted	$ 0.07	$ (0.10)	$ 0.31	$ 0.20

1 See Note 4 for discussion of discontinued operations.

2 Represent the sale of a 286-acre agricultural parcel in the third quarter of 2012 classified as "Gain on sale of agricultural parcel" in the consolidated statement of income, but reflected as revenue for segment reporting purposes.

3 The Real Estate Development and Sales segment operating profit for the second quarter of 2012 includes noncash impairment and equity losses of $9.8 million related to the Company's Bakersfield and Santa Barbara real estate projects.

Segment results by quarter for 2011 are listed below (in millions, except per-share amounts):

	2011			
	Q1	Q2	Q3	Q4
Revenue:				
Real Estate:				
Leasing	$ 26.0	$ 25.1	$ 24.4	$ 24.2
Sales	19.7	28.0	9.3	2.8
Less amounts reported in discontinued operations [1]	(15.7)	(23.5)	(9.2)	(0.9)
Agribusiness	15.8	43.4	37.1	61.2
Reconciling Items	—	—	—	—
Total Revenue	**$ 45.8**	**$ 73.0**	**$ 61.6**	**$ 87.3**
Operating Profit (Loss):				
Real Estate:				
Leasing	10.6	10.4	9.2	9.1
Sales	12.0	10.6	3.5	(10.6)
Less amounts reported in discontinued operations [1]	(7.4)	(9.4)	(7.3)	(0.7)
Agribusiness	2.6	8.5	3.8	7.3
Total operating profit	17.8	20.1	9.2	5.1
Interest Expense	(4.3)	(4.2)	(4.4)	(4.2)
General Corporate Expenses	(4.1)	(4.1)	(4.7)	(7.0)
Income (Loss) From Continuing Operations before Income Taxes	9.4	11.8	0.1	(6.1)
Income tax expense (benefit)	4.1	5.1	—	(2.6)
Income (Loss) From Continuing Operations	**5.3**	**6.7**	**0.1**	**(3.5)**
Discontinued Operations [1]	4.5	5.6	4.4	0.4
Net Income	**$ 9.8**	**$ 12.3**	**$ 4.5**	**$ (3.1)**
Earnings Per Share:				
Basic	$ 0.23	$ 0.29	$ 0.10	$ (0.07)
Diluted	$ 0.23	$ 0.29	$ 0.10	$ (0.07)

[1] See Note 4 for discussion of discontinued operations.

Table 4--U.S. raw sugar price, duty fee paid, New York, monthly, quarterly, and by calendar and fiscal year 1/

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	1st Q.	2nd Q.	3rd Q.	4th Q.	Calendar	Fiscal
	Cents per pound																	
1960	5.89	6.00	6.11	6.17	6.09	6.25	6.48	6.47	6.59	6.52	6.53	6.46	6.00	6.17	6.51	6.50	6.30	NA
1961	6.39	6.32	6.25	6.25	6.46	6.48	6.39	6.06	6.06	6.19	6.29	6.40	6.32	6.40	6.17	6.29	6.30	6.35
1962	6.45	6.37	6.43	6.43	6.43	6.45	6.39	6.54	6.43	6.52	6.44	6.54	6.42	6.44	6.45	6.50	6.45	6.40
1963	6.70	6.80	7.04	8.26	11.08	8.70	7.95	6.65	7.45	9.42	9.34	8.78	6.85	9.35	7.35	9.18	8.18	7.51
1964	9.29	8.02	7.33	7.43	6.65	6.45	6.25	6.18	6.20	6.27	6.17	6.55	8.21	6.84	6.21	6.33	6.90	7.61
1965	6.85	6.79	6.61	6.59	6.73	6.72	6.73	6.77	6.82	6.82	6.80	6.75	6.75	6.68	6.77	6.79	6.75	6.63
1966	6.88	6.92	6.84	6.89	6.90	6.92	7.00	7.05	7.11	7.15	7.12	7.14	6.88	6.90	7.05	7.14	6.99	6.91
1967	7.13	7.21	7.18	7.22	7.25	7.32	7.30	7.33	7.34	7.37	7.38	7.30	7.17	7.26	7.32	7.35	7.28	7.22
1968	7.41	7.38	7.35	7.42	7.48	7.53	7.59	7.59	7.62	7.66	7.58	7.62	7.38	7.48	7.60	7.62	7.52	7.45
1969	7.67	7.69	7.76	7.80	7.82	7.74	7.50	7.75	7.83	7.89	7.79	7.73	7.71	7.79	7.69	7.80	7.75	7.70
1970	8.11	7.96	7.90	7.90	8.16	8.22	8.16	8.19	8.16	8.14	7.96	8.02	7.99	8.09	8.17	8.04	8.07	8.01
1971	8.35	8.44	8.37	8.29	8.46	8.54	8.58	8.66	8.57	8.52	8.63	8.84	8.39	8.43	8.60	8.66	8.52	8.37
1972	9.10	9.02	9.16	8.89	8.76	8.77	9.17	9.33	9.39	9.32	9.03	9.19	9.09	8.81	9.30	9.18	9.09	8.97
1973	9.38	9.14	9.45	9.65	10.06	10.25	10.25	10.75	10.97	11.15	11.10	11.34	9.32	9.99	10.66	11.20	10.29	9.79
1974	12.63	17.09	18.11	19.25	23.05	26.30	28.35	32.60	33.71	38.83	57.30	46.74	15.94	22.87	31.55	47.62	29.50	20.39
1975	40.15	36.07	28.52	26.07	19.27	15.96	19.89	21.11	17.36	15.45	15.03	14.80	34.91	20.43	19.45	15.09	22.47	30.61
1976	15.42	15.04	16.27	15.58	15.97	14.40	14.59	11.32	9.80	10.65	10.46	10.22	15.58	15.32	11.90	10.44	13.31	14.47
1977	10.95	11.06	11.67	12.57	11.34	10.28	10.15	11.21	10.41	10.23	10.42	11.75	11.23	11.40	10.59	10.80	11.00	10.91
1978	13.28	14.75	14.00	13.93	13.62	13.57	12.63	13.29	14.41	15.17	14.24	14.25	14.01	13.71	13.44	14.55	13.93	12.99
1979	14.63	15.31	15.53	14.29	14.33	14.61	15.59	15.92	15.98	15.91	16.29	18.30	15.16	14.41	15.83	16.83	15.56	14.99
1980	19.66	24.69	21.18	22.67	31.89	32.10	28.75	33.13	36.03	41.69	39.28	30.29	21.84	28.89	32.64	37.09	30.11	25.05
1981	29.61	26.07	23.81	19.91	17.43	18.95	19.09	17.42	15.49	15.66	16.28	17.07	26.50	18.76	17.33	16.34	19.73	24.92
1982	18.16	17.77	17.13	17.89	19.57	21.03	22.15	22.45	20.88	20.44	20.79	20.83	17.69	19.50	21.83	20.69	19.92	18.84
1983	21.23	21.76	21.86	22.43	22.59	22.54	22.09	22.55	22.20	21.94	21.83	21.47	21.62	22.52	22.28	21.75	22.04	21.78
1984	21.51	21.90	22.00	22.03	22.01	22.06	21.89	21.72	21.70	21.56	21.40	21.10	21.80	22.03	21.77	21.35	21.74	21.84
1985	20.72	20.38	20.91	20.97	21.09	21.27	21.23	20.59	19.51	18.68	18.89	19.89	20.67	21.11	20.44	19.15	20.34	20.89
1986	20.67	21.01	20.95	20.85	20.88	20.99	20.97	20.87	20.87	21.08	21.17	21.12	20.88	20.91	20.90	21.12	20.95	20.46
1987	21.50	21.76	21.76	21.81	22.01	22.06	22.07	21.88	21.88	21.69	21.75	21.76	21.67	21.96	21.94	21.73	21.83	21.68
1988	21.83	22.11	22.16	22.16	22.13	22.54	23.43	21.90	21.77	21.74	21.70	21.99	22.03	22.28	22.37	21.81	22.12	22.10
1989	21.88	22.07	22.12	22.30	22.45	22.99	23.56	23.57	23.50	23.14	23.24	22.84	22.02	22.58	23.54	23.07	22.81	22.49
1990	23.11	22.93	23.58	23.81	23.58	23.33	23.42	23.27	23.23	23.29	23.15	22.47	23.21	23.57	23.31	22.97	23.26	23.29
1991	21.86	21.42	21.46	21.23	21.29	21.42	21.25	21.83	22.06	21.76	21.75	21.50	21.58	21.31	21.71	21.67	21.57	21.89
1992	21.38	21.56	21.36	21.38	21.04	20.92	21.10	21.34	21.55	21.61	21.39	21.11	21.43	21.11	21.33	21.37	21.31	21.39
1993	20.76	21.16	21.56	21.76	21.36	21.42	21.89	21.85	21.97	21.80	21.87	22.00	21.16	21.51	21.90	21.89	21.62	21.49
1994	22.00	21.95	21.95	22.08	22.18	22.44	22.72	21.84	21.78	21.58	21.57	22.35	21.97	22.23	22.11	21.83	22.04	22.05
1995	22.65	22.69	22.46	22.76	23.10	23.09	24.47	23.18	23.21	22.67	22.60	22.63	22.60	22.98	23.62	22.63	22.96	22.76
1996	22.39	22.68	22.57	22.71	22.62	22.48	21.80	22.51	22.38	22.37	22.12	22.14	22.55	22.60	22.23	22.21	22.40	22.50
1997	21.88	22.07	21.81	21.79	21.70	21.62	22.04	22.21	22.30	22.27	21.90	21.93	21.92	21.70	22.18	22.03	21.96	22.00
1998	21.85	21.79	21.74	22.14	22.31	22.42	22.66	22.19	21.92	21.67	21.83	22.19	21.79	22.29	22.26	21.90	22.06	22.09
1999	22.41	22.38	22.55	22.57	22.65	22.61	22.61	21.24	20.10	19.50	17.45	17.87	22.45	22.61	21.32	18.27	21.16	22.07
2000	17.70	17.24	18.46	19.43	19.12	19.31	17.64	18.12	18.97	21.15	21.39	20.56	17.80	19.29	18.24	21.03	19.09	18.40
2001	20.81	21.18	21.40	21.51	21.19	21.04	20.64	21.10	20.87	20.90	21.19	21.43	21.13	21.25	20.87	21.17	21.11	21.07
2002	21.03	20.69	19.92	19.73	19.52	19.93	20.86	20.91	21.65	21.94	22.22	22.03	20.55	19.73	21.14	22.06	20.87	20.65
2003	21.62	21.91	22.14	21.87	21.80	21.62	21.32	21.26	21.34	20.92	20.91	20.37	21.89	21.76	21.31	20.73	21.42	21.76
2004	20.54	20.57	20.86	20.88	20.69	20.03	20.14	20.10	20.47	20.31	20.40	20.55	20.66	20.53	20.24	20.42	20.46	20.54
2005	20.57	20.36	20.54	21.21	21.96	21.89	21.94	20.49	21.10	21.71	21.83	21.74	20.49	21.69	21.18	21.76	21.28	20.94
2006	23.61	24.05	23.10	23.56	23.48	23.32	22.44	21.38	21.27	20.22	19.66	19.59	23.59	23.45	21.70	19.82	22.14	22.62
2007	20.03	20.59	20.85	20.91	21.27	21.33	22.72	21.80	21.42	20.56	20.25	20.12	20.49	21.17	21.98	20.31	20.99	20.87
2008	20.24	20.21	20.65	20.54	20.83	21.80	23.76	23.15	23.10	21.46	19.83	20.00	20.37	21.06	23.34	20.43	21.30	21.27
2009	20.15	19.83	19.75	21.58	21.64	22.47	23.02	26.18	28.91	30.48	31.86	33.30	19.91	21.90	26.04	31.88	24.93	22.07
2010	39.36	40.13	35.11	30.86	30.89	32.73	33.66	34.24	38.17	39.30	38.84	38.35	38.20	31.49	35.36	38.83	35.97	34.23
2011	38.46	39.69	39.65	38.32	35.04	35.65	37.93	40.16	40.15	38.19	37.92	36.32	39.27	36.34	39.41	37.48	38.12	38.46
2012	34.69	33.57	34.94	31.87	30.20	28.89	28.68	28.84	26.27	23.89	22.52	22.41	34.40	30.32	27.93	22.94	28.90	32.53
2013	21.20	20.72	20.82	20.38	19.51	19.31	19.22	20.97	21.05	21.82	20.61		20.91	19.73	20.41			21.00

1/ Contract No. 14/16, duty fee paid New York. Average of nearest futures month for which an entire month of prices will be available. For example, April 2001's price average of 21.51 cents is the average of closes for the July 2001 futures during the month of April since there was not a full month of May 2001 futures in April (the May 2001 futures expired April 10th, July 2001 became the nearest futures, so July 2001 was used for the entire month of April).

Source: Intercontinental Exchange.

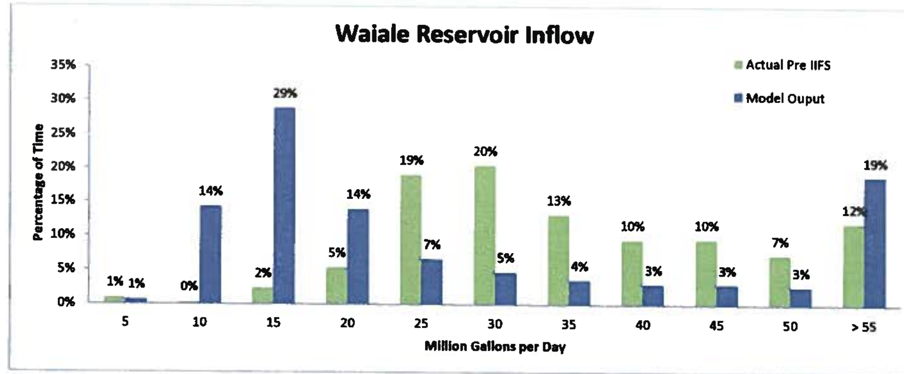
Last Updated: 12/2/2013

Exhibit E-R7

Scenario 1

Inputs/Assumptions

Waihee IIFS @ Waihee Ditch	5	MGD	Q90 = 24
Waihee IIFS @ Spreckels Ditch	5	MGD	
Iao IIFS @ Iao Waikapu Ditch	4	MGD	Q90 = 13
Iao IIFS @ Spreckels Ditch	4	MGD	
Waihee-Hopoi Fields Daily Requirement + Losses	23.75	MGD	
Iao Waikapu Fields Daily Requirement	5.9	MGD	
County Water Treatment Plant	1.5	MGD	
WWCo Customers, Kuleana Users and Losses	2.7	MGD	
Contribution from Waikapu Stream	2	MGD	Q90 = 3.3 - 4.6 (est.)



Summary

			actual ditch deliveries pre IIFS	actual ditch deliveries post IIFS
Average Daily Flow				
Waihee Ditch @ Hopoi Chute	17.01	MGD	15.94	11.74
Spreckels Ditch @ Mill Street	8.66	MGD	17.50	12.68
Total inflows to Waiale Reservoirs	25.67	MGD	33.44	24.41
Median Daily Flow				
Waihee Ditch @ Hopoi Chute	15.31	MGD	15.02	10.06
Spreckels Ditch @ Mill Street	0.00	MGD	15.86	10.89
Total inflows to Waiale Reservoirs	16.83	MGD	30.43	21.10

		to meet daily requirement
Well 7 Water Pumped (MGD)		5.12
Operating Cost To Run Well 7 (annually)		$ 348,695
Amoritized Cost of Well 7 Improvements		$ 105,705
		$ 454,400
Total Revenue Shortfall Due to Less Than	Iao Waikapu	$ 80,813
Daily Water Requirements	Waihee-Hopoi	$ 1,105
Total Financial Impact (Additional Costs + Lost Revenue)		$ 536,318

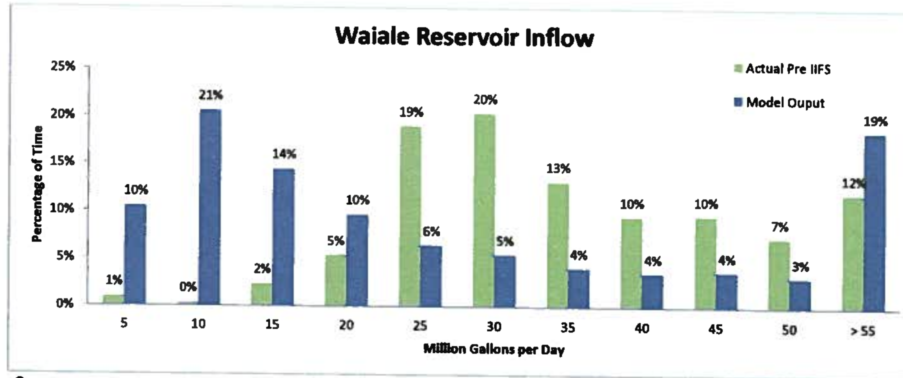
Inflows to Waiale Reservoirs			
Zero Days (Annualized)	2	Days	1%
County Water Treatment Plant			
Zero Days (Annualized)	0	Days	0%
Less than 1.5 MGD Available	0	Days	0%
Iao Waikapu Fields			
Zero Days (Annualized)	0	Days	0%
Less than Daily Requirement Available	1	Days	0%
Annual Water Shortfall	67	MG	
Waihee-Hopoi Fields			
Less than Daily Requirement Available	230	Days	63%
Less than Daily Requirement Available with Well 7 Pumping	2	Days	1%
Annual Water Shortfall	1	MG	

Exhibit E-R8

Scenario 2

Inputs/Assumptions

Waihee IIFS @ Waihee Ditch	10	MGD	Q90 = 24
Waihee IIFS @ Spreckels Ditch	10	MGD	
Iao IIFS @ Iao Waikapu Ditch	0	MGD	Q90 = 13
Iao IIFS @ Spreckels Ditch	0	MGD	
Waihee-Hopoi Fields Daily Requirement + Losses	23.75	MGD	
Iao Waikapu Fields Daily Requirement	5.9	MGD	
County Water Treatment Plant	1.5	MGD	
WWCo Customers, Kuleana Users and Losses	2.7	MGD	
Contribution from Waikapu Stream	2	MGD	Q90 = 3.3 - 4.6 (est.)



Summary

			actual ditch deliveries pre IIFS	post IIFS
Average Daily Flow				
Waihee Ditch @ Hopoi Chute	13.18	MGD	15.94	11.74
Spreckels Ditch @ Mill Street	11.52	MGD	17.50	12.68
Total inflows to Waiale Reservoirs	24.70	MGD	33.44	24.41
Median Daily Flow				
Waihee Ditch @ Hopoi Chute	10.31	MGD	15.02	10.06
Spreckels Ditch @ Mill Street	6.29	MGD	15.86	10.89
Total inflows to Waiale Reservoirs	17.25	MGD	30.43	21.10

		to meet daily requirement
Well 7 Water Pumped (MGD)		6.42
Operating Cost To Run Well 7 (annually)		$ 437,155
Amortized Cost of Well 7 improvements		$ 105,705
		$ 542,860
Total Revenue Shortfall Due to Less Than Daily Water Requirements	Iao Waikapu	$ 2,229
	Waihee-Hopoi	$ 202,828
Total Financial Impact (Additional Costs + Lost Revenue)		$ 747,917

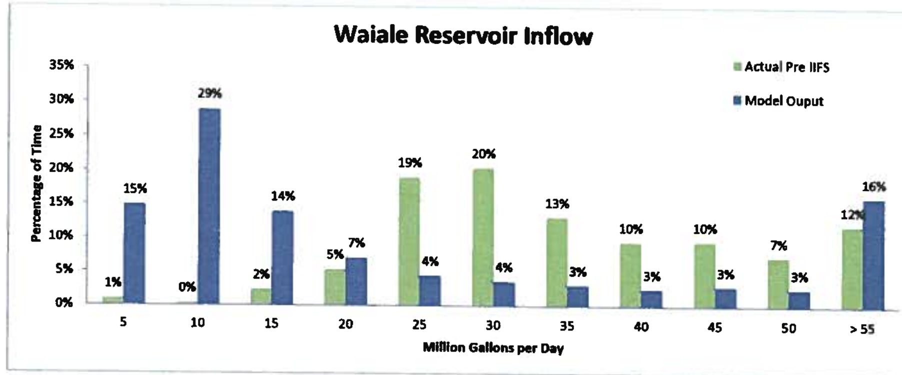
Inflows to Waiale Reservoirs			
Zero Days (Annualized)	2	Days	0%
County Water Treatment Plant			
Zero Days (Annualized)	0	Days	0%
Less than 1.5 MGD Available	0	Days	0%
Iao Waikapu Fields			
Zero Days (Annualized)	0	Days	0%
Less than Daily Requirement Available	0	Days	0%
Annual Water Shortfall	2	MG	
Waihee-Hopoi Fields			
Less than Daily Requirement Available	222	Days	61%
Less than Daily Requirement Available with Well 7 Pumping	47	Days	13%
Annual Water Shortfall	169	MG	

Exhibit E-R9

Scenario 3

Inputs/Assumptions

Waihee IIFS @ Waihee Ditch	10	MGD	Q90 = 24
Waihee IIFS @ Spreckels Ditch	10	MGD	
Iao IIFS @ Iao Waikapu Ditch	4	MGD	Q90 = 13
Iao IIFS @ Spreckels Ditch	4	MGD	
Waihee-Hopoi Fields Daily Requirement + Losses	23.75	MGD	
Iao Waikapu Fields Daily Requirement	5.9	MGD	
County Water Treatment Plant	1.5	MGD	
WWCo Customers, Kuleana Users and Losses	2.7	MGD	
Contribution from Waikapu Stream	2	MGD	Q90 = 3.3 - 4.6 (est.)



Summary

			actual ditch deliveries pre IIFS	post IIFS
Average Daily Flow				
Waihee Ditch @ Hopoi Chute	13.14	MGD	15.94	11.74
Spreckels Ditch @ Mill Street	8.30	MGD	17.50	12.68
Total Inflows to Waiale Reservoirs	21.44	MGD	33.44	24.41
Median Daily Flow				
Waihee Ditch @ Hopoi Chute	10.31	MGD	15.02	10.06
Spreckels Ditch @ Mill Street	0.00	MGD	15.86	10.89
Total Inflows to Waiale Reservoirs	11.83	MGD	30.43	21.10

		to meet daily requirement
Well 7 Water Pumped (MGD)		8.24
Operating Cost To Run Well 7 (annually)		$ 560,731
Amortized Cost of Well 7 Improvements		$ 105,705
		$ 666,436
Total Revenue Shortfall Due to Less Than Daily Water Requirements	Iao Waikapu	$ 80,813
	Waihee-Hopoi	$ 282,540
Total Financial Impact (Additional Costs + Lost Revenue)		$ 1,029,790

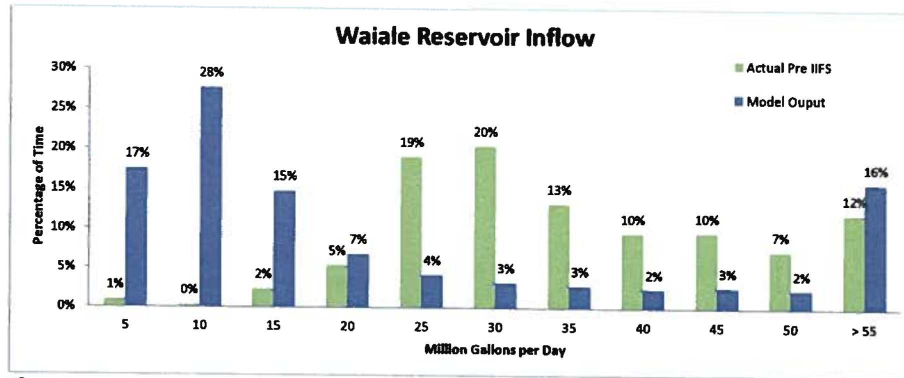
Inflows to Waiale Reservoirs			
Zero Days (Annualized)	2	Days	1%
County Water Treatment Plant			
Zero Days (Annualized)	0	Days	0%
Less than 1.5 MGD Available	0	Days	0%
Iao Waikapu Fields			
Zero Days (Annualized)	0	Days	0%
Less than Daily Requirement Available	1	Days	0%
Annual Water Shortfall	67	MG	
Waihee-Hopoi Fields			
Less than Daily Requirement Available	250	Days	69%
Less than Daily Requirement Available with Well 7 Pumping	66	Days	18%
Annual Water Shortfall	235	MG	

Exhibit E-R10

Scenario 4

Inputs/Assumptions

Waihee IIFS @ Waihee Ditch	10	MGD	Q90 = 24
Waihee IIFS @ Spreckels Ditch	10	MGD	
Iao IIFS @ Iao Waikapu Ditch	4	MGD	Q90 = 13
Iao IIFS @ Spreckels Ditch	4	MGD	
Waihee-Hopoi Fields Daily Requirement + Losses	23.75	MGD	
Iao Waikapu Fields Daily Requirement	5.9	MGD	
County Water Treatment Plant	1.5	MGD	
WWCo Customers, Kuleana Users and Losses	2.7	MGD	
Contribution from Waikapu Stream	0	MGD	Q90 = 3.3 - 4.6 (est.)



Summary

			actual ditch deliveries pre IIFS	actual ditch deliveries post IIFS
Average Daily Flow				
Waihee Ditch @ Hopoi Chute	12.99	MGD	15.94	11.74
Spreckels Ditch @ Mill Street	7.79	MGD	17.50	12.68
Total Inflows to Waiale Reservoirs	20.78	MGD	33.44	24.41
Median Daily Flow				
Waihee Ditch @ Hopoi Chute	10.31	MGD	15.02	10.06
Spreckels Ditch @ Mill Street	0.00	MGD	15.86	10.89
Total Inflows to Waiale Reservoirs	11.60	MGD	30.43	21.10

		to meet daily requirement
Well 7 Water Pumped (MGD)		8.61
Operating Cost To Run Well 7 (annually)		$ 585,937
Amortized Cost of Well 7 Improvements		$ 105,705
		$ 691,642
Total Revenue Shortfall Due to Less Than Daily Water Requirements	Iao Waikapu	$ 227,113
	Waihee-Hopoi	$ 270,487
Total Financial Impact (Additional Costs + Lost Revenue)		$ 1,189,242

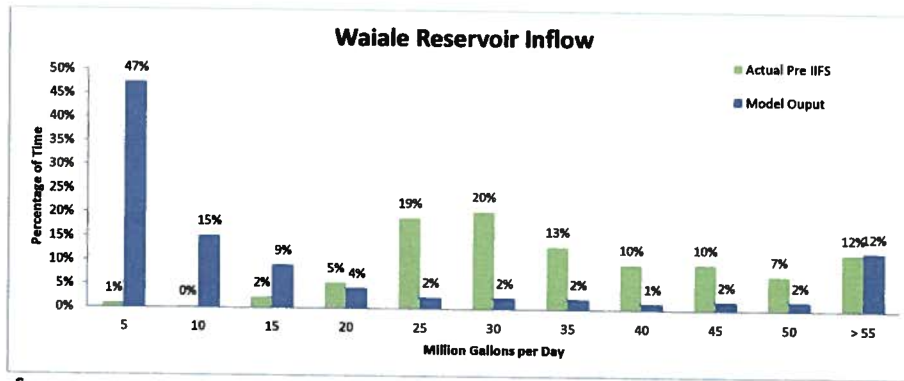
Inflows to Waiale Reservoirs			
Zero Days (Annualized)	5	Days	1%
County Water Treatment Plant			
Zero Days (Annualized)	0	Days	0%
Less than 1.5 MGD Available	0	Days	0%
Iao Waikapu Fields			
Zero Days (Annualized)	0	Days	0%
Less than Daily Requirement Available	4	Days	1%
Annual Water Shortfall	189	MG	
Waihee-Hopoi Fields			
Less than Daily Requirement Available	254	Days	70%
Less than Daily Requirement Available with Well 7 Pumping	72	Days	20%
Annual Water Shortfall	225	MG	

Exhibit E-R11

Scenario 5

Inputs/Assumptions

Waihee IIFS @ Waihee Ditch	14	MGD	Q90 = 24
Waihee IIFS @ Spreckels Ditch	14	MGD	
Iao IIFS @ Iao Waikapu Ditch	13	MGD	Q90 = 13
Iao IIFS @ Spreckels Ditch	8	MGD	
Waihee-Hopoi Fields Daily Requirement + Losses	23.75	MGD	
Iao Waikapu Fields Daily Requirement	5.9	MGD	
County Water Treatment Plant	1.5	MGD	
WWCo Customers, Kuleana Users and Losses	2.7	MGD	
Contribution from Waikapu Stream	2	MGD	Q90 = 3.3 - 4.6 (est.)



Summary

			actual ditch deliveries pre IIFS	post IIFS
Average Daily Flow				
Waihee Ditch @ Hopoi Chute	9.26	MGD	15.94	11.74
Spreckels Ditch @ Mill Street	5.73	MGD	17.50	12.68
Total inflows to Waiale Reservoirs	15.00	MGD	33.44	24.41
Median Daily Flow				
Waihee Ditch @ Hopoi Chute	5.36	MGD	15.02	10.06
Spreckels Ditch @ Mill Street	0.00	MGD	15.86	10.89
Total inflows to Waiale Reservoirs	5.66	MGD	30.43	21.10

		to meet daily requirement
Well 7 Water Pumped (MGD)		11.91
Operating Cost To Run Well 7 (annually)		$ 810,803
Amortized Cost of Well 7 Improvements		$ 105,705
		$ 916,508
Total Revenue Shortfall Due to Less Than Daily Water Requirements	*Iao Waikapu*	$ 548,167
	Waihee-Hopoi	$ 232,579
Total Financial Impact (Additional Costs + Lost Revenue)		$ 1,697,254

Inflows to Waiale Reservoirs			
Zero Days (Annualized)	101	Days	28%
County Water Treatment Plant			
Zero Days (Annualized)	84	Days	23%
Less than 1.5 MGD Available	107	Days	29%
Iao Waikapu Fields			
Zero Days (Annualized)	0	Days	0%
Less than Daily Requirement Available	98	Days	27%
Annual Water Shortfall	457	MG	
Waihee-Hopoi Fields			
Less than Daily Requirement Available	284	Days	78%
Less than Daily Requirement Available with Well 7 Pumping	178	Days	49%
Annual Water Shortfall	194	MG	

Exhibit E-R12

Leak Detection

Leak detection is a necessary component to the management of water distribution systems worldwide. Accurate determination of the position of leaking water pipes within a supply system and subsequent repair serves to conserve water as well as energy. Water that is lost after treatment and pressurization, but before delivery to customers, is money and energy wasted.

LEAK DETECTION FREQUENTLY ASKED QUESTIONS

How much water is lost to leaks?

Answer: A detailed water audit and leak detection program of 47 California water utilities found an average loss of 10 percent and a range of 30 percent to less than 5 percent of the total water supplied by the utilities. The July 1997 Journal American Water Works Association cites examples of more than 45 percent leakage.

Do leaks get bigger with age?

Answer: Yes. Leaks invariably get larger with time. A small leak this year will grow to become a large leak next year, all the while losing water and causing greater damage to infrastructure and property.

Does water from leaks always rise to the surface?

Answer: No, leaks are often unseen at the surface. Nonvisible leaks include leaks that percolate into the surrounding ground, leaks that enter other conveyance facilities, such as storm drains, sewers, stream channels, or old abandoned pipes. DWR estimates that up to 700,000 acre-feet of leakage occurs in California each year from nonvisible leaks.

What are the reasons to find and repair leaks?

Answer:

- Leaks get bigger with age.
- Repairing leaks reduces growing water losses.
- Repairing leaks with regularly scheduled maintenance reduces overtime costs of unscheduled repairs.
- Leak repairs provide more treated, pressurized water to sell to customers.
- Leak detection and repair can reduce power costs to deliver water and reduce chemical costs to treat water.
- Leaks have been known to cause damage to nearby roads, other infrastructure, and sometimes buildings. Some water utilities conduct frequent leak detection and repair programs near unstable geologic areas to reduce their legal liability against expensive lawsuits.

Exhibit E-R13

- Leak detection and repair improves public relations. The public appreciates seeing that its water systems are being maintained.
- The utility gains credibility by putting its own house in order before asking the customers to conserve water.

How can I determine if there are leaks at my home or business?

Answer: Leaks from the pipes going to the building or inside the building lose water delivered through the utility meter and service.

There is one way to test if leaks exist inside the building:

- Repair leaky faucets, showers, toilets, etc.
- Turn off all the water using appliances (including the swimming pool, ice cube maker, water softener, etc.),
- Look at the meter. On the dial of many meters is a small triangle which rotates if any water passes through the meter. If this device is turning, then water is flowing to an appliance or a leak.
- You can also listen for the sound of leaks at the meter or at a hose bib.

What is Unaccounted-for-Water?

Answer: Unaccounted-for-water is a misleading term long used by the water industry. Unaccounted-for-water includes unmeasured water put to beneficial use as well as water losses from the system. Better terms distinguish between authorized unmetered uses and water losses. Authorized unmetered uses include firefighting, main flushing, process water for water treatment plants, landscaping of public areas, etc. Water losses include all water that is not identified as authorized metered water use or authorized unmetered use. Water losses are lost from the distribution system, do not produce revenue, and are unavailable for other beneficial uses. Examples of water losses are: illegal connections, accounting procedure errors, reservoir seepage and leakage, reservoir overflow, leaks, theft, evaporation, and malfunctioning distribution system controls.

Where does the water from leaks go?

Answer: Leaks often stay underground. The water may enter other underground facilities such as storm drains, sewers, electrical conduits, basements of buildings, or old abandoned pipes. Some water percolates into the surrounding ground, flows over the surface to stream channels, or evaporates.

What does leak detection cost?

Answer: Acoustic leak detection surveys can be conducted at the rate of about 2 miles of pipe main per day. The dollar cost will vary with local labor or consultant charges. For a California leak detection program, half the savings were achieved with survey cost of less than $100 per acre-foot and 80 percent of the water savings were achieved with survey cost of less than $200 per acre-foot.

What do leak repairs cost?

Answer: The cost of leak repair varies widely, from a few minutes by one person to tighten a nut on a leaky meter, to two days by a crew with heavy equipment to repair a deeply buried main. Scheduled maintenance for leak repairs is far cheaper than unscheduled overtime.

Why do leaks produce noise?

Answer: Leaks make noise because the pressurized water forced out through a leak loses energy to the pipe wall and to the surrounding soil area. This energy creates sound waves in the audible range, which can be sensed and amplified by electronic transducers, or in some cases, by simple mechanical means. Some additional noise created by the impact of water upon soil in the area of the leak. Agitated sand and gravel can sometimes be heard striking the pipe.

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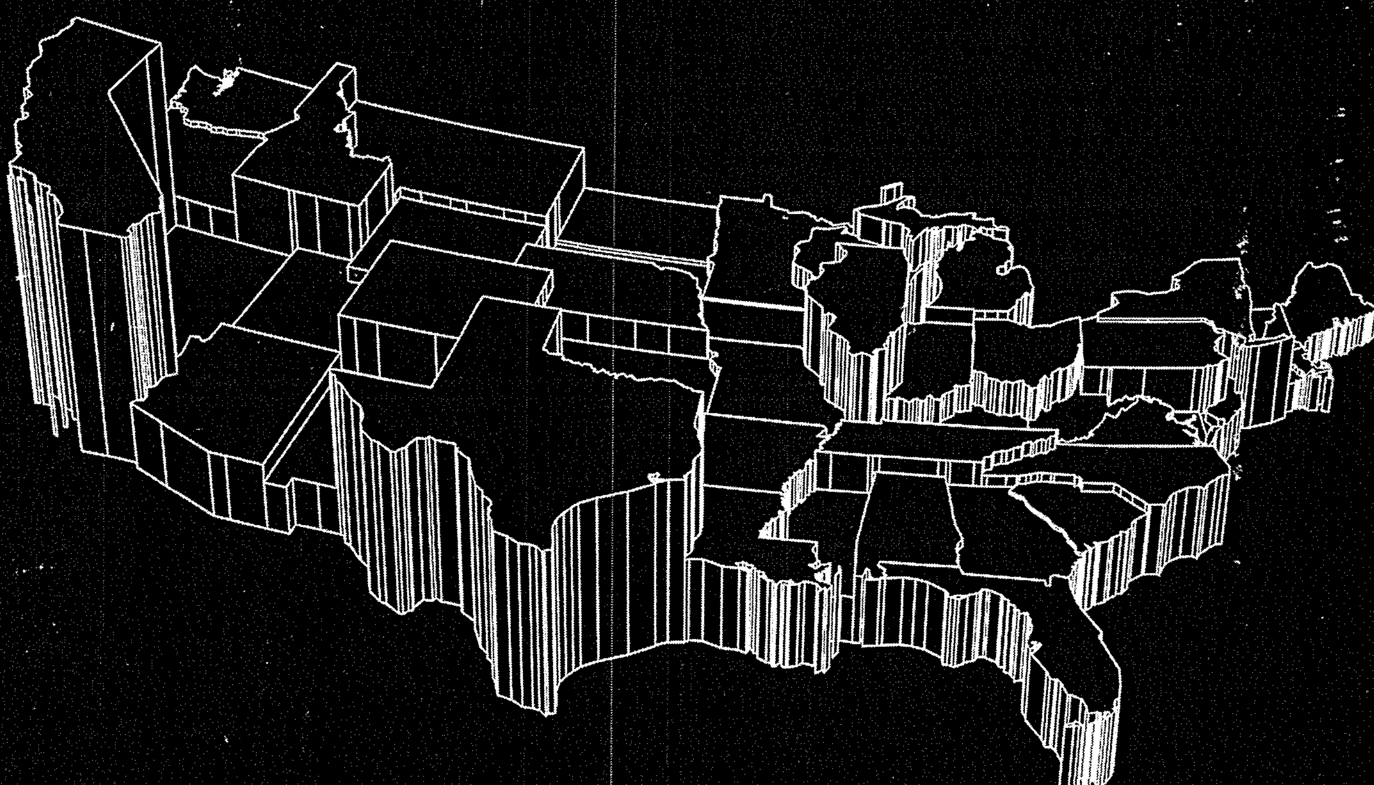
ESTIMATED USE OF WATER IN THE UNITED STATES IN 1995

U.S. Geological Survey Circular 1200



U.S. Department of the Interior
U.S. Geological Survey

Exhibit E-R14

Availability of Publications of the U.S. Geological Survey

Order U.S. Geological Survey (USGS) publications from the offices listed below. Detailed ordering instructions, along with prices of the last offerings, are given in the current-year issues of the catalog "New Publications of the U.S. Geological Survey."

Books, Maps, and Other Publications

By Mail

Books, maps, and other publications are available by mail from—

USGS Information Services
Box 25286, Federal Center
Denver, CO 80225

Publications include Professional Papers, Bulletins, Water-Supply Papers, Techniques of Water-Resources Investigations, Circulars, Fact Sheets, publications of general interest, single copies of permanent USGS catalogs, and topographic and thematic maps.

Over the Counter

Books, maps, and other publications of the U.S. Geological Survey are available over the counter at the following USGS Earth Science Information Centers (ESIC's), all of which are authorized agents of the Superintendent of Documents:

- Anchorage, Alaska–Rm. 101, 4230 University Dr.
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ESTIMATED USE OF WATER IN THE UNITED STATES IN 1995

By Wayne B. Solley, Robert R. Pierce,
and Howard A. Perlman

U.S. GEOLOGICAL SURVEY CIRCULAR 1200

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Foreword

The balance between supply and demand for water is a delicate one, marked over time by political and environmental conflicts, the impacts of natural disasters and human actions, and the day-to-day demands for a multiplicity of uses for this most vital resource. Although a renewable resource, water is not always available to a thirsty Nation when and where it is needed, nor is it always of suitable quality for the intended use. Water must be considered as a finite resource that has limits and boundaries to its availability and suitability for use.

In the United States, many existing sources of water are being stressed by withdrawals from aquifers and diversions from rivers and reservoirs to meet the needs of homes, cities, farms, and industries. Increasing requirements to leave water in the streams and rivers to meet environmental, fish and wildlife, and recreational needs further complicate the matter. After continual increases in the Nation's total withdrawal of surface water and ground water for the years reported from 1950 to 1980, water withdrawals declined and have remained fairly constant since the mid 1980's. The decline in withdrawals is especially significant in light of the fact that population continued to increase during the same period. Clearly as a Nation, we are using our surface- and ground-water resources more efficiently. This decline signals that water use does respond to economic and regulatory factors, and that the general public has an enhanced awareness about water-resources and conservation issues.

As planners, managers, and elected officials wrestle with the varied water-management problems facing the Nation at the beginning of the new century, they need consistent information on water supply and use by State, watershed, and water-use category. This will help the Nation realize the maximum benefit from its water resources and will help strike that crucial balance between supply and demand.

The U.S. Geological Survey has compiled and disseminated estimates of water use for the Nation at 5-year intervals since 1950. In 1977, the Congress expanded the Survey's water-use activities by establishing a National Water-Use Information Program, which, in cooperation with the States, collects reliable and uniform information on the sources, uses, and dispositions of water in the United States. The result of that cooperative effort is a valuable long-term data set of national water-use estimates that can be used to assess the effectiveness of alternative water-management policies, regulations, and conservation activities, and to make projections of future demands. This Circular documents water use in 1995 and identifies changes in water use that have occurred over the past 45 years.

More detailed water-use information is available on our Web site at URL:
http://water.usgs.gov/public/watuse/

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Conversion Factors

Multiply	By	To Obtain
		Area
acre	43,560	square foot (ft^2)
	4,047	square meter (m^2)
	0.001562	square mile (mi^2)
	Flow	
gallon per day (gal/d)	3.785	liter per day
million gallons per day (Mgal/d)	1.121	thousand acre-feet per year
	0.001547	thousand cubic feet per second
	0.6944	thousand gallons per minute
	0.003785	million cubic meters per day
	1.3815	million cubic meters per year
thousand acre-feet per year	0.8921	million gallons per day
	0.001380	thousand cubic feet per second
	0.6195	thousand gallons per minute
	0.003377	million cubic meters per day

Some water relations in inch-pounds units are listed below:

		(Approximations)
1 gallon	=	8.34 pounds
1 million gallons	=	3.07 acre-feet
1 cubic foot	=	62.4 pounds
	=	7.48 gallons
1 acre-foot (acre-ft)	=	325,851 gallons
	=	43,560 cubic feet
1 inch of rain	=	17.4 million gallons per sqare mile
	=	27,200 gallons per acre
	=	100 tons per acre

GLOSSARY

Water-use terminology is continuing to expand in this series of water-use circulars prepared at 5-year intervals. The term "water use" as initially used in 1950 in the U.S. Geological Survey's water-use circulars meant withdrawals of water; in the report for 1960, the term was redefined to include consumptive use of water as well as withdrawals. With the beginning of the Survey's National Water-Use Information Program in 1978 the term was again redefined to include return flow and offstream and instream uses. In the report for 1985, the term was redefined to include withdrawals plus deliveries.

acre-foot (acre-ft)—the volume of water required to cover 1 acre of land (43,560 square feet) to a depth of 1 ft.

animal specialties—water use associated with the production of fish in captivity except fish hatcheries, fur-bearing animals in captivity, horses, rabbits, and pets. *See also* livestock water use.

aquaculture—farming of organisms that live in water, such as fish, shellfish, and algae.

aquifer—a geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

commercial water use—water for motels, hotels, restaurants, office buildings, other commercial facilities, and institutions. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

consumptive use—that part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. Also referred to as water consumed.

conveyance loss—water that is lost in transit from a pipe, canal, conduit, or ditch by leakage or evaporation. Generally, the water is not available for further use; however, leakage from an irrigation ditch, for example, may percolate to a ground-water source and be available for further use.

cooling water—water used for cooling purposes, such as of condensers and nuclear reactors.

delivery/release—the amount of water delivered to the point of use and the amount released after use; the difference between these amounts is usually the same as the consumptive use. *See also* consumptive use.

domestic water use—water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Also called residential water use. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

evaporation—process by which water is changed from a liquid into a vapor. *See also* evapotranspiration.

evapotranspiration—a collective term that includes water discharged to the atmosphere as a result of evaporation from the soil and surface-water bodies and as a result of plant transpiration. *See* also evaporation and transpiration.

freshwater—water that contains less than 1,000 parts per million (ppm) of dissolved solids; generally, more than 500 ppm of dissolved solids is undesirable for drinking and many industrial uses.

ground water—generally all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids are filled with water).

hydroelectric power water use—the use of water in the generation of electricity at plants where the turbine generators are driven by falling water. Hydroelectric water use is classified as an instream use in this report.

in-channel use—*see* instream use.

industrial water use—water used for industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, mining, and petroleum refining. The water may be obtained from a public supply or may be self supplied. *See also* public supply and self-supplied water.

instream use—water that is used, but not withdrawn, from a ground- or surface-water source for such purposes as hydroelectric power generation, navigation, water-quality improvement, fish propagation, and recreation. Sometimes called nonwithdrawal use or in-channel use.

irrigation district—a cooperative, self-governing public corporation set up as a subdivision of the State government, with definite geographic boundaries, organized and having taxing power to obtain and distribute water for irrigation of lands within the district; created under the authority of a State legislature with the consent of a designated fraction of the landowners or citizens.

irrigation water use—artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf courses.

kilowatthour (kWh)—a unit of energy equivalent to one thousand watthours.

livestock water use—water for livestock watering, feed lots, dairy operations, fish farming, and other on-farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are animal specialties. *See* also rural water use and animal specialties.

million gallons per day (Mgal/d)—a rate of flow of water.

mining water use—water use for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Also includes uses associated with quarrying, milling (crushing, screening, washing, floatation, and so forth), and other preparations customarily done at the mine site or as part of a mining activity. Does not include water used in processing, such as smelting, refining petroleum, or slurry pipeline operations. These uses are included in industrial water use.

offstream use—water withdrawn or diverted from a ground- or surface-water source for public-water supply, industry, irrigation, livestock, thermoelectric power generation, and other uses. Sometimes called off-channel use or withdrawal use.

per-capita use—the average amount of water used per person during a standard time period, generally per day.

public supply—water withdrawn by public and private water suppliers and delivered to users. Public suppliers provide water for a variety of uses, such as domestic, commercial, thermoelectric power, industrial, and public water use. *See also* commercial water use, domestic water use, thermoelectric power water use, and industrial water use.

public-supply deliveries—water provided to users through a public-supply distribution system.

public water use—water supplied from a public-water supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools. *See also* public supply.

reclaimed wastewater—wastewater treatment plant effluent that has been diverted for beneficial use before it reaches a natural waterway or aquifer.

recycled water—water that is used more than one time before it passes back into the natural hydrologic system.

residential water use—*see* domestic water use.

return flow—the water that reaches a ground- or surface-water source after release from the point of use and thus becomes available for further use.

reuse—*see* recycled water.

rural water use—term used in previous water-use circulars to describe water used in suburban or farm areas for domestic and livestock needs. The water generally is self supplied, and includes domestic use, drinking water for livestock, and other uses, such as dairy sanitation, evaporation from stock-watering ponds, and cleaning and waste disposal. *See also* domestic water use, livestock water use, and self-supplied water.

saline water—slightly saline water contains from 1,000 to 3,000 parts per million (ppm) of dissolved solids. Moderatly saline water contains from 3,000 ppm to 10,000 ppm, and highly saline water contains from 10,000 to 35,000 ppm.

self-supplied water—water withdrawn from a surface- or ground-water source by a user rather than being obtained from a public supply.

standard industrial classification (SIC) codes—four-digit codes established by the Office of Management and Budget and used in the classification of establishments by type of activity in which they are engaged.

surface water—an open body of water, such as a stream or a lake.

thermoelectric power water use—water used in the process of the generation of thermoelectric power. The water may be obtained from a public supply or may be self supplied. *See* also public supply and self-supplied water.

transpiration—process by which water that is absorbed by plants, usually through the roots, is evaporated into the atmosphere from the plant surface. *See also* evaporation and evapotranspiration.

wastewater—water that carries wastes from homes, businesses, and industries.

wastewater treatment—the processing of wastewater for the removal or reduction of contained solids or other undesirable constituents.

wastewater-treatment return flow—water returned to the hydrologic system by wastewater-treatment facilities.

water-resources region—designated natural drainage basin or hydrologic area that contains either the drainage area of a major river or the combined drainage areas of two or more rivers; of 21 regions, 18 are in the conterminous United States, and one each are in Alaska, Hawaii, and the Caribbean. (*See* map on inside of front cover.)

water-resources subregion—the 21 designated water-resources regions of the United States are subdivided into 222 subregions. Each subregion includes that area drained by a river system, a reach of a river and its tributaries in that reach, a closed basin(s), or a group of streams forming a coastal drainage system.

water transfer—artificial conveyance of water from one area to another.

water use—1) in a restrictive sense, the term refers to water that is actually used for a specific purpose, such as for domestic use, irrigation, or industrial processing. In this report, the quantity of water use for a specific category is the combination of self-supplied withdrawals and public-supply deliveries. 2) More broadly, water use pertains to human's interaction with and influence on the hydrologic cycle, and includes elements such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and instream use. *See also* offstream use and instream use.

watthour (Wh)—an electrical energy unit of measure equal to one watt of power supplied to, or taken from, an electrical circuit steadily for one hour.

withdrawal—water removed from the ground or diverted from a surface-water source for use. *See also* offstream use and self-supplied water.

ESTIMATED USE OF WATER IN THE UNITED STATES IN 1995

By Wayne B. Solley, Robert R. Pierce, *and* Howard A. Perlman

ABSTRACT

Estimates indicate that after continual increases in the Nation's total water withdrawals for the years reported from 1950 to 1980, withdrawals declined from 1980 to 1995. The withdrawal of fresh- and saline water in the United States during 1995 is estimated to have been 402,000 million gallons per day (Mgal/d) for all offstream uses—2 percent less than the 1990 estimate. The 1995 withdrawal estimate is nearly 10 percent less than the 1980 estimate, which is the peak year of water use documented in this 5-year compilation series that began in 1950. This decline in water withdrawals occurred even though population increased 16 percent from 1980 to 1995. Total freshwater withdrawals are an estimated 341,000 Mgal/d for 1995, or about the same as in 1990. Per-capita use for all offstream uses in 1995 was 1,500 gallons per day (gal/d) of fresh- and saline water combined and 1,280 gal/d of freshwater, compared to 1990 when per-capita use was 1,620 gal/d of fresh- and saline water and 1,340 gal/d of freshwater.

Estimates of withdrawals by source indicate that during 1995, total surface-water withdrawals were 324,000 Mgal/d, which is about the same as during 1990, and total ground-water withdrawals were 77,500 Mgal/d, or 4 percent less than during 1990. Total saline-water withdrawals during 1995 were 60,800 Mgal/d, or 12 percent less than during 1990, most of which was saline surface water. The use of reclaimed wastewater is estimated to have been 1,020 Mgal/d during 1995, which is 36 percent more than the 750 Mgal/d used during 1990.

Offstream water-use categories are classified in this report as public supply, domestic, commercial, irrigation, livestock, industrial, mining, and thermoelectric power. The two largest water-use categories continue to be thermoelectric power and irrigation. In 1995, the most water (190,000 Mgal/d, of which 57,900 Mgal/d was saline) was withdrawn for thermoelectric power cooling, whereas the most freshwater (134,000 Mgal/d) was withdrawn for irrigation. The estimate of total (fresh, saline) self-supplied withdrawals for "other" industrial uses during 1995 is 29,100 Mgal/d, or about 3 percent less than during 1990. Industrial withdrawals declined from 1980 to 1995 after remaining about the same for the years reported from 1965 to 1980. In fact, self-supplied withdrawals for "other" industrial use during 1995 are the lowest since records began in 1950.

Water for hydroelectric power generation, the only instream use compiled in this report, is estimated to have been about 3,160,000 Mgal/d during 1995. This is 4 percent less than the 1990 estimate.

Total freshwater consumptive use is estimated to have been about 100,000 Mgal/d during 1995, or 6 percent more than during 1990. Consumptive use by irrigation accounts for the largest part of total consumptive use and is an estimated 81,300 Mgal/d for 1995. Freshwater consumptive use in the East (water-resources regions east of and including the Mississippi regions) is about 12 percent of freshwater withdrawn in the East and accounts for only 20 percent of the Nation's consumptive use. By comparison, freshwater consumptive use in the West is about 47 percent of freshwater withdrawals. The higher consumptive use in the West is attributable to the 90 percent of the water withdrawn for irrigation that occurs in the West.

A comparison of total withdrawals by water-resources region indicates that the California, South Atlantic-Gulf, and Mid-Atlantic regions account for one-third of the total water withdrawn in the United States. The largest amount of irrigation occurs in the California, Pacific Northwest, and Missouri regions; and the largest withdrawals for thermoelectric power occur in the Mid-Atlantic and South Atlantic-Gulf regions. A similar comparison of total withdrawals by State indicates that California accounts for the largest withdrawal, which is about 45,900 Mgal/d, followed by Texas, Illinois, and Florida. Some 24 States and Puerto Rico had less water withdrawn for offstream uses during 1995 than during 1990.

INTRODUCTION

Many existing sources of water are being stressed by withdrawals from aquifers and diversions from rivers and reservoirs to meet the needs of homes, cities, farms, and industries. Increasing requirements to leave water in the streams and rivers to meet environmental, human, and recreational needs further complicate the matter.

Traditionally, water management in the United States has focused on manipulating the country's supplies of freshwater to meet the needs of users. A number of large dams were built during the early 20th century to increase the supply of freshwater for any given time. This era of building large dams to meet water demand in the United States has passed. As we approach the 21st century, the finite water supply and established infrastructure require that demand be managed effectively within the available sustainable supply. Quantitative assessments derived from this type of national water-use compilation can be used to evaluate the impacts of population growth and the effectiveness of alternative water-management policies, regulations, and conservation activities. As the focus on water management is increasingly on the river basin or watershed, often spanning multiple States, this national compilation of data also can be used to develop and evaluate trends in water use, to plan for more effective uses of the Nation's water resources, and to make projections of future demands.

PURPOSE AND SCOPE

The purpose of this report is to present consistent and current water-use estimates by State and water-resources region for the United States, Puerto Rico, the U.S. Virgin Islands, and the District of Columbia. Estimates of water withdrawn from surface- and ground-water sources, estimates of consumptive use, and estimates of instream use and wastewater releases during 1995 are presented in this report. The U.S. Geological Survey (USGS) has compiled similar national estimates at 5-year intervals since 1950 (MacKichan, 1951, 1957; MacKichan and Kammerer, 1961; Murray, 1968; Murray and Reeves, 1972, 1977; and Solley and others, 1983, 1988, 1993). This series of water-use reports serves as one of the few sources of information about regional or naional trends in water use. This report discusses eight categories of offstream water use—public supply, domestic, commercial, irrigation, livestock, industrial, mining, and thermoelectric power—and one category of instream use: hydroelectric power. Detailed information for other instream uses, such as navigation, recreation, pollution abatement, and fish habitat is beyond the scope of this report. Information on wastewater-treatment facilities is given in the "Wastewater Release" section.

For each category of offstream water use, 1995 withdrawal and consumptive-use estimates are discussed and those estimates are compared with corresponding 1990 estimates. The text is supplemented with illustrations and tables showing data for each State, Puerto Rico, the U.S. Virgin Islands, and the District of Columbia and for each of the 21 water-resources regions. (Water-resources regions are shown on a map on the inside of the front cover.) Totals are highlighted in the tables for ease of reference. At the beginning of this report is a section on total water use by category and source of water, and at the end is a section on trends in water use for the period 1950-95.

TERMINOLOGY

The terms and units used in this report are similar to those used in previous water-use circulars in this series. In this report, the term "offstream use" refers to water diverted or withdrawn from a surface- or ground-water source and conveyed to a place of use. "Instream use" refers to uses taking place within the river channel itself. Hydroelectric power generation is discussed as an "instream use," although some hydroelectric power water use was reported as offstream use. The hydroelectric power offstream use is included in the instream totals for consistency with previous reports. The terms "freshwater," "saline water," and "reclaimed wastewater," as types of water, are defined in the glossary. The definition of saline water has been expanded in the glossary to include slightly saline, moderately saline, and highly saline. Slightly saline withdrawals, 1,000 to 3,000 parts per million (ppm) of dissolved solids, are reported as freshwater in this series. Saline water is tabulated only for the industrial, mining, and thermoelectric power categories. A few States reported saline withdrawals for the commercial, animal specialties, and public-supply categories. These withdrawals are small and are included under freshwater for the commercial and public-supply categories. The saline withdrawals reported for animal specialties are not listed in the tables or included in the totals. Some public supplies treat slightly saline water before it is distributed, but all public-supply withdrawals are considered as freshwater in this report. Surface water and ground water, as sources of water, and the categories of water use also are defined in the glossary. In this report, withdrawals refer to self-supplied withdrawals, and deliveries refer to public-supply deliveries. "Consumptive use" refers to that part of the water withdrawn that is evaporated, transpired, incorporated into products and crops, consumed by humans or livestock, or otherwise removed from the immediate water supply.

Sources of Data and Methods of Analysis

In cooperation with State and local agencies, the water-use estimates for 1995 were compiled by the USGS's District offices for each county in the United States, Puerto Rico, and the U.S. Virgin Islands, and for the 2,149 water-resources cataloging units. [For an explanation of cataloging units, see Seaber and others (1987)]. These estimates were entered into a State aggregate water-use data base in each District office, reviewed by a regional water-use specialist, and submitted to the USGS's headquarters in Reston, Va. The information was aggregated by State (including Puerto Rico, the U.S. Virgin Islands, and the District of Columbia) and by the 21 water-resources regions for each category of water use. All the water-use information compiled for this report is stored in the USGS's Aggregate Water-Use Data System (AWUDS) and is available by both county and cataloging unit on the World Wide Web through URL:

http://water.usgs.gov/public/watuse/

Sources of information and accuracy of data vary and are discussed for each category in subsequent parts of this report. This compilation effort was coordinated by the USGS's National Water-Use Information Program which was implemented in 1977 to provide more uniform, current, and reliable information on water use. "Guidelines for Preparing U.S. Geological Survey Water-Use Estimates in the United States for 1995" were developed and distributed on the Web, and are available at the site identified above. USGS water-use project chiefs also are identified at the Web site mentioned above. Each project chief compiled and analyzed information from various State cooperators, made estimates of missing data elements, and prepared documentation that identifies the sources of water-use information for each State and describes how the water-use estimates were determined for this report. Many state agencies publish reports on water use as part of their participation in the National Water-Use Information Program, and a list of these publications is given at the end of this report.

The following national data files were made available to each USGS District office for reference: U.S. Environmental Protection Agency Permit Compliance files and Safe Drinking Water Information System (SDWIS) files, U.S. Bureau of Census population files, and the U.S. Department of Energy, Energy Information Administration reports. Each District is responsible for determining the most reliable source of information available for that State.

Water-use numerical data are the average daily quantities used. Irrigation water is applied during only a part of each year and at variable rates; therefore, the actual rate of application is much greater than the average daily rate given in tables in this report. In this report, numerical data generally are rounded to three significant figures for values greater than 100 and two significant figures for values less than 100. Most tables show these data in million gallons per day. Selected tables also show per-capita-use data in gallons per day, rounded to three significant figures, and irrigation and hydroelectric power data in thousand-acre feet per year. A conversion table is given before the glossary to assist those readers who may wish to convert the data to other units of measurement. All numbers were rounded independently; thus, the sums of individual rounded numbers may not equal the totals. The percentage changes discussed in the text were calculated from the unrounded data.

Population data, which are from the U.S. Bureau of the Census population estimates and projections (U.S. Bureau of the Census, 1996), are shown to the nearest thousand. Data on population served by public supply were compiled in cooperation with State and local agencies and are rounded to three significant figures.

Acknowledgments

The authors acknowledge the assistance provided by the many State and local agencies that cooperated with the U.S. Geological Survey, and the many USGS State water-use project chiefs that participated in the collection and compilation of data for this report. USGS water-use project chiefs responsible for the 1995 compilation for each state are identified on the Web through the URL:

http://water.usgs.gov/public/watuse/

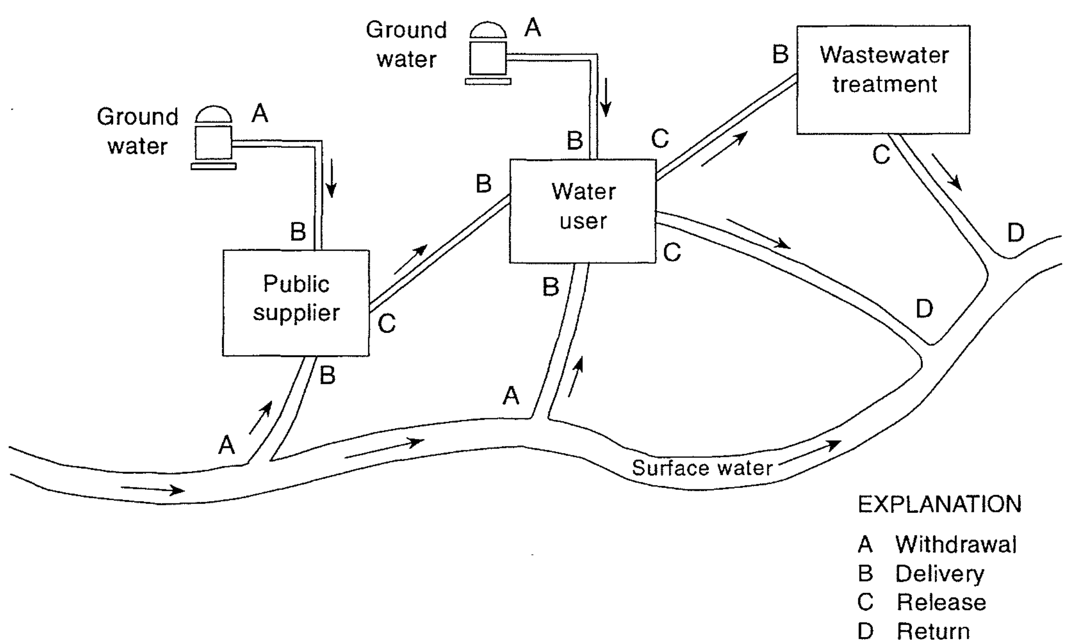
In many States, such as West Virginia and New Mexico, cooperator personnel worked as full partners with the USGS in this compilation and analysis effort.

WATER USE

Water use in this report is subdivided into offstream use, instream use, and wastewater release. The difference among these types of use is explained below.

Offstream use is a water use that refers to water being diverted or withdrawn from a surface- or ground-water source and conveyed to the place of use. To determine the total quantity of offstream water use (self-supplied withdrawals and public-supply deliveries), five subtypes of use are evaluated, as explained below and shown in the following sketch.

1. Withdrawal—The quantity of water diverted or withdrawn from a surface- or ground-water source. (A in sketch).
2. Delivery/release—The quantity of water delivered at the point of use (B) and the quantity released after use (C).
3. Conveyance loss—The quantity of water that is lost in transit, for example, from point of withdrawal to point of delivery (A-B), or from point of release to point of return (C-D).
4. Consumptive use—That part of water withdrawn that is evaporated, transpired, or incorporated into products or crops. In some instances, consumptive use will be the difference between the volume of water delivered and the volume released (B-C).
5. Return flow—The quantity of water that is discharged to a surface- or ground-water source (D) after release from the point of use and thus becomes available for further use.



In this report, self-supplied withdrawals by source, deliveries from public suppliers (where applicable), and consumptive-use estimates are given for the following categories of offstream use: domestic, commercial, irrigation, livestock, industrial, mining, and thermoelectric power. For the public-supply category, in addition to withdrawals, the report also gives water delivered to domestic, commercial, industrial, and thermoelectric power users.

Each category of offstream use typically effects the reuse potential of return flows differently. Reuse potential reflects the quality and the quantity of water available for subsequent uses; for example, irrigation return flow may be contaminated by pesticides and fertilizers, and, because of the high consumptive use of water during irrigation, the mineral content of the return flow often is substantially greater than that of the water applied. Consequently, irrigation return flow frequently may have little reuse potential. This is a significant contrast to the reuse potential of most water discharged from thermoelectric plants, where the principal change is an increase in water temperature.

Instream use is a water use that takes place without the water being diverted or withdrawn from surface- or ground-water sources. Examples of instream uses are hydroelectric power generation, navigation, freshwater dilution of saline estuaries, maintenance of minimum streamflows to support fish and wildlife habitat, and wastewater assimilation.

Quantitative estimates for most instream uses are difficult to compile on a national scale. However, because such uses compete with offstream uses and affect the quality and quantity of water resources for all uses, effective water-resources management requires that methods and procedures be devised to enable instream uses to be assessed quantitatively. California is one of the first States to quantify various types of instream uses.

The only instream-use estimates compiled for this report are for hydroelectric power generation. Unlike other instream uses, the water used for hydroelectric power generation is a measurable quantity because the amount of water passed through the plant can be documented. Consumptive use in actual hydroelectric power generation (as opposed to evaporation from impoundments created by hydroelectric dams) generally is negligible.

In this report, wastewater release refers to water released from private and public wastewater-treatment facilities. Information is provided on the number of publicly and privately owned wastewater-treatment facilities and on releases from only the public wastewater-treatment facilities. The releases can be either returned to the natural environment or reclaimed for beneficial uses, such as irrigation of golf courses and parks.

OFFSTREAM USE

Total Water Use

402,000 million gallons per day

Total fresh and saline withdrawals during 1995 are estimated to have been 402,000 million gallons per day (Mgal/d) for all offstream water-use categories (public supply, domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power), which is nearly 2 percent less than the withdrawal estimate for 1990. Total freshwater withdrawals were an estimated 341,000 Mgal/d during 1995, which is about the same as during 1990. Per-capita use for all offstream uses in 1995 was 1,500 gallons per day (gal/d) of fresh- and saline water combined and 1,280 gal/d of freshwater, compared to 1990 when per-capita use was 1,620 gal/d of fresh- and saline water and 1,340 gal/d of freshwater (Solley and others, 1993).

Estimates of withdrawals by source indicate that during 1995, total surface-water withdrawals were 324,000 Mgal/d, which is about the same as during 1990. About 59,700 Mgal/d of surface water withdrawn was saline water. Total ground-water withdrawals were 77,500 Mgal/d, or 4 percent less than during 1990. About 99 percent of ground water withdrawn was freshwater.

A comparison of total withdrawals by water-resources region (figure 1; table 1) indicates that the California, South Atlantic-Gulf, and Mid-Atlantic regions account for one-third of the total water withdrawn in the United States. The largest amount of irrigation occurs in the California, Pacific Northwest, and Missouri regions; and the largest withdrawals (fresh and saline) for thermoelectric power occur in the Mid-Atlantic and South Atlantic-Gulf regions. A similar comparison of total withdrawals by State (figure 2; table 2) indicates that California accounts for the largest withdrawals, 45,900 Mgal/d, followed by Texas, Illinois, and Florida. Some 24 States and Puerto Rico had less water withdrawn for offstream uses during 1995 than during 1990.

The two largest water-use categories continue to be thermoelectric power and irrigation. During 1995, the most water (190,000 Mgal/d, of which 57,900 Mgal/d was saline) was withdrawn for thermoelectric power cooling, whereas the most freshwater (134,000 Mgal/d) was withdrawn for irrigation (tables 3, 4). California accounts for the largest irrigation withdrawals; whereas, Illinois accounts for the largest thermoelectric freshwater withdrawals (table 4).

Surface-water withdrawals by water-use category are shown by water-resources region in table 5 and by State in table 6. Ground-water withdrawals by water-use category are shown by water-resources region in table 7 and by State in table 8.

Total freshwater consumptive use was about 100,000 Mgal/d during 1995, or 6 percent more than during 1990. Freshwater consumptive use in the East (water-resource regions east of and including the Mississippi regions) is about 12 percent of freshwater withdrawn in the East and accounts for only 20 percent of Nation's consumptive use (figure 3; table 1). By comparison, freshwater consumptive use in the West is about 47 percent of freshwater withdrawals. The higher consumptive use in the West is attributable to the 90 percent of the water withdrawn for irrigation that occurs in the West and irrigation accounts for the largest part of consumptive use. California accounts for the largest consumptive use (figure 4) because it has the largest amount of irrigation.

The distribution of per-capita freshwater withdrawals by State is shown in figure 5 and table 2. High per-capita values are characteristic of thinly populated states having large acreages of irrigated land such as Idaho, Montana, and Wyoming. In contrast, figure 6 shows the intensity of freshwater withdrawals by State in million gallons per day per square mile. The smaller states in the northeast show the most intense withdrawals by area.

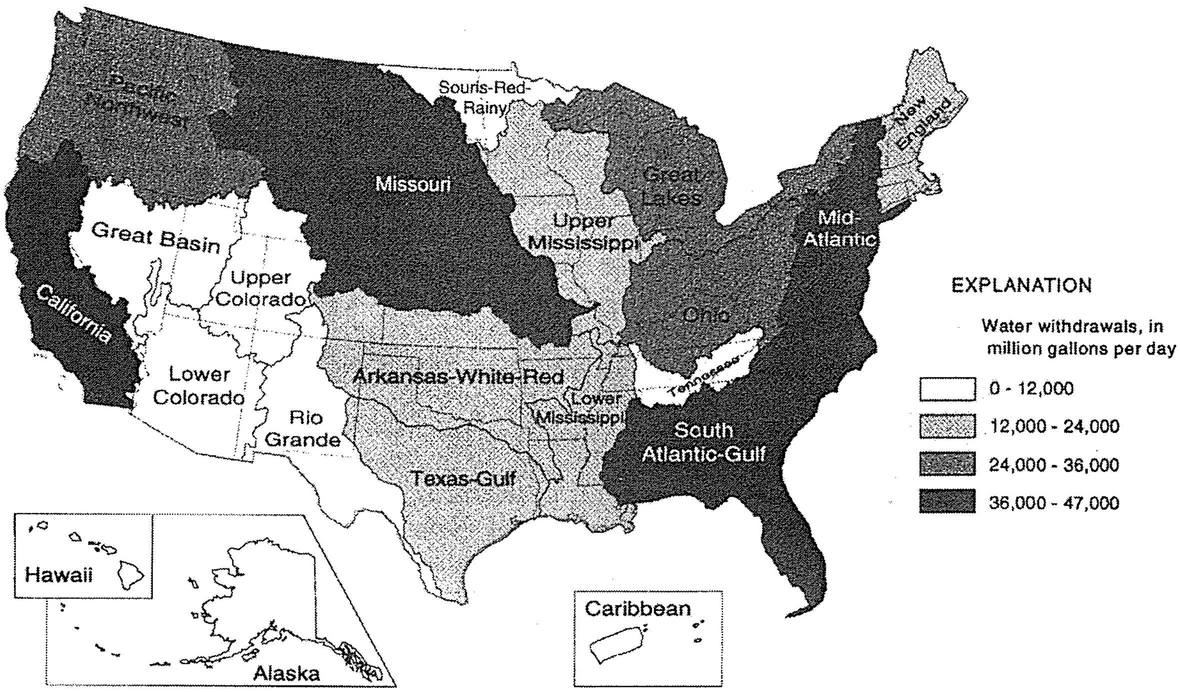


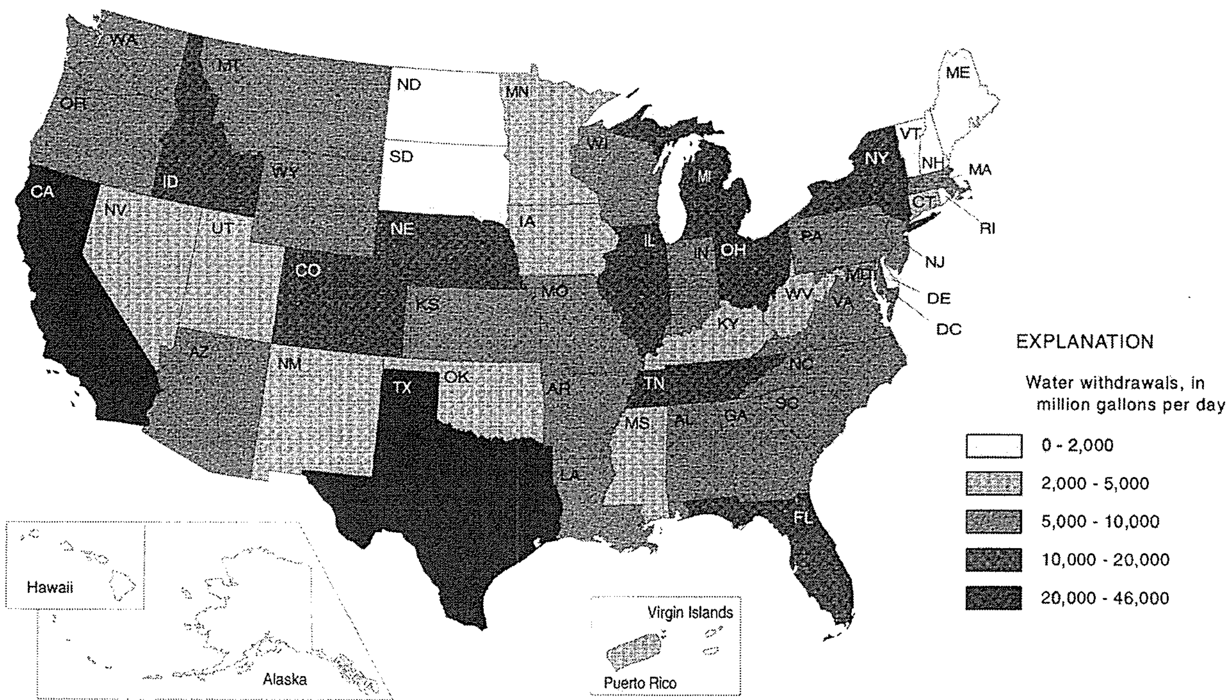
Figure 1. Total water withdrawals by water-resources region, 1995.

Table 1. Total offstream water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

REGION	POPULATION, in thousands	PER CAPITA USE, freshwater, in gal/d	WITHDRAWALS, in Mgal/d (includes irrigation conveyance losses): By source and type: Ground water			Surface water			Total			RECLAIMED WASTEWATER, in Mgal/d	CONVEYANCE LOSSES, in Mgal/d	CONSUMPTIVE USE, freshwater, in Mgal/d
			Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total			
New England	12,849	289	725	0	725	2,980	8,800	11,800	3,710	8,800	12,500	0	0	388
Mid-Atlantic	42,412	509	2,690	1.0	2,690	18,900	20,300	39,200	21,600	20,300	41,900	72	1.9	1,170
South Atlantic-Gulf	37,845	848	7,110	16	7,120	25,000	12,700	37,700	32,100	12,700	44,800	237	33	5,570
Great Lakes	21,836	1,500	1,510	4.6	1,520	31,100	6.5	31,100	32,700	11	32,700	0	.1	1,580
Ohio	22,631	1,330	1,980	22	2,000	28,100	.6	28,100	30,100	23	30,100	1.1	.7	1,870
Tennessee	4,198	2,140	258	0	258	8,730	0	8,730	8,980	0	8,980	.3	0	289
Upper Mississippi	22,268	1,050	2,570	4.2	2,570	20,700	0	20,700	23,300	4.2	23,300	11	0	1,660
Lower Mississippi	7,324	2,720	9,180	0	9,180	10,800	0	10,800	20,000	0	20,000	.7	553	7,740
Souris-Red-Rainy	693	364	115	0	115	138	0	138	253	0	253	0	1.8	122
Missouri Basin	10,664	3,380	9,320	38	9,360	26,700	0	26,700	36,000	38	36,100	22	7,840	14,200
Arkansas-White-Red	8,931	1,800	7,490	284	7,780	8,590	0	8,590	16,100	284	16,400	37	944	8,190
Texas-Gulf	16,755	1,050	5,960	324	6,280	11,700	4,860	16,600	17,700	5,190	22,900	71	390	7,340
Rio Grande	2,566	2,600	1,930	61	1,990	4,740	0	4,740	6,670	61	6,730	7.2	1,360	2,960
Upper Colorado	714	10,400	116	14	130	7,310	0	7,310	7,420	14	7,440	1.7	1,940	2,520
Lower Colorado	5,318	1,500	3,000	12	3,010	4,970	2.3	4,970	7,960	14	7,980	187	1,090	4,520
Great Basin	2,405	2,510	1,610	56	1,660	4,420	143	4,560	6,030	199	6,230	33	1,140	3,260
Pacific Northwest	9,948	3,220	5,500	0	5,500	26,500	38	26,500	32,000	38	32,000	.1	8,050	10,600
California	32,060	1,140	14,600	185	14,800	21,900	9,450	31,300	36,500	9,640	46,100	330	1,860	25,300
Alaska	604	350	58	75	132	154	43	196	211	117	329	0	.1	25
Hawaii	1,187	853	515	16	531	497	906	1,400	1,010	922	1,930	6.2	98	542
Caribbean	3,858	152	156	.2	156	433	2,450	2,880	588	2,450	3,040	0	15	189
Total	267,068	1,280	76,400	1,110	77,500	264,000	59,700	324,000	341,000	60,800	402,000	1,020	25,300	100,000

TOTAL WITHDRAWALS



SURFACE-WATER WITHDRAWALS

GROUND-WATER WITHDRAWALS

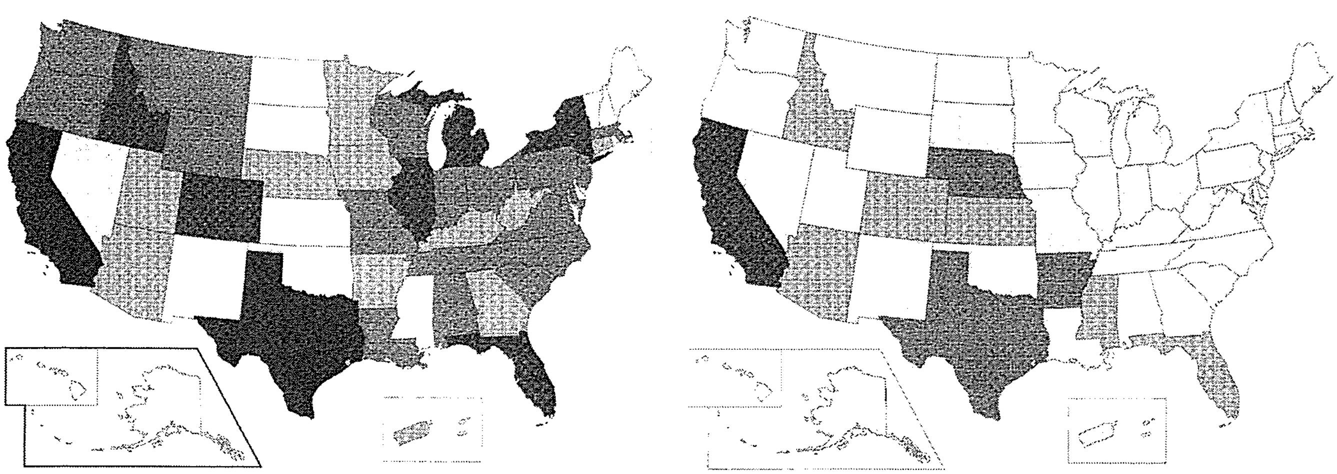


Figure 2. Total water withdrawals by source and State, 1995.

Table 2. Total offstream water use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

STATE	POPULATION, in thousands	PER CAPITA USE, freshwater, in gal/d	WITHDRAWALS, in Mgal/d (includes irrigation conveyance losses): By source and type: Ground water: Fresh	Ground water: Saline	Ground water: Total	Surface water: Fresh	Surface water: Saline	Surface water: Total	Total: Fresh	Total: Saline	Total: Total	RECLAIMED WASTEWATER, in Mgal/d	CONVEYANCE LOSSES, in Mgal/d	CONSUMPTIVE USE, freshwater, in Mgal/d
Alabama	4,253	1,670	436	9.1	445	6,650	0	6,650	7,090	9.1	7,100	0.1	0	532
Alaska	604	350	58	75	132	154	43	196	211	117	329	0	.1	25
Arizona	4,218	1,620	2,830	12	2,840	3,980	2.3	3,990	6,820	14	6,830	180	1,030	3,830
Arkansas	2,484	3,530	5,460	0	5,460	3,310	0	3,310	8,770	0	8,770	0	416	4,760
California	32,063	1,130	14,500	185	14,700	21,800	9,450	31,300	36,300	9,640	45,900	334	1,670	25,500
Colorado	3,747	3,690	2,260	17	2,270	11,600	0	11,600	13,800	17	13,800	11	3,770	5,230
Connecticut	3,275	389	166	0	166	1,110	3,180	4,290	1,280	3,180	4,450	0	0	97
Delaware	717	1,050	110	0	110	642	743	1,390	752	743	1,500	0	0	71
D.C.	554	18	.5	0	.5	9.7	0	9.7	10	0	10	0	0	15
Florida	14,166	509	4,340	4.6	4,340	2,880	11,000	13,800	7,210	11,000	18,200	236	32	2,780
Georgia	7,201	799	1,190	0	1,190	4,560	64	4,630	5,750	64	5,820	.6	0	1,170
Hawaii	1,187	853	515	16	531	497	906	1,400	1,010	922	1,930	6.2	98	542
Idaho	1,163	13,000	2,830	0	2,830	12,300	0	12,300	15,100	0	15,100	0	5,480	4,340
Illinois	11,830	1,680	928	25	953	19,000	0	19,000	19,900	25	19,900	2.0	0	857
Indiana	5,803	1,570	709	0	709	8,430	0	8,430	9,140	0	9,140	0	0	505
Iowa	2,842	1,070	528	0	528	2,510	0	2,510	3,030	0	3,030	0	0	290
Kansas	2,565	2,040	3,510	0	3,510	1,720	0	1,720	5,240	0	5,240	6.8	143	3,620
Kentucky	3,860	1,150	226	0	226	4,190	0	4,190	4,420	0	4,420	0	.5	318
Louisiana	4,342	2,270	1,350	0	1,350	8,500	0	8,500	9,850	0	9,850	0	166	1,930
Maine	1,241	178	80	0	80	141	105	246	221	105	326	0	0	48
Maryland	5,042	289	246	0	246	1,210	6,270	7,480	1,460	6,270	7,730	70	0	150
Massachusetts	6,074	189	351	0	351	795	4,370	5,160	1,150	4,370	5,510	0	0	180
Michigan	9,549	1,260	858	4.4	862	11,200	0	11,200	12,100	4.4	12,100	0	0	667
Minnesota	4,610	736	714	0	714	2,680	0	2,680	3,390	0	3,390	0	0	417
Mississippi	2,697	1,140	2,590	0	2,590	502	112	614	3,090	112	3,200	0	17	1,570
Missouri	5,324	1,320	891	0	891	6,140	0	6,140	7,030	0	7,030	11	0	692
Montana	870	10,200	204	13	217	8,640	0	8,640	8,850	13	8,860	0	4,410	1,960
Nebraska	1,637	6,440	6,200	4.7	6,200	4,350	0	4,350	10,500	4.7	10,500	2.0	906	7,020
Nevada	1,530	1,480	855	42	896	1,400	0	1,400	2,260	42	2,300	24	473	1,340
New Hampshire	1,148	388	81	0	81	364	877	1,240	446	877	1,320	0	0	35
New Jersey	7,945	269	580	0	580	1,560	3,980	5,530	2,140	3,980	6,110	1.1	0	210
New Mexico	1,686	2,080	1,700	0	1,700	1,800	0	1,800	3,510	0	3,510	0	628	1,980
New York	18,136	567	1,010	1.5	1,010	9,270	6,500	15,800	10,300	6,500	16,800	0	0	469
North Carolina	7,195	1,070	535	2.1	535	7,200	1,550	8,750	7,730	1,560	9,290	1.0	0	713
North Dakota	641	1,750	122	0	122	1,000	0	1,000	1,120	0	1,120	0	5.1	181
Ohio	11,151	944	905	0	905	9,620	0	9,620	10,500	0	10,500	0	.2	791
Oklahoma	3,278	543	959	259	1,220	822	0	822	1,780	259	2,040	0	4.9	716
Oregon	3,140	2,520	1,050	0	1,050	6,860	0	6,860	7,910	0	7,910	0	1,300	3,210
Pennsylvania	12,072	802	860	0	860	8,820	0	8,820	9,680	0	9,680	1.1	0	565
Rhode Island	990	138	27	0	27	109	275	383	136	275	411	0	0	19
South Carolina	3,673	1,690	322	0	322	5,880	0	5,880	6,200	0	6,200	0	0	321
South Dakota	729	631	187	0	187	273	0	273	460	0	460	0	54	249
Tennessee	5,256	1,920	435	0	435	9,640	0	9,640	10,100	0	10,100	.5	0	233
Texas	18,724	1,300	8,370	411	8,780	16,000	4,860	20,800	24,300	5,280	29,600	109	540	10,500
Utah	1,951	2,200	776	14	790	3,530	143	3,670	4,300	157	4,460	14	612	2,200
Vermont	585	967	50	0	50	515	0	515	565	0	565	0	0	24
Virginia	6,618	826	358	0	358	5,110	2,800	7,900	5,470	2,800	8,260	0	2.9	218
Washington	5,431	1,620	1,760	0	1,760	7,060	38	7,100	8,820	38	8,860	0	1,090	3,080
West Virginia	1,828	2,530	146	.5	146	4,470	0	4,470	4,620	.5	4,620	0	0	352
Wisconsin	5,102	1,420	759	0	759	6,490	0	6,490	7,250	0	7,250	0	0	443
Wyoming	480	14,700	317	18	335	6,720	0	6,720	7,040	18	7,060	9.1	2,470	2,800
Puerto Rico	3,755	154	155	0	155	422	2,260	2,680	576	2,260	2,840	0	15	187
Virgin Islands	103	113	.5	.2	.7	11	190	201	12	190	202	0	0	1.9
Total	267,068	1,280	76,400	1,110	77,500	264,000	59,700	324,000	341,000	60,800	402,000	1,020	25,300	100,000

Table 3. Total water withdrawals by water-use category and water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	PUBLIC SUPPLY	DOMESTIC	COMMER-CIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMOELECTRIC		TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline
New England	1,440	169	90	146	19	153	0	24	0	1,670	8,800	3,710	8,800
Mid-Atlantic	6,000	486	283	293	134	1,430	526	321	8.6	12,600	19,700	21,600	20,300
South Atlantic-Gulf	5,470	719	130	4,600	405	2,790	40	339	9.1	17,600	12,700	32,100	12,700
Great Lakes	4,420	355	152	315	70	4,170	3.6	390	7.6	22,800	0	32,700	11
Ohio	2,680	328	170	104	141	3,690	0	327	23	22,600	0	30,100	23
Tennessee	574	64	22	48	205	1,070	0	11	0	6,990	0	8,980	0
Upper Mississippi	1,880	311	208	484	255	988	0	134	4.2	19,100	0	23,300	4.2
Lower Mississippi	1,070	73	36	8,130	1,010	2,890	0	5.3	0	6,730	0	20,000	0
Souris-Red-Rainy	66	17	.3	88	20	22	0	1.4	0	38	0	253	0
Missouri Basin	1,570	138	34	24,600	426	152	0	306	38	8,800	0	36,000	38
Arkansas-White-Red	1,550	105	115	9,250	395	438	0	56	284	4,170	0	16,100	284
Texas-Gulf	2,840	115	42	5,530	208	1,060	996	197	324	7,680	3,870	17,700	5,190
Rio Grande	487	25	19	6,020	35	10	0	55	60	18	1.0	6,670	61
Upper Colorado	141	12	6.2	7,030	54	6.4	0	23	14	146	0	7,420	14
Lower Colorado	1,170	45	30	6,410	40	47	0	152	14	63	0	7,960	14
Great Basin	605	14	25	5,110	86	91	.1	74	162	24	37	6,030	199
Pacific Northwest	1,910	260	1,070	25,700	1,510	1,080	38	35	0	385	0	32,000	38
California	5,610	124	396	29,100	453	541	36	78	151	205	9,450	36,500	9,640
Alaska	81	8.7	11	.6	.5	55	1.8	24	116	31	0	211	117
Hawaii	214	3.7	46	652	10	19	.9	.5	0	67	903	1,010	922
Caribbean	437	13	3.4	107	6.4	14	17	4.5	0	2.2	2,440	588	2,450
Total	40,200	3,390	2,890	134,000	5,490	20,700	1,660	2,560	1,210	132,000	57,900	341,000	60,800

Table 4. Total water withdrawals by water-use category and State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	PUBLIC SUPPLY	DOMESTIC	COMMERCIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMOELECTRIC		TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline
Alabama	813	62	4.9	139	129	733	0	11	9.1	5,200	0	7,090	9.1
Alaska	81	8.6	11	.6	.5	55	1.8	24	116	31	0	211	117
Arizona	807	39	21	5,670	32	39	0	144	14	62	0	6,820	14
Arkansas	381	38	100	5,940	354	187	0	.1	0	1,770	0	8,800	0
California	5,620	120	385	28,900	459	538	36	76	151	205	9,450	36,300	9,640
Colorado	705	27	8.6	12,700	59	123	0	52	17	114	0	13,800	17
Connecticut	393	55	27	28	1.4	9.6	0	1.7	0	760	3,180	1,280	3,180
Delaware	89	12	2.8	48	4.1	61	3.2	0	0	534	740	752	743
D.C.	0	0	0	0	0	.5	0	0	0	9.7	0	10	0
Florida	2,070	297	50	3,470	56	345	8.0	296	0	636	11,000	7,210	11,000
Georgia	1,150	99	46	722	48	633	32	12	0	3,040	33	5,750	64
Hawaii	214	3.7	46	652	10	19	.9	.5	0	67	903	1,010	922
Idaho	189	65	306	13,000	1,460	47	0	29	0	0	0	15,100	0
Illinois	1,820	129	104	180	56	452	0	50	25	17,100	0	19,900	25
Indiana	669	115	93	116	46	2,270	0	137	0	5,690	0	9,140	0
Iowa	373	45	43	39	110	258	0	43	0	2,120	0	3,030	0
Kansas	370	24	5.2	3,380	109	53	0	24	0	1,270	0	5,240	0
Kentucky	496	25	22	12	46	347	0	28	0	3,440	0	4,420	0
Louisiana	638	39	11	769	325	2,580	0	1.8	0	5,480	0	9,850	0
Maine	100	35	11	27	1.9	11	0	5.0	0	30	105	221	105
Maryland	834	73	24	62	35	65	261	5.2	0	360	6,000	1,460	6,270
Massachusetts	725	34	12	82	10	85	0	3.2	0	196	4,370	1,150	4,370
Michigan	1,300	194	41	227	14	1,850	3.6	58	.8	8,370	0	12,100	4.4
Minnesota	485	88	66	157	62	140	0	298	0	2,090	0	3,390	0
Mississippi	344	33	18	1,740	396	290	0	3.7	0	263	112	3,090	112
Missouri	699	58	14	567	76	39	0	24	0	5,550	0	7,030	0
Montana	143	18	0	8,550	52	60	0	6.6	13	22	0	8,850	13
Nebraska	286	42	.3	7,550	142	30	0	141	4.7	2,350	0	10,500	4.7
Nevada	468	11	21	1,640	5.7	15	0	68	11	27	30	2,260	42
New Hampshire	98	32	30	6.3	.8	43	0	7.0	0	229	877	446	877
New Jersey	1,040	86	18	125	1.5	201	195	90	0	580	3,780	2,140	3,980
New Mexico	311	26	20	2,990	30	8.3	0	61	0	56	0	3,510	0
New York	3,000	144	200	30	34	259	0	45	16	6,570	6,490	10,300	6,500
North Carolina	769	172	7.6	239	297	369	0	16	0	5,860	1,550	7,730	1,560
North Dakota	73	12	.2	117	24	11	0	5.8	0	880	0	1,120	0
Ohio	1,420	140	68	27	27	557	0	93	0	8,190	0	10,500	0
Oklahoma	567	30	23	864	147	21	0	5.4	259	124	0	1,780	259
Oregon	504	68	756	6,170	23	378	0	1.2	0	9.0	0	7,910	0
Pennsylvania	1,550	181	30	16	55	1,680	0	252	0	5,920	0	9,680	0
Rhode Island	114	7.3	1.5	2.3	3.6	1.1	0	6.2	0	0	275	136	275
South Carolina	543	71	1.7	52	25	700	0	2.9	0	4,810	0	6,200	0
South Dakota	88	9.4	10	269	46	5.1	0	27	0	5.4	0	460	0
Tennessee	777	54	20	24	37	863	0	5.5	0	8,300	0	10,100	0
Texas	3,290	130	44	9,450	315	1,300	996	211	409	9,590	3,870	24,300	5,280
Utah	497	9.4	3.8	3,530	108	86	.1	16	150	48	6.7	4,300	157
Vermont	47	19	26	3.9	5.3	9.4	0	3.0	0	453	0	565	0
Virginia	786	125	41	30	36	516	67	39	0	3,890	2,730	5,470	2,800
Washington	1,180	125	24	6,470	34	611	38	3.5	0	376	0	8,820	38
West Virginia	176	41	46	0	18	1,320	0	11	.5	3,010	0	4,620	.5
Wisconsin	600	92	17	169	92	441	0	12	0	5,830	0	7,250	0
Wyoming	90	10	1.6	6,590	25	2.8	0	96	18	220	0	7,040	18
Puerto Rico	431	12	2.7	107	6.3	11	0	4.2	0	2.2	2,260	576	2,260
Virgin Islands	6.5	1.4	.8	0	.1	3.0	17	0	0	0	173	12	190
Total	40,200	3,390	2,890	134,000	5,490	20,700	1,660	2,560	1,210	132,000	57,900	341,000	60,800

Table 5. Surface-water withdrawals by water-use category and water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	PUBLIC SUPPLY	DOMESTIC	COMMER-CIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMOELECTRIC		TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline
New England	1,100	0.5	26	99	13	100	0	21	0	1,620	8,800	2,980	8,800
Mid-Atlantic	4,730	.6	65	185	55	1,090	526	163	7.5	12,600	19,700	18,900	20,300
South Atlantic-Gulf . . .	2,710	0	16	2,320	217	2,010	40	162	0	17,500	12,700	25,000	12,700
Great Lakes	3,830	1.0	108	145	20	3,900	0	356	6.5	22,800	0	31,100	6.5
Ohio	1,800	5.0	80	43	81	3,310	0	212	.6	22,600	0	28,100	.6
Tennessee	449	0	18	39	187	1,030	0	7.2	0	6,990	0	8,730	0
Upper Mississippi	731	0	114	54	39	660	0	112	0	19,000	0	20,700	0
Lower Mississippi	330	.1	21	1,200	272	2,280	0	2.2	0	6,670	0	10,800	0
Souris-Red-Rainy	32	0	.1	43	3.0	20	0	1.0	0	38	0	138	0
Missouri Basin	926	1.2	15	16,600	173	50	0	201	0	8,770	0	26,700	0
Arkansas-White-Red . .	1,170	0	99	2,590	205	360	0	26	0	4,140	0	8,590	0
Texas-Gulf	1,860	0	8.0	1,170	126	846	996	79	0	7,630	3,870	11,700	4,860
Rio Grande	131	0	1.8	4,600	8.5	.1	0	2.1	0	2.2	0	4,740	0
Upper Colorado	106	.4	.7	6,990	50	4.0	0	3.5	0	146	0	7,310	0
Lower Colorado	698	.2	7.5	4,200	6.8	5.5	0	26	2.3	17	0	4,970	2.3
Great Basin	254	1.6	15	4,020	77	31	0	2.8	143	21	0	4,420	143
Pacific Northwest	993	7.3	1,030	21,700	1,470	866	38	29	0	384	0	26,500	38
California	2,880	12	319	18,200	222	19	26	62	0	202	9,430	21,900	9,450
Alaska	50	.4	.1	.5	.4	51	1.8	24	41	26	0	154	43
Hawaii	14	1.3	.4	479	2.6	0	0	.1	0	0	903	497	906
Caribbean	342	6.9	2.1	75	1.8	4.0	17	1.1	0	0	2,440	433	2,450
Total	25,100	38	1,950	84,700	3,230	16,700	1,640	1,490	201	131,000	57,900	264,000	59,700

Table 6. Surface-water withdrawals by water-use category and State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	PUBLIC SUPPLY	DOMESTIC	COMMERCIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMOELECTRIC		TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Saline	Fresh	Saline
Alabama	560	0	0	88	107	699	0	7.0	0	5,190	0	6,650	0
Alaska	50	.3	.1	.5	.4	51	1.8	24	41	26	0	154	43
Arizona	398	0	0	3,540	2.4	0	0	25	2.3	20	0	3,980	2.3
Arkansas	246	0	100	1,010	110	80	0	.1	0	1,770	0	3,310	0
California	2,880	12	309	18,100	225	16	26	62	0	202	9,430	21,800	9,450
Colorado	605	0	.9	10,700	36	86	0	27	0	93	0	11,600	0
Connecticut	329	0	1.5	12	.1	6.2	0	1.4	0	760	3,180	1,110	3,180
Delaware	49	0	0	15	.4	43	3.2	0	0	534	740	642	743
D.C.	0	0	0	0	0	0	0	0	0	9.7	0	9.7	0
Florida	210	0	.2	1,800	5.9	106	8.0	148	0	615	11,000	2,880	11,000
Georgia	890	0	13	243	38	337	32	2.9	0	3,040	33	4,560	64
Hawaii	14	1.3	.4	479	2.6	0	0	.1	0	0	903	497	906
Idaho	9.9	0	297	10,500	1,440	7.9	0	27	0	0	0	12,300	0
Illinois	1,450	0	88	0	2.2	290	0	44	0	17,100	0	19,000	0
Indiana	350	0	48	55	18	2,160	0	126	0	5,680	0	8,430	0
Iowa	116	0	25	3.6	27	184	0	42	0	2,110	0	2,510	0
Kansas	209	0	.3	230	19	3.2	0	11	0	1,250	0	1,720	0
Kentucky	441	2.5	14	11	44	255	0	21	0	3,410	0	4,190	0
Louisiana	344	0	.7	294	181	2,230	0	1.4	0	5,450	0	8,500	0
Maine	75	0	1.7	24	.5	5.9	0	3.7	0	30	105	141	105
Maryland	751	0	4.9	26	23	45	261	4.3	0	358	6,000	1,210	6,270
Massachusetts	533	0	0	54	8.5	47	0	2.7	0	150	4,370	795	4,370
Michigan	952	.1	25	127	1.4	1,670	0	51	0	8,370	0	11,200	0
Minnesota	154	0	20	37	0	83	0	292	0	2,090	0	2,680	0
Mississippi	41	0	0	97	19	124	0	.2	0	220	112	502	112
Missouri	473	0	.5	33	57	18	0	15	0	5,540	0	6,140	0
Montana	89	1.0	0	8,460	35	29	0	3.8	0	22	0	8,640	0
Nebraska	53	0	0	1,770	33	4.4	0	134	0	2,350	0	4,350	0
Nevada	351	.2	14	1,000	4.7	7.5	0	3.5	0	21	0	1,400	0
New Hampshire	66	.5	18	6.1	.2	38	0	7.0	0	228	877	364	877
New Jersey	640	0	1.2	93	0	158	195	87	0	578	3,780	1,560	3,980
New Mexico	34	0	1.6	1,710	3.6	2.0	0	.7	0	46	0	1,800	0
New York	2,450	0	65	14	12	132	0	34	15	6,570	6,490	9,270	6,500
North Carolina	633	0	.3	181	207	308	0	4.3	0	5,860	1,550	7,200	1,550
North Dakota	43	0	.2	57	9.9	7.9	0	2.0	0	879	0	1,000	0
Ohio	923	2.8	41	16	19	399	0	46	0	8,170	0	9,620	0
Oklahoma	468	0	16	98	101	17	0	0	0	121	0	822	0
Oregon	417	7.2	752	5,290	20	365	0	0	0	9.0	0	6,860	0
Pennsylvania	1,300	0	14	7.7	7.1	1,530	0	41	0	5,920	0	8,820	0
Rhode Island	99	0	0	1.6	3.1	0	0	5.7	0	0	275	109	275
South Carolina	436	0	0	25	12	640	0	0	0	4,770	0	5,880	0
South Dakota	35	0	4.1	184	28	1.0	0	20	0	1.9	0	273	0
Tennessee	500	0	18	15	15	795	0	2.7	0	8,300	0	9,640	0
Texas	2,160	0	11	2,920	176	1,070	996	83	0	9,530	3,870	16,000	4,860
Utah	204	1.7	0	3,140	100	31	0	.9	143	48	0	3,530	143
Vermont	32	.4	16	3.5	1.3	7.4	0	2.8	0	452	0	515	0
Virginia	704	0	13	24	28	410	67	37	0	3,890	2,730	5,110	2,800
Washington	548	0	.4	5,650	11	478	38	.7	0	375	0	7,060	38
West Virginia	139	.8	9.2	0	3.6	1,300	0	7.5	0	3,010	0	4,470	0
Wisconsin	289	0	0	1.5	13	363	0	4.3	0	5,820	0	6,490	0
Wyoming	52	.5	.6	6,410	11	1.2	0	25	0	219	0	6,720	0
Puerto Rico	336	5.5	1.5	75	1.8	1.1	0	1.4	0	0	2,260	422	2,260
Virgin Islands	6.2	1.4	.6	0	0	2.9	17	0	0	0	173	11	190
Total	25,100	38	1,950	84,700	3,230	16,700	1,640	1,490	201	131,000	57,900	264,000	59,700

Table 7. Ground-water withdrawals by water-use category and water-resources region, 1995
[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	PUBLIC SUPPLY	DOMESTIC	COMMERCIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMOELECTRIC	TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Fresh	Saline
New England	335	168	64	47	6.4	53	0	2.9	0	48	725	0
Mid-Atlantic	1,270	485	217	128	79	344	0	159	1.0	11	2,690	1.0
South Atlantic-Gulf	2,760	719	114	2,280	188	787	0	177	9.1	79	7,110	16
Great Lakes	585	354	44	170	50	270	3.6	34	1.0	7.6	1,510	4.6
Ohio	880	323	91	61	60	379	0	115	22	70	1,980	22
Tennessee	125	64	3.6	8.7	19	35	0	3.7	0	0	258	0
Upper Mississippi	1,150	311	94	430	216	328	0	22	4.2	24	2,570	4.2
Lower Mississippi	741	73	15	6,930	740	611	0	3.1	0	69	9,180	0
Souris-Red-Rainy	34	17	.2	45	17	1.7	0	.4	0	0	115	0
Missouri Basin	643	137	19	8,030	253	102	0	104	38	30	9,320	38
Arkansas-White-Red	378	105	16	6,660	190	78	0	30	284	37	7,490	284
Texas-Gulf	978	115	34	4,370	82	214	.5	118	324	50	5,960	324
Rio Grande	356	25	17	1,420	27	10	0	53	60	16	1,930	61
Upper Colorado	35	11	5.6	38	4.2	2.4	0	20	14	0	116	14
Lower Colorado	476	44	22	2,210	33	42	0	126	12	45	3,000	12
Great Basin	350	13	10	1,090	9.2	60	.1	71	19	2.6	1,610	56
Pacific Northwest	917	253	37	4,030	44	215	0	6.5	0	.5	5,500	0
California	2,730	112	77	10,900	231	522	10	16	151	3.6	14,600	185
Alaska	30	8.3	11	.1	.1	3.8	0	0	75	4.2	58	75
Hawaii	200	2.4	45	173	7.5	19	.9	.5	0	67	515	16
Caribbean	95	6.4	1.3	33	4.5	10	.2	3.4	0	2.2	156	.2
Total	15,100	3,350	939	49,000	2,260	4,090	15	1,070	1,010	565	76,400	1,110

Table 8. Ground-water withdrawals by water-use category and State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	PUBLIC SUPPLY	DOMESTIC	COMMER-CIAL	IRRIGATION	LIVESTOCK	INDUSTRIAL		MINING		THERMO-ELECTRIC	TOTAL	
	Fresh	Fresh	Fresh	Fresh	Fresh	Fresh	Saline	Fresh	Saline	Fresh	Fresh	Saline
Alabama	253	62	4.9	51	22	34	0	4.0	9.1	6.0	436	9.1
Alaska	30	8.3	11	.1	.1	3.8	0	0	75	4.2	58	75
Arizona	409	39	21	2,130	29	39	0	119	12	42	2,830	12
Arkansas	135	38	.4	4,930	244	108	0	0	0	5.2	5,460	0
California	2,740	108	77	10,800	234	522	10	14	151	3.6	14,500	185
Colorado	100	27	7.7	2,020	23	37	0	25	17	22	2,260	17
Connecticut	65	55	25	16	1.4	3.5	0	.3	0	.2	166	0
Delaware	40	12	2.8	34	3.8	17	0	0	0	.2	110	0
D.C.	0	0	0	0	0	.5	0	0	0	0	.5	0
Florida	1,860	297	50	1,670	50	240	0	148	0	21	4,340	4.6
Georgia	263	99	33	479	9.7	295	0	8.7	0	4.8	1,190	0
Hawaii	200	2.4	45	173	7.5	19	.9	.5	0	67	515	16
Idaho	180	65	9.8	2,520	17	39	0	1.2	0	0	2,830	0
Illinois	371	129	16	180	54	162	0	5.5	25	11	928	25
Indiana	319	115	45	61	28	119	0	10	0	11	709	0
Iowa	257	45	18	35	82	74	0	1.1	0	15	528	0
Kansas	161	24	4.9	3,150	91	50	0	13	0	14	3,510	0
Kentucky	55	23	8.0	.5	2.3	92	0	7.4	0	38	226	0
Louisiana	294	39	10	475	144	356	0	.4	0	31	1,350	0
Maine	25	35	9.8	2.6	1.4	4.6	0	1.3	0	.7	80	0
Maryland	83	73	19	37	13	19	0	.9	0	1.8	246	0
Massachusetts	192	34	12	28	1.5	38	0	.5	0	46	351	0
Michigan	348	194	16	101	13	177	3.6	7.1	.8	3.0	858	4.4
Minnesota	331	88	46	120	62	58	0	6.3	0	1.9	714	0
Mississippi	302	33	18	1,640	377	166	0	3.5	0	42	2,590	0
Missouri	226	58	13	535	20	21	0	8.6	0	9.5	891	0
Montana	55	17	0	82	16	31	0	2.8	13	0	204	13
Nebraska	232	42	.3	5,780	108	26	0	6.1	4.7	4.4	6,200	4.7
Nevada	117	11	7.1	641	1.0	7.4	0	65	11	6.3	855	42
New Hampshire	31	31	12	.3	.6	5.6	0	0	0	.8	81	0
New Jersey	397	86	17	32	1.5	43	0	2.4	0	1.9	580	0
New Mexico	277	26	18	1,280	26	6.3	0	61	0	9.3	1,700	0
New York	552	144	136	16	22	127	0	11	1.5	0	1,010	1.5
North Carolina	136	172	7.3	57	89	61	0	12	0	.1	535	2.1
North Dakota	30	12	.1	59	14	3.6	0	3.8	0	.3	122	0
Ohio	497	138	28	12	7.6	158	0	47	0	19	905	0
Oklahoma	99	30	6.6	766	45	3.8	0	5.4	259	3.5	959	259
Oregon	87	61	4.4	878	3.4	13	0	1.2	0	0	1,050	0
Pennsylvania	243	181	16	8.2	48	147	0	211	0	6.2	860	0
Rhode Island	16	7.3	1.5	.7	.5	1.1	0	.5	0	0	27	0
South Carolina	107	71	1.7	27	12	60	0	2.9	0	39	322	0
South Dakota	53	9.3	6.1	85	18	4.1	0	7.8	0	3.4	187	0
Tennessee	277	54	2.0	9.9	21	68	0	2.8	0	0	435	0
Texas	1,130	130	33	6,530	139	226	.5	128	409	59	8,370	411
Utah	293	7.7	3.8	393	7.6	55	.1	16	7.3	0	776	14
Vermont	15	18	9.6	.4	4.0	1.9	0	.3	0	.4	50	0
Virginia	82	125	28	5.6	7.8	107	0	2.6	0	.4	358	0
Washington	631	125	24	819	24	133	0	2.8	0	.5	1,760	0
West Virginia	38	40	36	0	15	13	0	3.7	.5	.5	146	.5
Wisconsin	311	92	17	167	79	78	0	7.9	0	5.8	759	0
Wyoming	38	9.7	.9	181	13	1.6	0	71	18	1.0	317	18
Puerto Rico	95	6.4	1.2	33	4.5	10	0	2.8	0	2.2	155	0
Virgin Islands	.3	0	.1	0	.1	.1	.2	0	0	0	.5	.2
Total	15,100	3,350	939	49,000	2,260	4,090	15	1,070	1,010	565	76,400	1,110

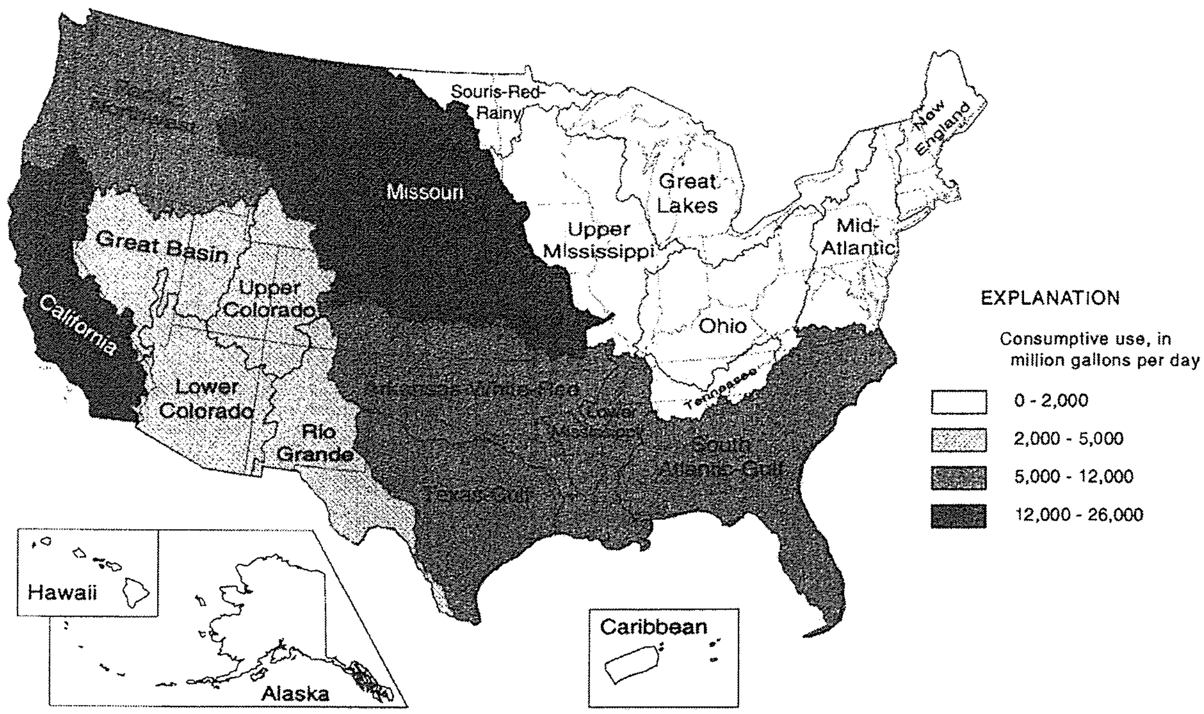


Figure 3. Freshwater consumptive use by water-resources region, 1995.

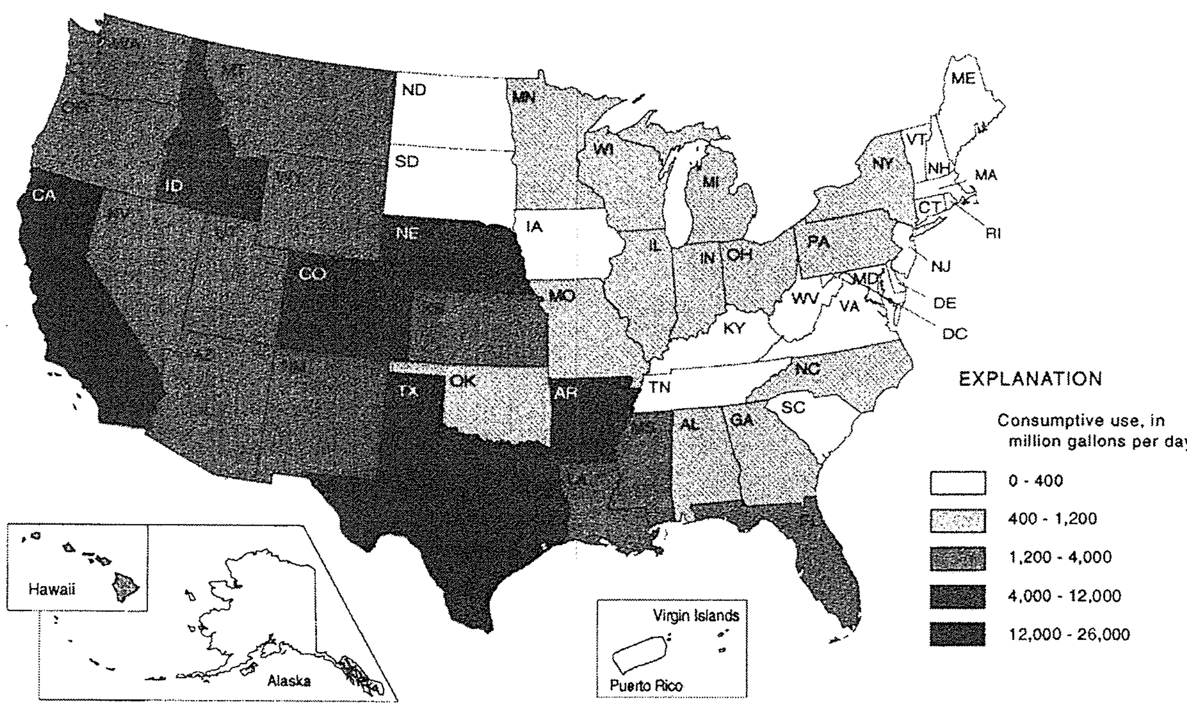


Figure 4. Freshwater consumptive use by State, 1995.

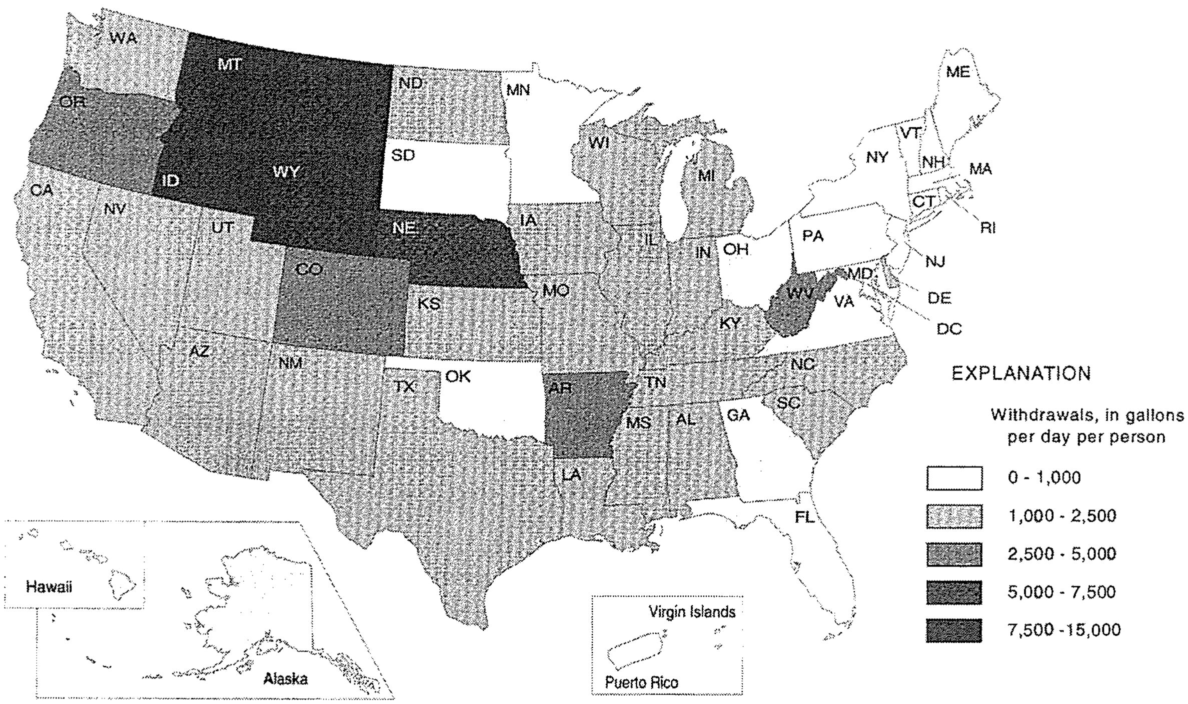


Figure 5. Intensity of freshwater withdrawals per capita by State, 1995.

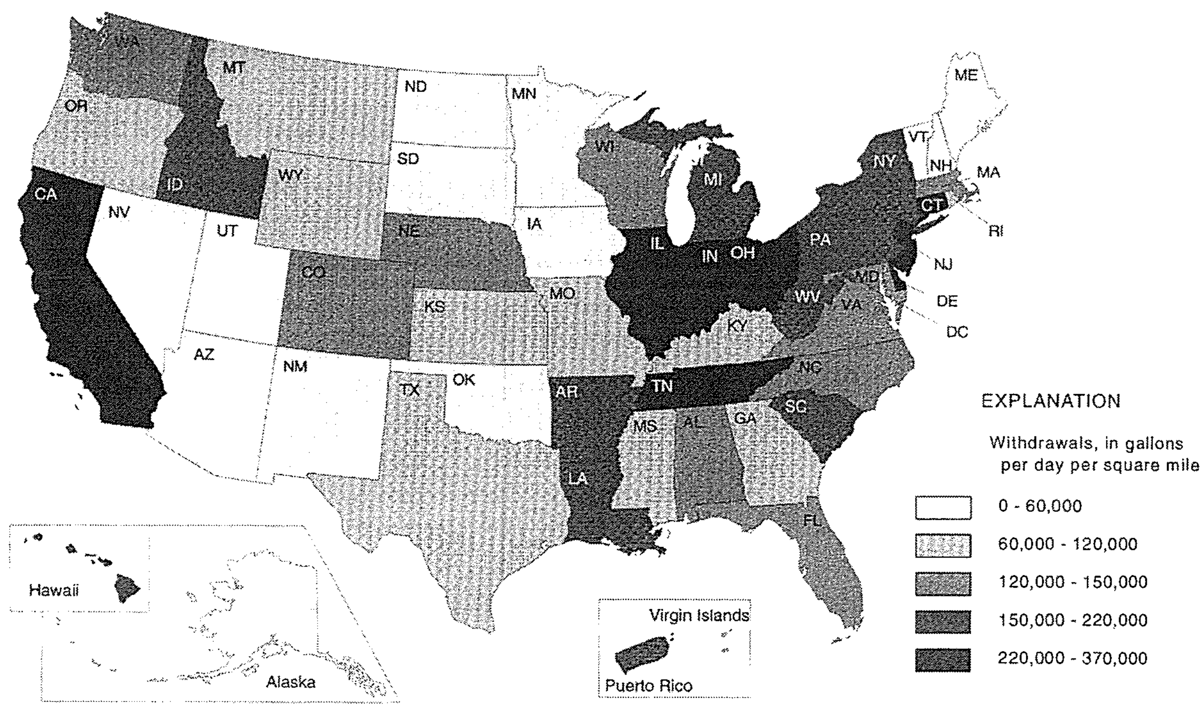


Figure 6. Intensity of freshwater withdrawals per area by State, 1995.

For an overview of how the 341,000 Mgal/d of freshwater withdrawn in the United States during 1995 was used (table 2), the eight offstream categories mentioned above have been combined into five major categories: public supply, domestic and commercial, irrigation and livestock, industrial and mining, and thermoelectric power. The source (withdrawals), use (withdrawals, deliveries), and disposition of freshwater for each category of use are summarized in figure 7. The source column shows the proportion of withdrawals by source and the distribution of withdrawals by water-use category. Source data indicate, for example, that surface water was the source of 264,000 Mgal/d of freshwater (table 2), or 77.6 percent of total freshwater withdrawals. Of the 264,000 Mgal/d of surface water withdrawn, 49.6 percent was for thermoelectric power. Public supply is considered a source of water and figure 7 shows the total quantity of water withdrawn by public supply, the percentage of surface and ground water withdrawn, and the percentage of water delivered to the other water-use categories. The use column shows total freshwater use for each category, and the percentage each category represents total offstream water use. In addition, the use column shows the proportion of the source (surface water, ground water, public supply) and disposition (consumptive use, return flow) for each category. The use data indicate, for example, that domestic and commercial use totaled 41,700 Mgal/d (tables 12 and 14), (including losses in the public-supply distribution system), or 12.2 percent of the Nation's total freshwater withdrawals. Of this 41,700 Mgal/d, 84.9 percent was supplied by public-supply systems, and 80.8 percent was returned to a surface- or ground-water source after use. The disposition column shows the quantity of consumptive use and return flow after use (figure 7). The disposition data indicate that of the total freshwater withdrawn, consumptive use was 100,000 Mgal/d (table 2), or 29.3 percent, and return flow was 241,000 Mgal/d, or 70.7 percent (including 25,300 Mgal/d of irrigation conveyance losses) (figure 7). Irrigation-Livestock accounted for 84.6 percent of consumptive use and thermoelectric power accounted for 53.4 percent of return flow.

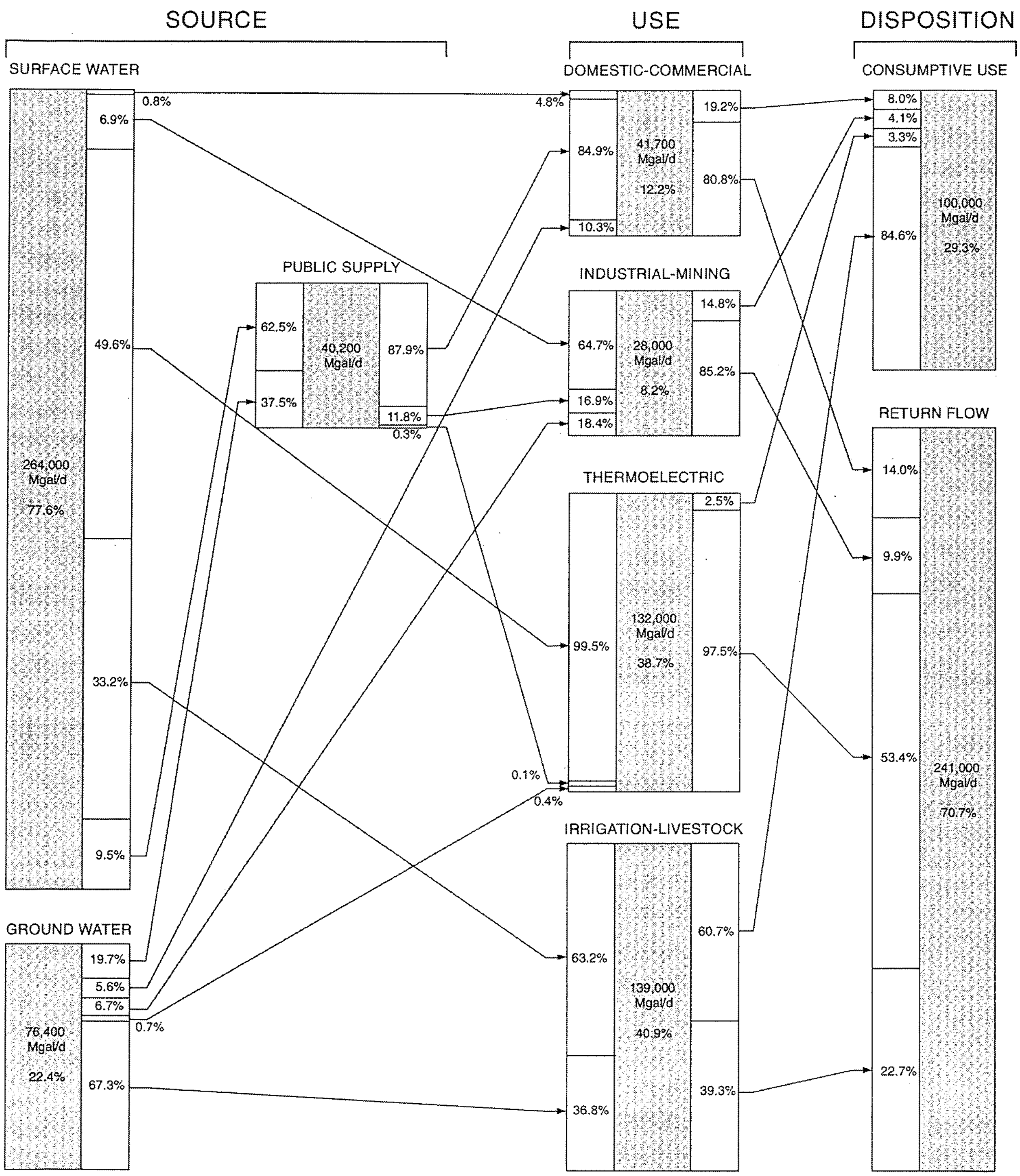


Figure 7. Source, use, and disposition of freshwater in the United States, 1995. For each water-use category, this diagram shows the relative proportion of water source and disposition and the general distribution of water from source to disposition. The lines and arrows indicate the distribution of water from source to disposition for each category; for example, surface water was 77.6 percent of total freshwater withdrawn, and going from "Source" to "Use" columns, the line from the surface-water block to the domestic and commercial block indicates that 0.8 percent of all surface water withdrawn was the source for 4.8 percent of total water (self-supplied withdrawals, public-supply deliveries) for domestic and commercial purposes. In addition, going from the "Use" to "Disposition" columns, the line from the domestic and commercial block to the consumptive use block indicates that 19.2 percent of the water for domestic and commercial purposes was consumptive use; this represents 8.0 percent of total consumptive use by all water-use categories.

Public Supply

40,200 million gallons per day

The quantity of water withdrawn for public supply during 1995 was an estimated 40,200 Mgal/d, or 4 percent more than during 1990. (See tables 9, 10). Public suppliers served about 225 million people during 1995, which is about 84 percent of the total population and a 7-percent increase from 1990. Total public-supply withdrawals in 1995 averaged 179 gal/d for each person served compared to 184 gal/d in 1990 and 183 gal/d in 1985. This is the first time public supply per-capita use declined since 1950.

The source and delivery of water for public supply for 1995 are shown in the chart below. Surface water was the source for 63 percent of public-supply withdrawals. Public-supply water was distributed to users as follows: domestic, 56 percent; commercial, 17 percent; industrial, 12 percent; and thermoelectric power, 0.3 percent. The remaining 15 percent was unaccounted water or public use and losses. This unaccounted water represents 2 percent of freshwater use for all offstream categories.

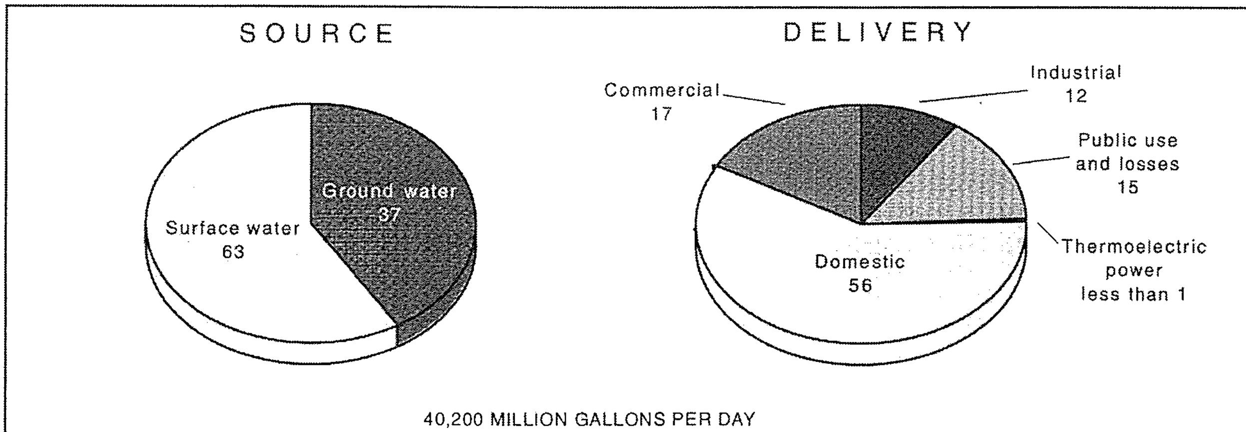
Public supply refers to water withdrawn by public and private water suppliers and delivered to multiple users for domestic, commercial, industrial, and thermoelectric power uses. In this report, public supply includes public and private water systems that furnish water to at least 25 people, or that have a minimum of 15 connections.

The difference between the quantity of water withdrawn by public suppliers in a water-resources region or State and the quantity of water delivered to all users represents losses in the distribution systems, filter back flushing, public use (water for firefighting, street washing, municipal office buildings, parks and swimming pools) and, in a few areas, water transferred between adjacent States or water-resources regions. These differences are shown in tables 9 and 10 as "Public use and losses." Large positive values of "Public use and losses" may indicate, in addition to public use and losses, large exports of public-supply water to adjacent areas; negative values indicate imports of public-supply water from adjacent areas to the extent that public-supply deliveries in a region or in a State exceed public-supply withdrawals. This is the case in Washington, D.C., which imports public-supply water from Maryland.

Information on public supply generally is available from State health agencies and through State permitting offices. The U.S. Environmental Protection Agency's Safe Drinking Water Information System also is available as a reference. Data on population served and withdrawals usually are accurate because local and State agencies maintain nearly complete information. Deliveries from public suppliers to various users are more difficult to obtain, and the information generally is less accurate.

State agencies were asked in 1995 for the first time to report saline-water withdrawals. Slightly saline ground-water withdrawals were reported for three states: Florida, 60 Mgal/d; California, 2.0 Mgal/d; and North Carolina, 2 Mgal/d. These values are included in the tables as freshwater.

Public-supply withdrawals in the Mid-Atlantic, South Atlantic-Gulf, and California water-resources regions, the three most populated regions, account for about 42 percent of total public-supply withdrawals (figure 8; table 9). Public-supply withdrawals in California, Texas, New York, and Florida, the four most populous States (31 percent of the Nation's population), account for 35 percent of nation-wide public-supply withdrawals (figure 9; table 10).



PUBLIC–SUPPLY SOURCE AND DELIVERY, 1995, IN PERCENT

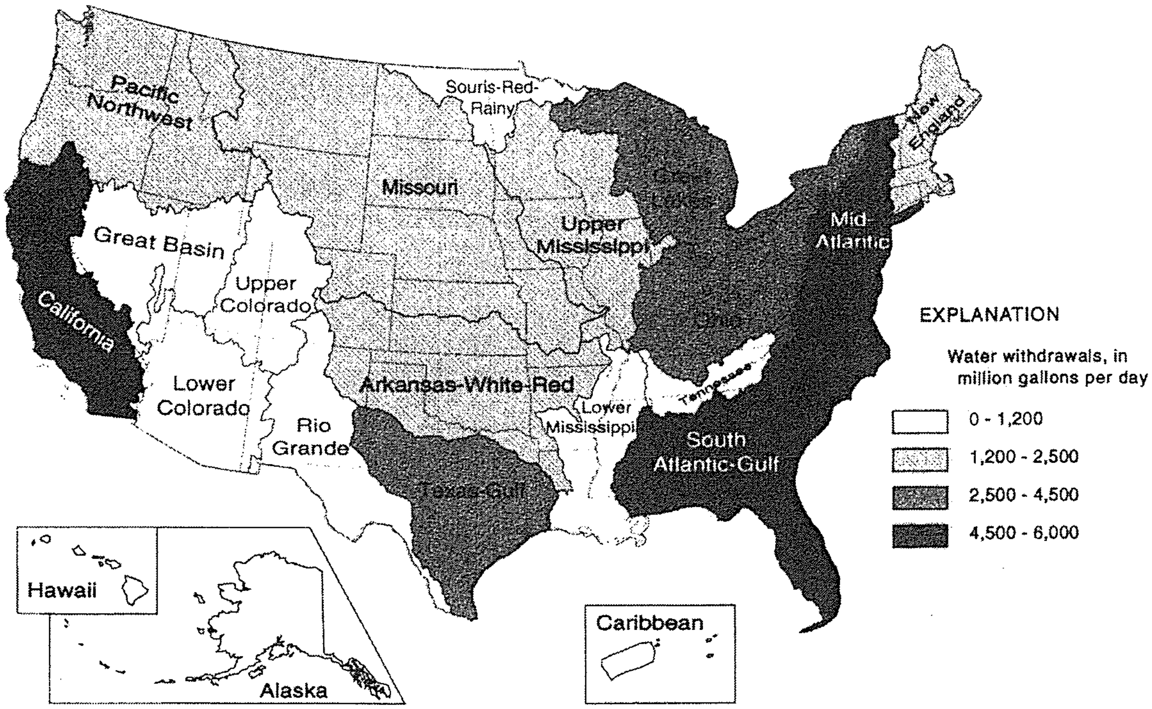


Figure 8. Public-supply freshwater withdrawals by water-resources region, 1995.

Table 9. Public-supply freshwater use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

REGION	POPULATION SERVED, in thousands			WATER WITHDRAWALS, in Mgal/d			PER CAPITA USE, in gal/d	WATER DELIVERIES, BY TYPE OF USE, in Mgal/d				PUBLIC USE AND LOSSES[1]
	Source			Source								
	Ground water	Surface water	Total	Ground water	Surface water	Total		Domestic	Commer-cial	Indus-trial	Thermo-electric power	
New England	3,950	6,470	10,400	335	1,100	1,440	138	717	343	168	2.3	210
Mid-Atlantic	10,100	25,600	35,700	1,270	4,730	6,000	168	3,340	942	516	27	1,170
South Atlantic-Gulf	17,000	13,100	30,100	2,760	2,710	5,470	182	3,080	866	742	5.6	779
Great Lakes	3,340	13,600	17,000	585	3,830	4,420	260	1,400	600	775	.1	1,640
Ohio	6,140	11,900	18,000	880	1,800	2,680	149	1,140	461	590	.3	494
Tennessee	862	2,380	3,250	125	449	574	177	274	134	101	0	64
Upper Mississippi	7,750	10,200	18,000	1,150	731	1,880	104	1,450	653	361	7.4	-599
Lower Mississippi	4,780	1,540	6,330	741	330	1,070	169	703	144	94	1.1	129
Souris-Red-Rainy	262	184	446	34	32	66	149	26	15	3.9	0	21
Missouri Basin	3,890	5,090	8,980	643	926	1,570	175	966	279	106	4.7	212
Arkansas-White-Red	2,540	5,140	7,680	378	1,170	1,550	202	767	275	291	28	193
Texas-Gulf	6,580	9,110	15,700	978	1,860	2,840	181	2,160	126	171	13	372
Rio Grande	1,560	735	2,300	356	131	487	212	340	73	20	0	55
Upper Colorado	154	407	561	35	106	141	252	86	25	4.2	0	26
Lower Colorado	2,440	2,510	4,950	476	698	1,170	237	757	235	68	1.5	113
Great Basin	1,230	1,050	2,280	350	254	605	265	417	132	17	0	39
Pacific Northwest	3,460	4,020	7,480	917	993	1,910	256	1,020	267	407	0	221
California	13,000	17,400	30,400	2,730	2,880	5,610	184	3,700	992	284	5.3	626
Alaska	161	220	381	30	50	81	212	38	23	12	.6	8.0
Hawaii	1,080	45	1,120	200	14	214	191	131	47	5.6	.3	31
Caribbean	835	2,750	3,580	95	342	437	122	173	64	15	2.2	183
Total	91,200	134,000	225,000	15,100	25,100	40,200	179	22,700	6,690	4,750	100	5,980

[1] Includes transfers from adjacent areas.

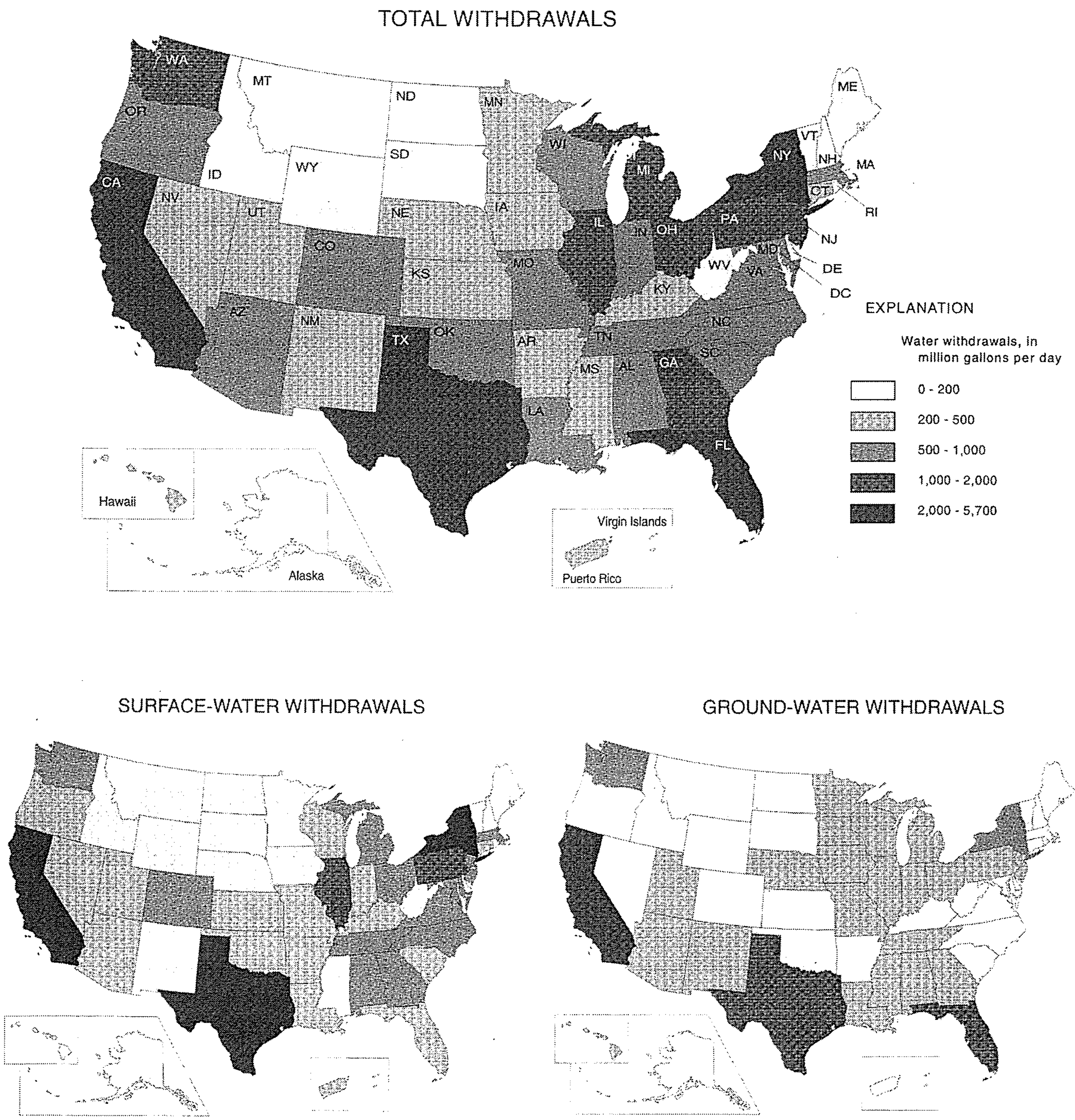


Figure 9. Public-supply freshwater withdrawals by source and State, 1995.

Table 10. Public-supply freshwater use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

STATE	POPULATION SERVED, in thousands			WATER WITHDRAWALS, in Mgal/d			PER CAPITA USE, in gal/d	WATER DELIVERIES, BY TYPE OF USE, in Mgal/d				PUBLIC USE AND LOSSES[1]
	Source			Source								
	Ground water	Surface water	Total	Ground water	Surface water	Total		Domestic	Commer-cial	Indus-trial	Thermo-electric power	
Alabama	1,380	2,040	3,430	253	560	813	237	383	122	213	0	94
Alaska	161	220	381	30	50	81	212	38	23	12	.6	8.0
Arizona	2,240	1,670	3,920	409	398	807	206	526	135	66	0	81
Arkansas	831	1,160	2,000	135	246	381	191	193	58	57	0	73
California	13,000	17,500	30,500	2,740	2,880	5,620	185	3,710	994	283	5.3	629
Colorado	475	2,920	3,390	100	605	705	208	481	101	19	14	90
Connecticut	1,030	1,500	2,530	65	329	393	155	191	89	42	1.0	70
Delaware	321	243	564	40	49	89	159	43	20	16	.5	11
D.C.	0	554	554	0	0	0	0	95	50	.7	0	-146
Florida	11,200	1,040	12,200	1,860	210	2,070	169	1,260	386	103	3.6	312
Georgia	1,680	4,220	5,900	263	890	1,150	195	629	168	194	0	161
Hawaii	1,080	45	1,120	200	14	214	191	131	47	5.6	.3	31
Idaho	736	44	780	180	9.9	189	243	141	18	6.7	0	23
Illinois	2,500	7,900	10,400	371	1,450	1,820	175	936	440	118	5.2	324
Indiana	2,170	2,120	4,280	319	350	669	156	326	119	125	0	99
Iowa	1,530	619	2,150	257	116	373	173	139	65	78	3.0	88
Kansas	1,050	1,270	2,320	161	209	370	159	191	67	37	.8	74
Kentucky	465	2,890	3,360	55	441	496	148	235	23	197	0	42
Louisiana	2,150	1,690	3,850	294	344	638	166	468	55	35	0	80
Maine	217	491	708	25	75	100	142	46	25	14	.9	14
Maryland	679	3,490	4,170	83	751	834	200	433	85	44	0	271
Massachusetts	2,280	3,300	5,580	192	533	725	130	362	188	86	0	88
Michigan	1,740	5,170	6,900	348	952	1,300	188	623	253	270	0	154
Minnesota	2,410	936	3,340	331	154	485	145	239	103	41	.1	103
Mississippi	2,050	214	2,260	302	41	344	152	248	33	20	2.2	40
Missouri	1,870	2,460	4,330	226	473	699	161	374	59	140	.2	125
Montana	240	405	645	55	89	143	222	77	26	1.0	0	39
Nebraska	1,080	212	1,290	232	53	286	221	155	79	26	0	26
Nevada	380	1,060	1,440	117	351	468	325	306	116	2.2	1.5	42
New Hampshire	257	440	697	31	66	98	140	57	21	13	.3	6.7
New Jersey	3,220	3,710	6,930	397	640	1,040	150	538	179	91	25	203
New Mexico	1,210	174	1,380	277	34	311	225	188	78	15	.1	30
New York	4,350	11,900	16,200	552	2,450	3,000	185	1,810	409	356	0	424
North Carolina	1,130	3,620	4,750	136	633	769	162	332	138	193	.4	105
North Dakota	213	276	489	30	43	73	149	40	15	2.5	0	15
Ohio	3,290	5,990	9,280	497	923	1,420	153	497	355	355	0	213
Oklahoma	759	2,170	2,930	99	468	567	194	241	170	122	1.2	34
Oregon	374	1,770	2,150	87	417	504	235	292	79	71	0	62
Pennsylvania	1,950	7,110	9,050	243	1,300	1,550	171	559	218	193	1.6	574
Rhode Island	150	728	878	16	99	114	130	57	20	12	0	26
South Carolina	698	2,020	2,720	107	436	543	200	368	50	44	0	81
South Dakota	382	220	602	53	35	88	147	52	21	7.9	0	7.1
Tennessee	1,630	2,790	4,420	277	500	777	176	355	214	130	.5	78
Texas	7,330	10,200	17,600	1,130	2,160	3,290	188	2,450	130	268	29	412
Utah	1,010	840	1,850	293	204	497	269	340	115	17	0	25
Vermont	110	204	315	15	32	47	148	26	7.7	7.7	0	5.5
Virginia	594	4,360	4,960	82	704	786	159	424	152	88	.5	121
Washington	2,300	2,130	4,430	631	548	1,180	266	565	161	331	0	122
West Virginia	282	1,040	1,320	38	139	176	134	96	23	14	.2	44
Wisconsin	2,020	1,540	3,560	311	289	600	169	189	111	151	.1	148
Wyoming	145	199	344	38	52	90	261	54	16	2.4	0	17
Puerto Rico	827	2,710	3,540	95	336	431	122	171	61	15	2.2	182
Virgin Islands	7.6	39	47	.3	6.2	6.5	138	1.6	3.3	0	.8	.8
Total	91,200	134,000	225,000	15,100	25,100	40,200	179	22,700	6,690	4,750	100	5,980

[1] Includes transfers from adjacent areas.

Domestic — 26,100 million gallons per day

Domestic water use during 1995 was an estimated 26,100 Mgal/d, or 3 percent more than during 1990. Domestic use represents about 8 percent of freshwater use for all offstream categories. Self-supplied domestic withdrawals were an estimated 3,390 Mgal/d (tables 11, 12). Ground water was the source for about 99 percent of self-supplied domestic withdrawals. Public suppliers delivered about 22,700 Mgal/d of water to domestic users; this accounted for 56 percent of total public-supply withdrawals.

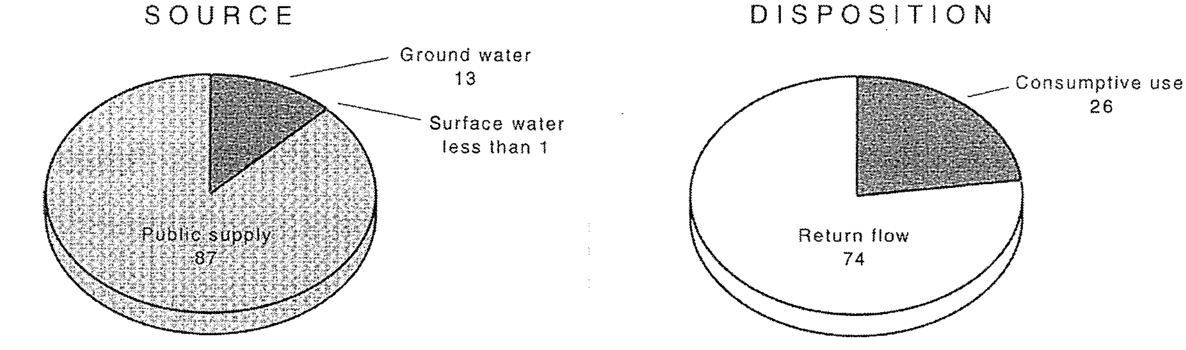
The source and disposition of water for domestic purposes for 1995 are shown in the chart below. Public supply is the dominant source of water (87 percent) for domestic use. The consumptive use of water for domestic purposes in 1995 was estimated at about 6,680 Mgal/d, or about 26 percent of withdrawals and deliveries.

Domestic water use includes water for normal household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Information from public suppliers about withdrawals and population served generally is reliable. Information on deliveries to various users is more difficult to obtain and generally is estimated from the population served.

The number of people served by their own water systems (self supplied) is determined by subtracting the number of people served by public suppliers from the total population as reported by the U.S. Bureau of the Census (1996). The difference between these totals indicates that 42.4 million people, or 16 percent of the Nation's total population, were served by their own water-supply systems in 1995, compared with 42.8 million people in 1990. Self-supplied domestic systems rarely are metered and few data exist. Self-supplied domestic withdrawals are estimated using per-capita use coefficients generally ranging from 60 to 120 gallons per person per day. Consumptive-use estimates are based on coefficients generally ranging from 10 to 50 percent of withdrawals and deliveries.

Withdrawals for the population served by their own water systems averaged about 80 gal/d for each person in 1995, about the same as 1990. Public-supply domestic deliveries averaged 101 gal/d for each person served in 1995, compared to 105 gal/d during 1990 and 1985. Per-capita use has remained about the same or declined in some areas for the last decade as the result of active conservation programs in many states that include the installation of additional meters and water-conserving plumbing fixtures.

In 1995, the South Atlantic-Gulf and Mid-Atlantic water-resources region had the largest self-supplied withdrawals for domestic purposes (figure 10), whereas the Mid-Atlantic, California, and South Atlantic-Gulf regions had a large total of domestic withdrawals and deliveries (table 11). Self-supplied withdrawals for domestic purposes are fairly evenly distributed among the States, led by Florida, Michigan, Pennsylvania, and North Carolina. (See figure 11; table 12.) California and Texas, along with New York, Florida, and Illinois, lead the Nation in total domestic use (withdrawals, deliveries) as shown in figure 12.



26,100 MILLION GALLONS PER DAY

DOMESTIC SOURCE AND DISPOSITION, 1995, IN PERCENT

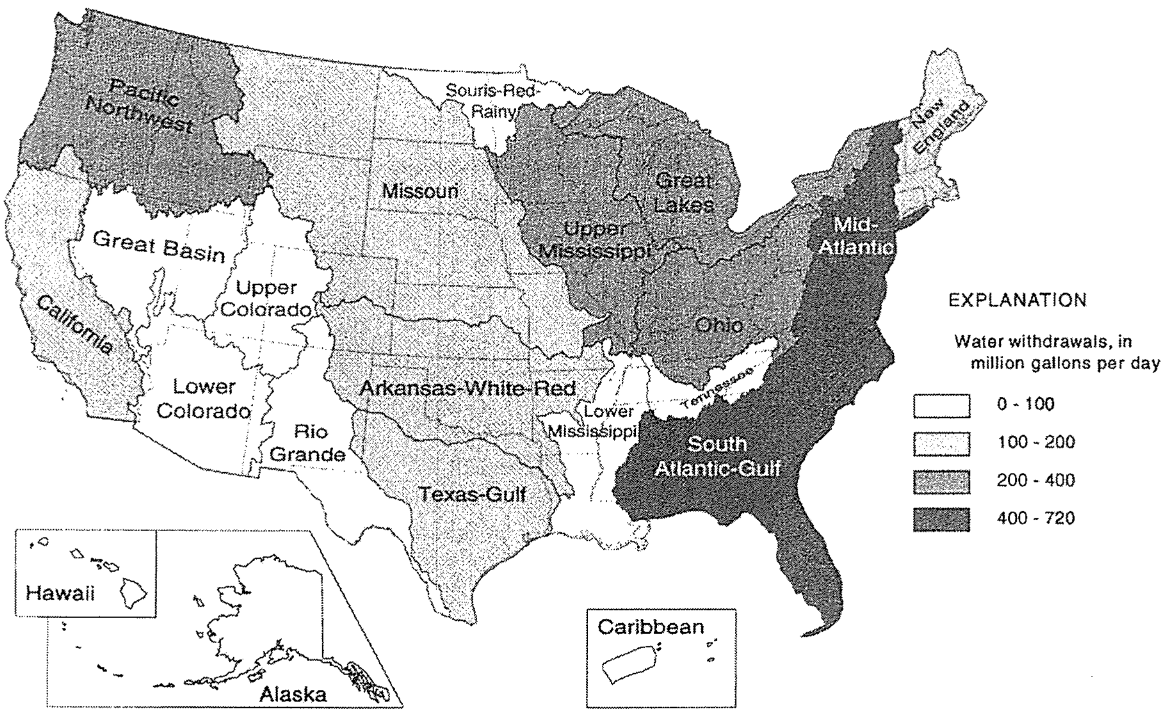


Figure 10. Domestic self-supplied withdrawals by water-resources region, 1995.

Table 11. Domestic freshwater use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

REGION	SELF SUPPLIED					PUBLIC SUPPLY			TOTAL USE	
	Population, in thousands	Water withdrawals, in Mgal/d: Source: Ground water	Surface water	Total	Per capita use, in gal/d	Population served, in thousands	Water deliveries, in Mgal/d	Per capita use, in gal/d	Withdrawals and deliveries, in Mgal/d	Consumptive use, in Mgal/d
New England	2,420	168	0.5	169	70	10,400	717	69	886	139
Mid-Atlantic	6,730	485	.6	486	72	35,700	3,340	94	3,830	355
South Atlantic-Gulf	7,700	719	0	719	93	30,100	3,080	102	3,800	888
Great Lakes	4,870	354	1.0	355	73	17,000	1,400	83	1,760	248
Ohio	4,640	323	5.0	328	71	18,000	1,140	63	1,470	189
Tennessee	953	64	0	64	67	3,250	274	85	338	51
Upper Mississippi	4,290	311	0	311	72	18,000	1,450	81	1,760	329
Lower Mississippi	996	73	.1	73	74	6,330	703	111	776	529
Souris-Red-Rainy	248	17	0	17	67	446	26	59	43	17
Missouri Basin	1,690	137	1.2	138	82	8,980	966	108	1,100	423
Arkansas-White-Red	1,250	105	0	105	84	7,680	767	100	872	374
Texas-Gulf	1,070	115	0	115	108	15,700	2,160	138	2,270	958
Rio Grande	269	25	0	25	94	2,300	340	148	365	173
Upper Colorado	153	11	.4	12	76	561	86	154	98	36
Lower Colorado	367	44	.2	45	121	4,950	757	153	802	397
Great Basin	126	13	1.6	14	114	2,280	417	183	431	160
Pacific Northwest	2,470	253	7.3	260	105	7,480	1,020	136	1,280	190
California	1,620	112	12	124	76	30,400	3,700	122	3,830	1,060
Alaska	223	8.3	.4	8.7	39	381	38	99	46	4.5
Hawaii	65	2.4	1.3	3.7	57	1,120	131	117	134	76
Caribbean	274	6.4	6.9	13	49	3,580	173	48	186	83
Total	42,400	3,350	38	3,390	80	225,000	22,700	101	26,100	6,680

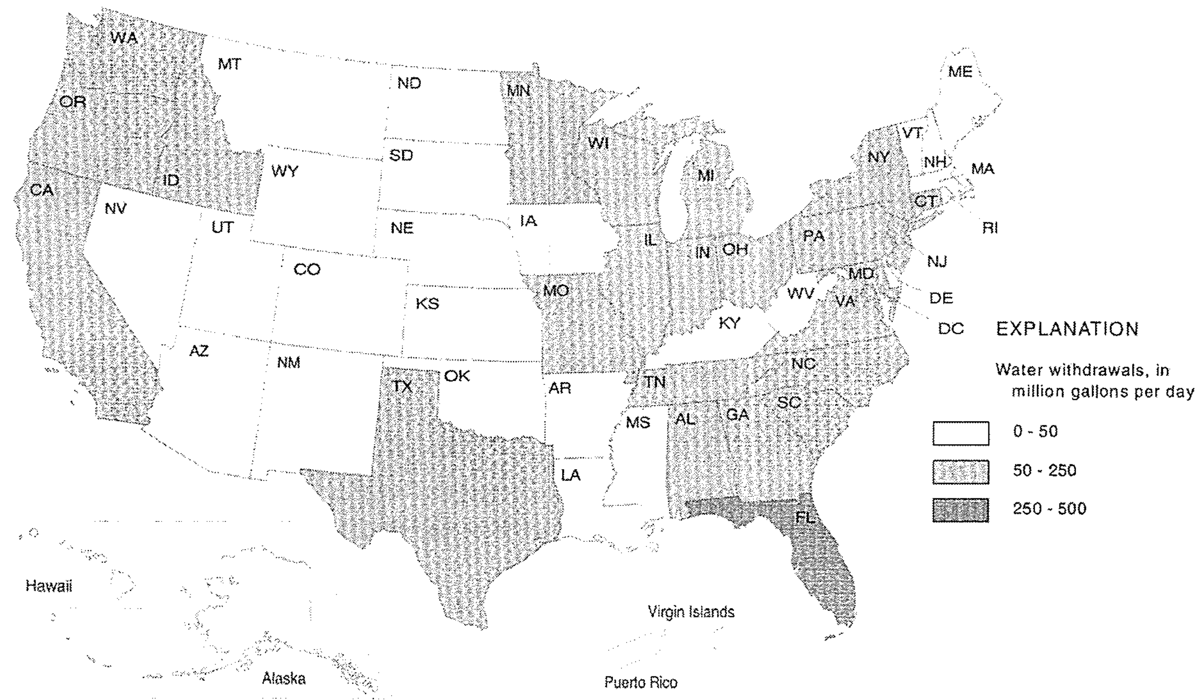


Figure 11. Domestic self-supplied withdrawals by State, 1995.

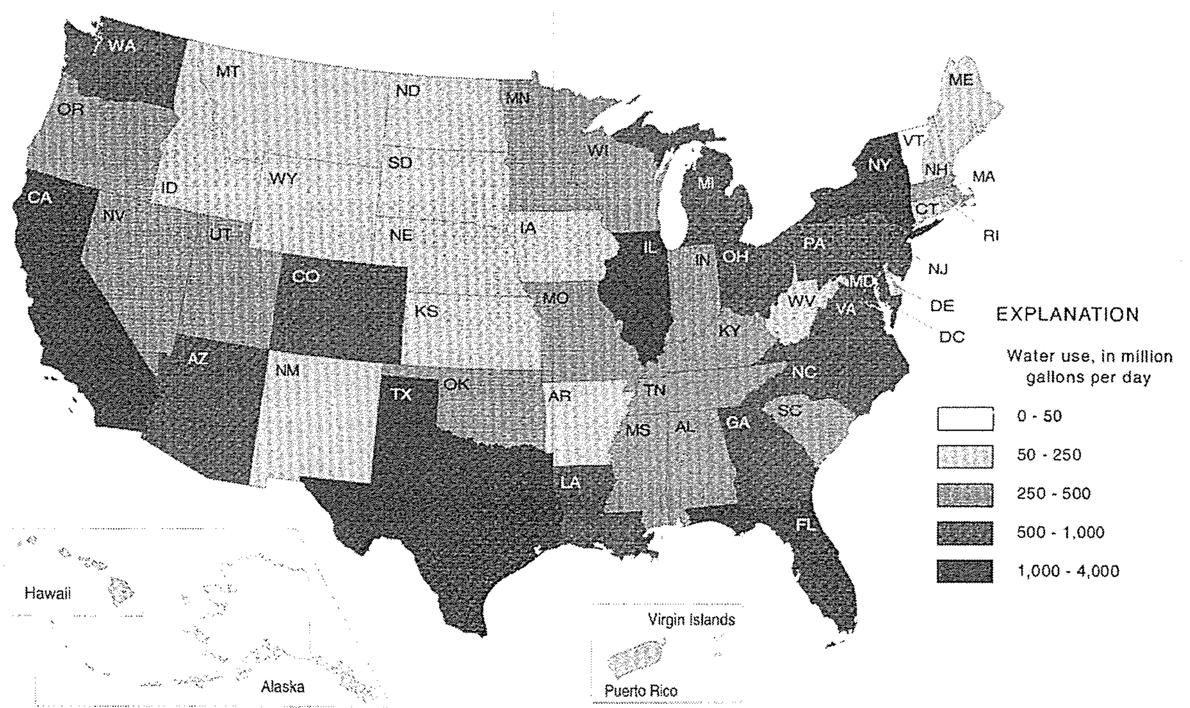


Figure 12. Domestic freshwater use (withdrawals, deliveries) by State, 1995.

Table 12. Domestic freshwater use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; gal/d = gallons per day]

STATE	SELF SUPPLIED					PUBLIC SUPPLY			TOTAL USE	
	Population, in thousands	Water withdrawals, in Mgal/d: Source: Ground water	Water withdrawals, in Mgal/d: Source: Surface water	Water withdrawals, in Mgal/d: Total	Per capita use, in gal/d	Population served, in thousands	Water deliveries, in Mgal/d	Per capita use, in gal/d	Withdrawals and deliveries, in Mgal/d	Consumptive use, in Mgal/d
Alabama	826	62	0	62	75	3,430	383	112	445	89
Alaska	223	8.3	.3	8.6	39	381	38	99	46	4.5
Arizona	301	39	0	39	131	3,920	526	134	565	283
Arkansas	488	38	0	38	78	2,000	193	97	231	100
California	1,600	108	12	120	75	30,500	3,710	122	3,830	1,060
Colorado	353	27	0	27	76	3,390	481	142	508	154
Connecticut	742	55	0	55	74	2,530	191	75	246	49
Delaware	153	12	0	12	80	564	43	76	55	5.5
D.C.	0	0	0	0	0	554	95	171	95	9.5
Florida	1,950	297	0	297	152	12,200	1,260	103	1,560	389
Georgia	1,300	99	0	99	76	5,900	629	107	728	131
Hawaii	65	2.4	1.3	3.7	57	1,120	131	117	134	76
Idaho	383	65	0	65	168	780	141	181	206	9.8
Illinois	1,430	129	0	129	90	10,400	936	90	1,060	107
Indiana	1,520	115	0	115	76	4,280	326	76	441	66
Iowa	689	45	0	45	65	2,150	139	65	184	73
Kansas	242	24	0	24	100	2,320	191	82	215	140
Kentucky	505	23	2.5	25	50	3,360	235	70	260	34
Louisiana	496	39	0	39	79	3,850	468	122	508	508
Maine	533	35	0	35	65	708	46	65	81	12
Maryland	875	73	0	73	83	4,170	433	104	506	51
Massachusetts	497	34	0	34	68	5,580	362	65	396	54
Michigan	2,650	194	.1	194	73	6,900	623	90	817	119
Minnesota	1,270	88	0	88	69	3,340	239	71	326	110
Mississippi	434	33	0	33	75	2,260	248	110	281	75
Missouri	995	58	0	58	59	4,330	374	86	433	108
Montana	225	17	1.0	18	78	645	77	119	94	46
Nebraska	346	42	0	42	121	1,290	155	120	197	100
Nevada	91	11	.2	11	120	1,440	306	213	317	158
New Hampshire	451	31	.5	32	70	697	57	82	89	13
New Jersey	1,010	86	0	86	85	6,930	538	78	624	122
New Mexico	306	26	0	26	86	1,380	188	136	215	118
New York	1,930	144	0	144	75	16,200	1,810	112	1,960	107
North Carolina	2,450	172	0	172	70	4,750	332	70	504	163
North Dakota	152	12	0	12	79	489	40	82	52	16
Ohio	1,870	138	2.8	140	75	9,280	497	54	637	96
Oklahoma	351	30	0	30	85	2,930	241	82	270	81
Oregon	995	61	7.2	68	68	2,150	292	136	360	83
Pennsylvania	3,020	181	0	181	60	9,050	559	62	740	74
Rhode Island	112	7.3	0	7.3	65	878	57	65	64	9.6
South Carolina	951	71	0	71	75	2,720	368	135	439	88
South Dakota	127	9.3	0	9.4	74	602	52	87	62	15
Tennessee	838	54	0	54	65	4,420	355	80	409	41
Texas	1,170	130	0	130	110	17,600	2,450	140	2,580	1,080
Utah	103	7.7	1.7	9.4	91	1,850	340	184	349	118
Vermont	270	18	.4	19	70	315	26	82	45	6.7
Virginia	1,660	125	0	125	75	4,960	424	86	548	55
Washington	1,000	125	0	125	125	4,430	565	128	691	83
West Virginia	509	40	.8	41	80	1,320	96	72	136	14
Wisconsin	1,540	92	0	92	60	3,560	189	53	281	56
Wyoming	136	9.7	.5	10	75	344	54	157	64	33
Puerto Rico	217	6.4	5.5	12	55	3,540	171	48	183	83
Virgin Islands	57	0	1.4	1.4	24	47	1.6	35	3.0	.7
Total	42,400	3,350	38	3,390	80	225,000	22,700	101	26,100	6,680

Commercial — 9,590 million gallons per day

Commercial water use during 1995 was an estimated 9,590 Mgal/d, or 16 percent more than during 1990. Commercial use represents about 3 percent of freshwater use for all offstream categories. Self-supplied commercial withdrawals were an estimated 2,890 Mgal/d. Surface water was the source for about 67 percent of self-supplied commercial withdrawals. Public suppliers delivered about 6,690 Mgal/d of water to commercial users during 1995; this accounted for 17 percent of total public-supply withdrawals.

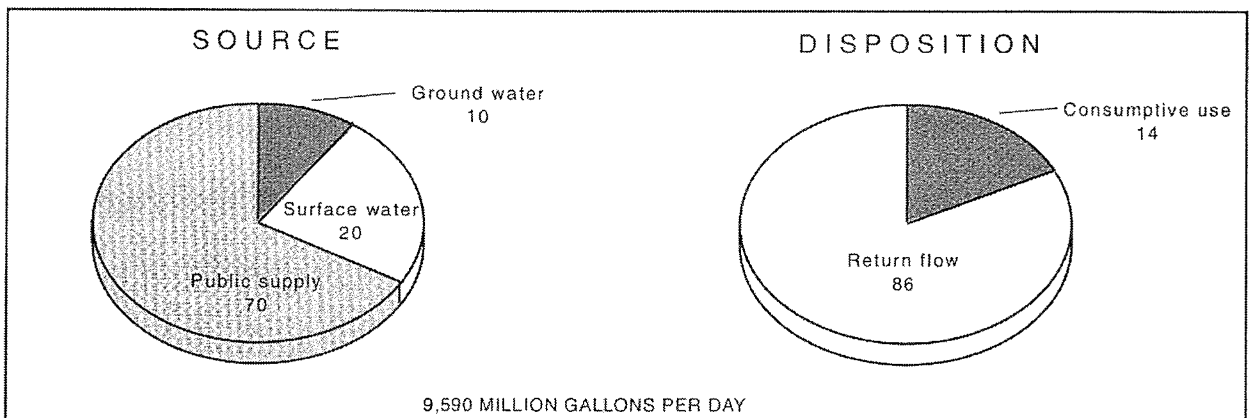
The source and disposition of water for commercial purposes are shown in the chart below. Public supply is the dominant source of water (70 percent) for commercial use. The consumptive use of water for commercial purposes during 1995 was estimated at about 1,310 Mgal/d, or about 14 percent of withdrawals and deliveries.

Commercial water was higher in 34 states in 1995 compared to commercial use in 1990. Some of the larger increases in commercial water use probably are because of different sources of information, changes in how the estimates are calculated, and how fish hatcheries and military establishments are reported, rather than actual changes in water use. California, Idaho, New York, Florida, and Oklahoma reported large increases in commercial use; whereas, Arkansas and Illinois reported large decreases.

Commercial water use includes water for motels, hotels, restaurants, office buildings, other commercial facilities, and civilian and military institutions. Also included are public-supply deliveries to golf courses. A few States, such as Arkansas, Oregon, and California, have some offstream fish hatcheries that also are included in the commercial category in this report. Most fish hatcheries are located instream and are not included in this compilation. Information on commercial withdrawals is limited but may be available through State agencies that permit withdrawals or require permits to operate potable water supplies. In many cases, withdrawal estimates are based on the population of the commercial facilities; that is, the number of students attending a university, inmates in a penal institution, workers in an office building, or the average occupancy rate of a hotel, rather than actual reported use. Information on deliveries from public suppliers to commercial users are estimated from a variety of methods if not available directly from public suppliers. Consumptive-use estimates are difficult to obtain and generally are based on coefficients, most ranging from 5 to 30 percent of withdrawals and deliveries.

States agencies were asked in 1995 for the first time to report saline-water withdrawals. Maryland was the only State to identify slightly-saline withdrawals for commercial use (8.8 Mgal/d). This value is included in the tables as freshwater.

In 1995, the Pacific Northwest water-resources region had the most water withdrawn for commercial purposes as shown in figure 13 and table 13. Oregon reported the largest self-supplied commercial withdrawals as shown in figure 14 and table 14. California, Oregon, New York, and Illinois reported the most commercial water use (figure 15).



COMMERCIAL SOURCE AND DISPOSITION, 1995, IN PERCENT

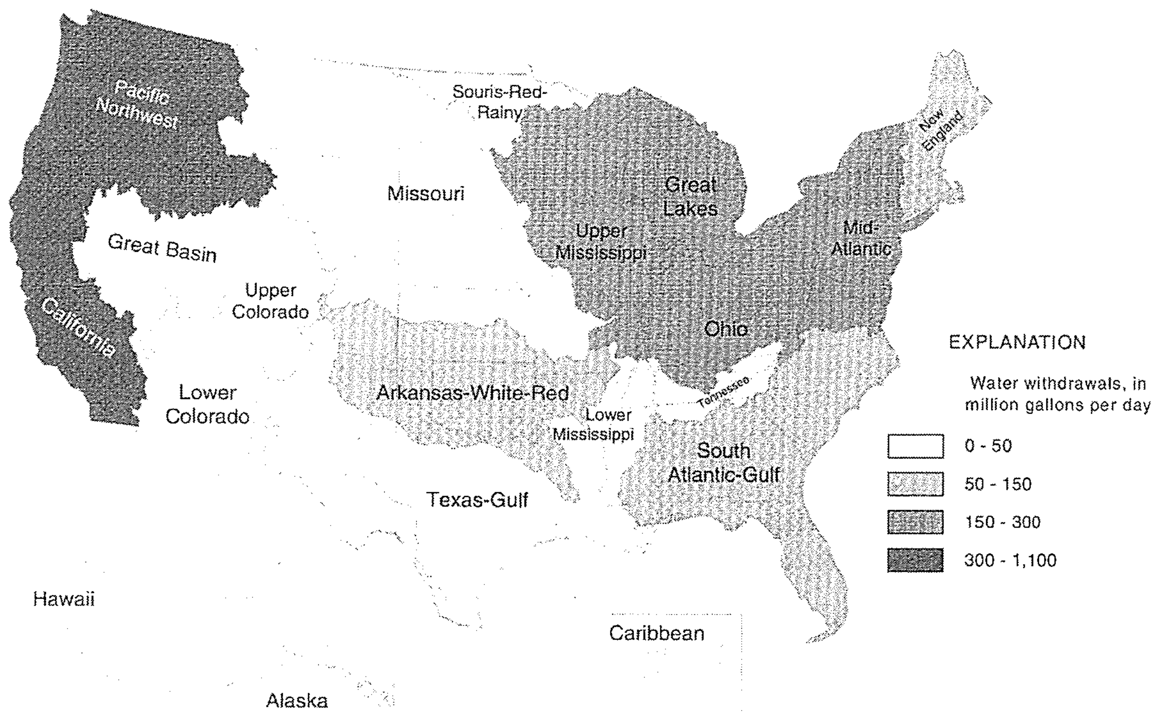


Figure 13. Commercial self-supplied withdrawals by water-resources region, 1995.

Table 13. Commercial freshwater use by water-resources region, 1995
[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	SELF-SUPPLIED WITHDRAWALS: Source: Ground water	SELF-SUPPLIED WITHDRAWALS: Source: Surface water	SELF-SUPPLIED WITHDRAWALS: Total	PUBLIC-SUPPLY DELIVERIES	TOTAL USE: Withdrawals and deliveries	TOTAL USE: Consumptive use
New England	64	26	90	343	433	46
Mid-Atlantic	217	65	283	942	1,230	102
South Atlantic-Gulf	114	16	130	866	996	138
Great Lakes	44	108	152	600	752	82
Ohio	91	80	170	461	631	93
Tennessee	3.6	18	22	134	156	18
Upper Mississippi	94	114	208	653	861	86
Lower Mississippi	15	21	36	144	180	16
Souris-Red-Rainy	.2	.1	.3	15	15	2.0
Missouri Basin	19	15	34	279	313	79
Arkansas-White-Red	16	99	115	275	390	51
Texas-Gulf	34	8.0	42	126	168	37
Rio Grande	17	1.8	19	73	91	49
Upper Colorado	5.6	.7	6.2	25	31	6.4
Lower Colorado	22	7.5	30	235	265	101
Great Basin	10	15	25	132	158	39
Pacific Northwest	37	1,030	1,070	267	1,330	42
California	77	319	396	992	1,390	257
Alaska	11	.1	11	23	34	5.1
Hawaii	45	.4	46	47	92	43
Caribbean	1.3	2.1	3.4	64	68	20
Total	939	1,950	2,890	6,690	9,590	1,310

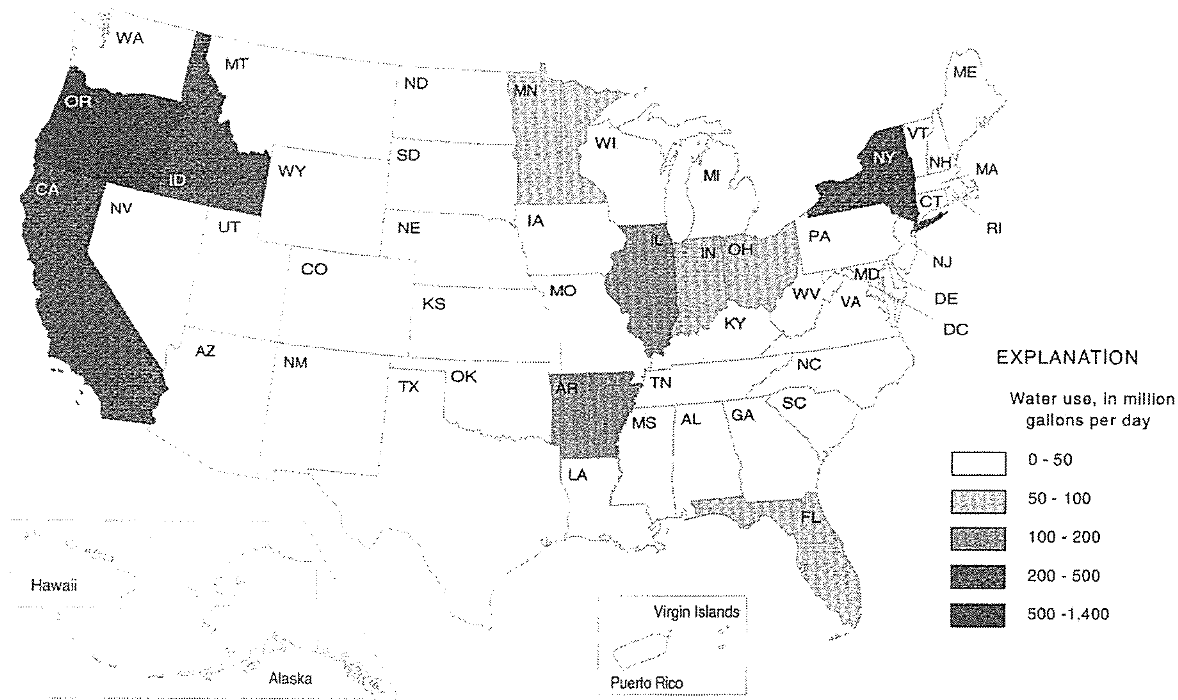


Figure 14. Commercial self-supplied withdrawals by State, 1995.

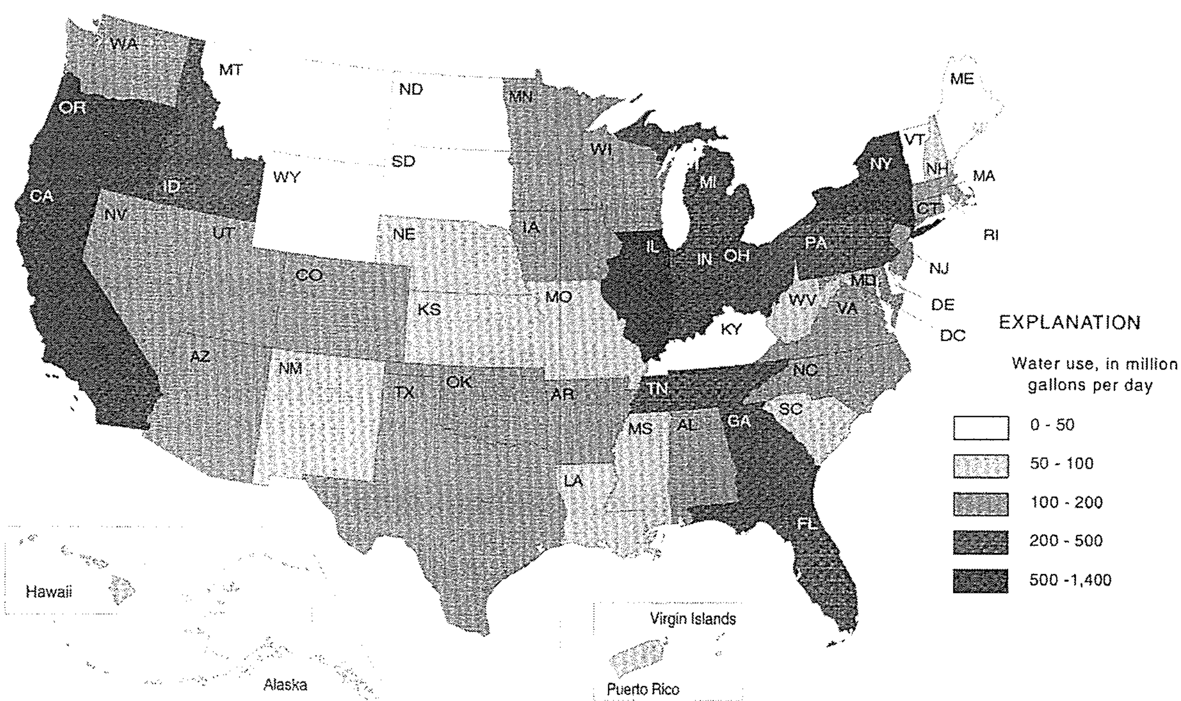


Figure 15. Commercial freshwater use (withdrawals, deliveries) by State, 1995.

Table 14. Commercial freshwater use by State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	SELF-SUPPLIED WITHDRAWALS			PUBLIC-SUPPLY DELIVERIES	TOTAL USE	
	Source		Total		Withdrawals and deliveries	Consumptive use
	Ground water	Surface water				
Alabama	4.9	0	4.9	122	127	28
Alaska	11	.1	11	23	34	5.1
Arizona	21	0	21	135	155	78
Arkansas	.4	100	100	58	158	12
California	77	309	385	994	1,380	259
Colorado	7.7	.9	8.6	101	109	16
Connecticut	25	1.5	27	89	116	12
Delaware	2.8	0	2.8	20	22	2.2
D.C.	0	0	0	50	50	5.0
Florida	50	.2	50	386	436	54
Georgia	33	13	46	168	215	39
Hawaii	45	.4	46	47	92	43
Idaho	9.8	297	306	18	324	1.4
Illinois	16	88	104	440	544	44
Indiana	45	48	93	119	212	32
Iowa	18	25	43	65	108	14
Kansas	4.9	.3	5.2	67	72	38
Kentucky	8.0	14	22	23	45	1.6
Louisiana	10	.7	11	55	66	8.8
Maine	9.8	1.7	11	25	37	3.7
Maryland	19	14	33	85	118	11
Massachusetts	12	0	12	188	200	25
Michigan	16	25	41	253	294	31
Minnesota	46	20	66	103	169	18
Mississippi	18	0	18	33	51	8.6
Missouri	13	.5	14	59	73	5.3
Montana	0	0	0	26	26	9.6
Nebraska	.3	0	.3	79	79	30
Nevada	7.1	14	21	116	137	24
New Hampshire	12	18	30	21	51	3.5
New Jersey	17	1.2	18	179	197	7.5
New Mexico	18	1.6	20	78	97	56
New York	136	65	200	409	609	61
North Carolina	7.3	.3	7.6	138	146	7.2
North Dakota	.1	.2	.2	15	15	2.3
Ohio	28	41	68	355	424	66
Oklahoma	6.6	16	23	170	193	18
Oregon	4.4	752	756	79	835	.7
Pennsylvania	16	14	30	218	247	11
Rhode Island	1.5	0	1.5	20	21	2.1
South Carolina	1.7	0	1.7	50	52	7.8
South Dakota	6.1	4.1	10	21	31	3.1
Tennessee	2.0	18	20	214	234	21
Texas	33	11	44	130	174	35
Utah	3.8	0	3.8	115	119	35
Vermont	9.6	16	26	7.7	33	2.4
Virginia	28	13	41	152	193	23
Washington	24	.4	24	161	185	37
West Virginia	36	9.2	46	23	68	10
Wisconsin	17	0	17	111	128	26
Wyoming	.9	.6	1.6	16	18	2.7
Puerto Rico	1.2	1.5	2.7	61	64	19
Virgin Islands	.1	.6	.8	3.3	4.1	.6
Total	939	1,950	2,890	6,690	9,590	1,310

Irrigation — 134,000 million gallons per day

The quantity of water withdrawn for irrigation during 1995 was an estimated 134,000 Mgal/d or 150 million acre-feet. Irrigation withdrawals during 1995 were 2 percent less than during 1990 and acres irrigated were 1 percent more. This indicates lower irrigation application rates because of improved irrigation techniques. In addition, many areas received more precipitation during 1995 than during 1990. Irrigation use represents 39 percent of freshwater use for all offstream categories.

The source and disposition of water for irrigation are shown in the chart below. Surface water was the source for about 63 percent of irrigation withdrawals, and, except for a small fraction of 1 percent that was reclaimed wastewater, ground water was the source for the remainder. Surface-water withdrawals for irrigation during 1995 were about 1 percent less than during 1990, and ground-water withdrawals were about 4 percent less. Of the 134,000 Mgal/d withdrawn for irrigation, 19 percent was lost in conveyance, 61 percent was consumptive use, and 20 percent was returned to surface- or ground-water supplies.

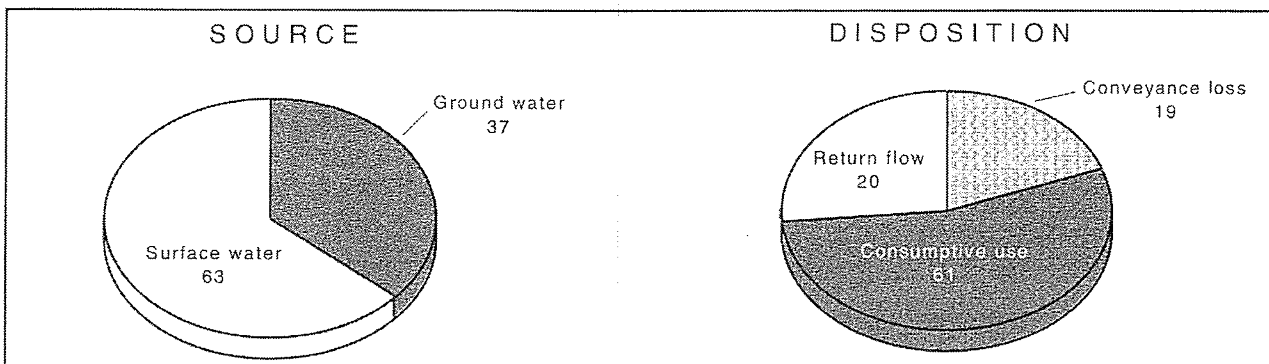
Irrigation water use includes all water artificially applied to farm and horticultural crops as well as self-supplied water used to irrigate public and private golf courses. Irrigation water can be self supplied or supplied by irrigation companies or districts. However, all irrigation withdrawals in this report are identified as self-supplied.

Irrigation of crops developed concurrently with the settlement of the arid West, where natural precipitation was insufficient to raise many crops. In the humid East, irrigation is used to supplement natural precipitation to increase the number of plantings per year or the yields of crops, and to reduce the risk of crop failures during droughts.

Information about the number of acres irrigated and the quantity of water withdrawn is obtained from a variety of sources such as State agencies responsible for permitting or allocating the withdrawal of water, the U.S. Soil Conservation Service, U.S. Bureau of Reclamation, county Cooperative Extension Service, individual farmers, agricultural research stations, and the U.S. Bureau of the Census, Agricultural Census, and the Farm and Ranch Survey. Total acres irrigated are reported in three types—sprinkler (includes center pivot and travelling gun), micro (includes trickle and drip), and surface (includes flooding, furrow, and ditch).

Methods of estimating withdrawals for irrigation vary greatly. In some instances, they are based on theoretical estimates of water required to raise a given crop in an area. In other instances, accurate records of water application rates are available. Fairly accurate estimates of water withdrawn for irrigation can be made if the acreage irrigated, water application rates, and conveyance losses are known. It usually is difficult to obtain reliable estimates for consumptive use and for conveyance loss. Thus, some of the estimates of consumptive use and conveyance loss may be only rough approximations of actual conditions. In most States, consumptive use is based on coefficients ranging from 40 to 100 percent of withdrawals, or on theoretical crop requirements. In a few States, consumptive use is calculated as the difference between reported withdrawals and reported return flows.

Irrigation is by far the largest water use in the West. The nine western water-resources regions (excluding Alaska and Hawaii), led by the California region, account for 89 percent of the total water withdrawn for irrigation (figure 16; table 15). In the eastern regions, most of the water withdrawn for irrigation is in the Lower Mississippi and South Atlantic-Gulf regions. By State, California, is the largest user of irrigation water (figure 17) and, together with Idaho, Colorado, Texas, and Montana account for 54 percent of the national total (table 16). Florida has the most water withdrawn for irrigation in the East although it ranks thirteenth nationwide.



134,000 MILLION GALLONS PER DAY

IRRIGATION SOURCE AND DISPOSITION, 1995, IN PERCENT

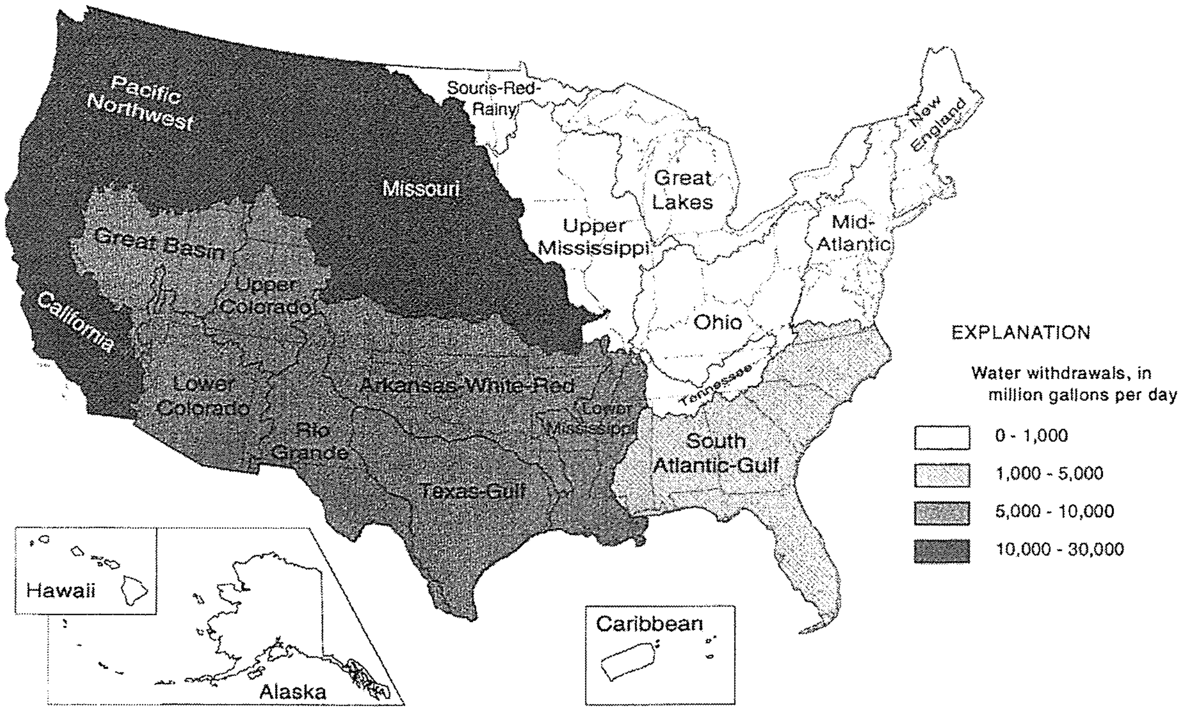


Figure 16. Irrigation freshwater withdrawals by water-resources region, 1995.

Table 15. Irrigation water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding]

STATE	IRRIGATED LAND BY TYPE, in thousand acres				THOUSAND ACRE-FEET PER YEAR: Withdrawals, by source, Freshwater		THOUSAND ACRE-FEET PER YEAR: Withdrawals, by source	MILLION GALLONS PER DAY: Withdrawals, by source, Freshwater		MILLION GALLONS PER DAY: Withdrawals, by source	MILLION GALLONS PER DAY		
	Sprinkler	Micro	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Reclaimed waste-water	Convey-ance losses	Consump-tive use, fresh water
New England	88	2.6	12	103	53	111	164	47	99	146	0	0	142
Mid Atlantic......	310	15	3.6	328	144	185	328	128	165	293	0	1.9	200
South Atlantic-Gulf	1,840	670	1,040	3,550	2,560	2,600	5,160	2,280	2,320	4,600	221	33	3,290
Great Lakes	535	19	1.6	556	191	162	353	170	145	315	0	.1	295
Ohio	219	1.2	1.3	222	68	48	117	61	43	104	1.1	.7	97
Tennessee	39	4.6	.3	44	9.7	44	54	8.7	39	48	.3	0	48
Upper Mississippi .	1,040	.8	13	1,050	482	60	542	430	54	484	1.2	0	449
Lower Mississippi .	1,230	1.9	4,490	5,730	7,770	1,350	9,110	6,930	1,200	8,130	.1	553	5,860
Souris-Red-Rainy .	130	0	37	168	50	48	99	45	43	88	0	1.8	78
Missouri Basin ...	5,980	9.5	7,170	13,200	9,000	18,600	27,600	8,030	16,600	24,600	18	7,840	13,000
Arkansas White Red	3,240	3.3	2,870	6,120	7,470	2,900	10,400	6,660	2,590	9,250	13	944	7,070
Texas Gulf	1,920	40	2,320	4,280	4,890	1,310	6,200	4,370	1,170	5,530	38	390	5,320
Rio Grande	282	15	968	1,260	1,600	5,150	6,750	1,420	4,600	6,020	3.0	1,360	2,640
Upper Colorado...	236	.1	1,470	1,710	42	7,840	7,880	38	6,990	7,030	1.7	1,940	2,320
Lower Colorado...	315	2.9	938	1,260	2,480	4,710	7,190	2,210	4,200	6,410	131	1,090	3,710
Great Basin	537	8.7	1,060	1,610	1,230	4,500	5,730	1,090	4,020	5,110	33	1,140	2,900
Pacific Northwest .	4,630	105	2,300	7,030	4,510	24,300	28,900	4,030	21,700	25,700	.1	8,050	10,100
California	1,850	628	7,060	9,540	12,200	20,400	32,600	10,900	18,200	29,100	252	1,860	23,300
Alaska	1.4	0	0	1.4	.1	.6	.6	.1	.5	.6	0	.1	.3
Hawaii	17	108	10	136	194	537	731	173	479	652	6.2	98	415
Caribbean.......	0	17	21	38	36	84	120	33	75	107	0	15	70
Total...........	24,400	1,650	31,800	57,900	55,000	94,900	150,000	49,000	84,700	134,000	718	25,300	81,300

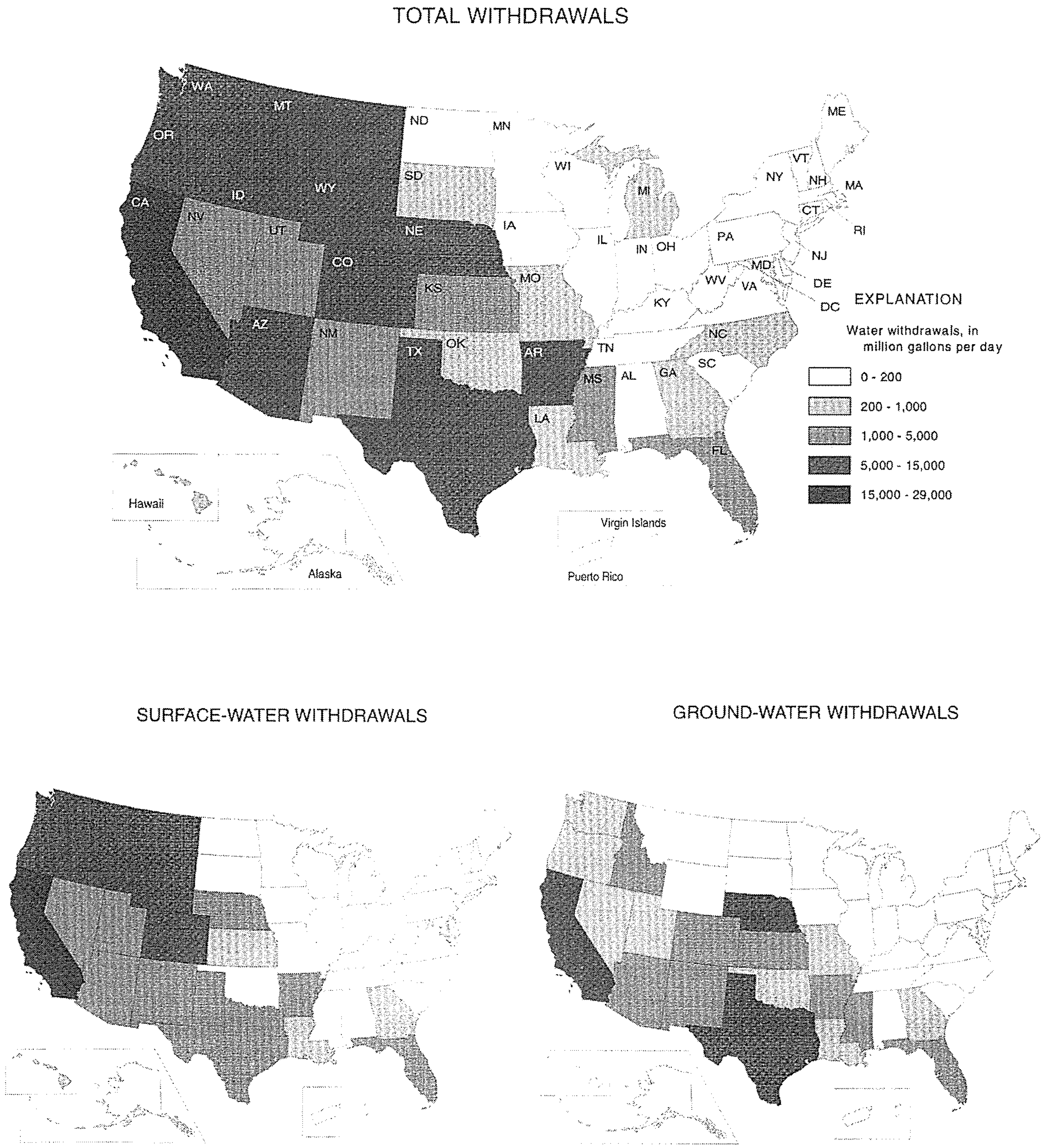


Figure 17. Irrigation freshwater withdrawals by source and State, 1995.

Table 16. Irrigation water use by State, 1995

[Figures may not add to totals because of independent rounding]

STATE	IRRIGATED LAND BY TYPE, in thousand acres				THOUSAND ACRE-FEET PER YEAR: Withdrawals, by source: Freshwater			MILLION GALLONS PER DAY: Withdrawals, by source: Freshwater					
	Sprinkler	Micro	Surface	Total	Ground	Surface	Total	Ground	Surface	Total	Reclaimed waste-water	Convey-ance losses	Consump-tive use, fresh water
Alabama	52	.4	0	52	57	98	155	51	88	139	.1	0	139
Alaska	1.4	0	0	1.4	.1	.6	.6	.1	.5	.6	0	.1	.3
Arizona	289	0	799	1,090	2,390	3,970	6,360	2,130	3,540	5,670	124	1,030	3,180
Arkansas	527	0	2,980	3,510	5,520	1,130	6,650	4,930	1,010	5,940	0	416	4,390
California	1,800	631	7,050	9,480	12,100	20,300	32,400	10,800	18,100	28,900	256	1,670	23,500
Colorado	797	0	2,510	3,310	2,260	12,000	14,300	2,020	10,700	12,700	7.1	3,770	4,910
Connecticut	18	.7	0	19	18	13	31	16	12	28	0	0	28
Delaware	66	0	0	66	38	17	54	34	15	48	0	0	48
D.C.	0	0	0	0	0	0	0	0	0	0	0	0	0
Florida	484	606	1,040	2,130	1,880	2,010	3,890	1,670	1,800	3,470	220	32	2,170
Georgia	1,090	60	0	1,150	537	273	810	479	243	722	0	0	722
Hawaii	17	108	10	136	194	537	731	173	479	652	6.2	98	415
Idaho	2,010	0	1,000	3,010	2,820	11,800	14,600	2,520	10,500	13,000	0	5,480	4,310
Illinois	359	0	0	359	202	0	202	180	0	180	2.0	0	180
Indiana	241	0	0	241	69	61	130	61	55	116	0	0	104
Iowa	158	0	0	158	39	4.0	43	35	3.6	39	0	0	39
Kansas	2,100	2.9	986	3,090	3,540	258	3,790	3,150	230	3,380	6.6	143	3,220
Kentucky	32	0	.7	32	.5	12	13	.5	11	12	0	.5	11
Louisiana	190	0	620	810	533	330	862	475	294	769	0	166	596
Maine	25	1.9	0	27	2.9	27	30	2.6	24	27	0	0	24
Maryland	74	0	0	74	41	29	70	37	26	62	0	0	57
Massachusetts	28	0	12	40	31	60	91	28	54	82	0	0	81
Michigan	334	19	1.5	354	113	142	255	101	127	227	0	0	216
Minnesota	377	0	25	401	135	41	176	120	37	157	0	0	140
Mississippi	389	0	985	1,370	1,840	109	1,950	1,640	97	1,740	0	17	1,110
Missouri	351	4.4	431	786	599	37	636	535	33	567	0	0	421
Montana	526	0	1,280	1,810	92	9,490	9,580	82	8,460	8,550	0	4,410	1,820
Nebraska	3,940	0	3,510	7,450	6,480	1,990	8,460	5,780	1,770	7,550	1.0	906	6,740
Nevada	136	0	424	560	719	1,120	1,840	641	1,000	1,640	24	473	1,060
New Hampshire	8.6	0	0	8.6	.3	6.8	7.1	.3	6.1	6.3	0	0	5.7
New Jersey	89	6.8	3.2	99	36	104	140	32	93	125	0	0	46
New Mexico	410	5.2	544	959	1,430	1,920	3,360	1,280	1,710	2,990	0	628	1,680
New York	44	2.8	.4	47	17	16	33	16	14	30	0	0	26
North Carolina	163	4.4	0	167	64	203	267	57	181	239	1.0	0	239
North Dakota	135	0	61	196	66	64	131	59	57	117	0	5.1	105
Ohio	59	0	0	59	13	17	31	12	16	27	0	.2	26
Oklahoma	377	0	184	560	859	110	969	766	98	864	0	4.9	401
Oregon	1,070	5.3	766	1,840	985	5,930	6,910	878	5,290	6,170	0	1,300	3,070
Pennsylvania	18	4.6	0	23	9.2	8.6	18	8.2	7.7	16	0	0	16
Rhode Island	7.1	0	0	7.1	.8	1.8	2.6	.7	1.6	2.3	0	0	2.3
South Carolina	23	0	0	23	31	28	58	27	25	52	0	0	52
South Dakota	225	0	77	301	95	206	301	85	184	269	0	54	175
Tennessee	55	4.6	4.1	63	11	16	27	9.9	15	24	.5	0	24
Texas	2,740	51	3,520	6,310	7,320	3,280	10,600	6,530	2,920	9,450	48	540	8,140
Utah	411	8.9	722	1,140	441	3,520	3,960	393	3,140	3,530	14	612	1,930
Vermont	3.8	0	0	3.8	.4	3.9	4.3	.4	3.5	3.9	0	0	3.5
Virginia	66	2.8	0	69	6.3	27	33	5.6	24	30	0	2.9	18
Washington	1,510	100	512	2,120	918	6,330	7,250	819	5,650	6,470	0	1,090	2,800
West Virginia	1.9	0	.9	2.8	0	0	0	0	0	0	0	0	0
Wisconsin	331	0	0	331	187	1.7	189	167	1.5	169	0	0	151
Wyoming	286	6.5	1,700	1,990	203	7,190	7,390	181	6,410	6,590	9.1	2,470	2,660
Puerto Rico	0	17	21	38	36	84	120	33	75	107	0	15	70
Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	24,400	1,650	31,800	57,900	55,000	94,900	150,000	49,000	84,700	134,000	718	25,300	81,300

Livestock 5,490 million gallons per day

The quantity of water withdrawn for total livestock purposes (livestock, animal specialties) during 1995 was an estimated 5,490 Mgal/d, or 22 percent more than withdrawn during 1990. Livestock use represents nearly 2 percent of freshwater use for all offstream categories. Idaho reported a substantial increase in withdrawals for animal specialties based on more reliable information.

The source and disposition of water for total livestock use are shown in the chart below. Surface water was the source for about 59 percent of withdrawals for total livestock use, and ground water was the source for the remaining 41 percent. The consumptive use of water for total livestock during 1995 was about 3,200 Mgal/d, or 58 percent of withdrawals.

Livestock water use includes water for livestock, feed lots, dairies, fish farms, and other on-farm needs. The "Livestock category" includes livestock water use, which is defined as water associated with the production of red meat, poultry, eggs, milk, and wool; and animal specialities water use, which is defined as water use associated with the production of fish in captivity (except fish hatcheries), fur-bearing animals in captivity, horses, rabbits, and pets (Office of Management and Budget, 1987, p. 27-29). A few States, such as Arkansas, Oregon, and California, have some offstream fish hatcheries that are included in the commercial category in this report. Water used instream for fish hatcheries is not included in this compilation.

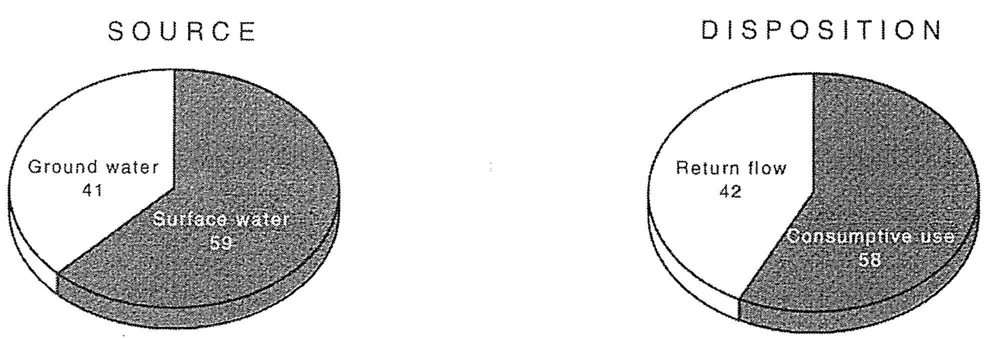
Livestock use in this report is equivalent to the livestock category listed under "Livestock" or "Rural use" in previous water-use circulars in this series. Beginning in 1990, animal specialties were identified as a subset of livestock activities because of the large increase in fish-farming water use. Fish farms are primarily engaged in the production of food fish under controlled feeding, sanitation, and harvesting procedures (Office of Management and Budget, 1987, p. 29). Most water used for fish farms is required to maintain acceptable pond levels and water quality.

The quantities of surface water and ground water withdrawn for use by livestock are estimated from the numbers of animals in a county. The livestock and poultry numbers are available in most States from the U.S. Department of Agriculture Crop and Livestock Reporting Service or the Cooperative Extension Service. The number of each type of animal in each county is multiplied by an average water use per animal to obtain the water-use estimate. The Crop and Livestock Reporting Service or the Cooperative Extension Service generally have pond acreage for fish farms. Water use is estimated by multiplying pond acreage by an application rate. In some States, water use for fish farms is reported under a permit system.

The uncertainties in the livestock water-use estimates include difficulties in determining the sources of water and great variations in estimates of consumptive use. Consumptive-use estimates generally are based on coefficients ranging from 10 to 100 percent of withdrawals.

State agencies in Hawaii and Maryland reported 18 Mgal/d and 3.3 Mgal/d, respectively, of saline withdrawals for animal specialties. These saline withdrawals are not listed in the tables or included in the totals.

In 1995, the Pacific Northwest and Lower Mississippi water-resources regions had the most water withdrawn for total livestock (figure 18; table 17) and accounted for nearly 46 percent of the Nation's total livestock use. The Missouri Basin and Arkansas-White-Red regions have the most water withdrawn for livestock, and the Pacific Northwest and Lower Mississippi regions have the most water withdrawn for animal specialties. By State, Idaho accounts for the largest use of water for total livestock (figure 19; table 18). Idaho, Mississippi, Louisiana, and Arkansas account for 76 percent of the Nation's animal-specialties water use, largely because of fish farming.



5,490 MILLION GALLONS PER DAY

TOTAL LIVESTOCK SOURCE AND DISPOSITION, 1995, IN PERCENT

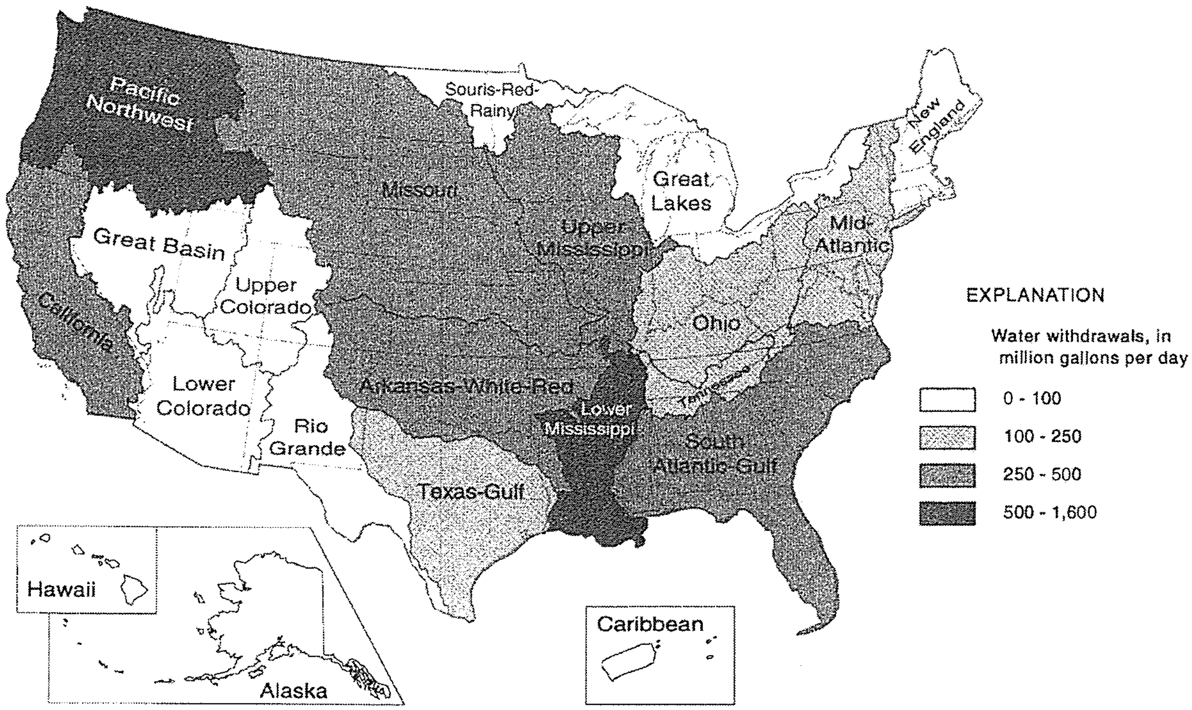


Figure 18. Total livestock freshwater withdrawals by water-resources region, 1995.

Table 17. Livestock freshwater use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	LIVESTOCK				ANIMAL SPECIALTIES				TOTAL LIVESTOCK			
	Withdrawals				Withdrawals				Withdrawals			
	Ground water	Surface water	Total	Consumptive use	Ground water	Surface water	Total	Consumptive use	Ground water	Surface water	Total	Consumptive use
New England	5.4	1.8	7.2	6.0	1.0	11	12	9.5	6.4	13	19	16
Mid-Atlantic	70	37	107	92	8.6	18	26	1.3	79	55	134	94
South Atlantic-Gulf . .	156	100	256	256	33	117	150	122	188	217	405	378
Great Lakes	45	17	61	53	4.8	3.7	8.6	1.8	50	20	70	55
Ohio	47	77	123	111	13	4.2	18	4.6	60	81	141	115
Tennessee	6.6	11	18	18	12	176	188	26	19	187	205	44
Upper Mississippi . . .	188	35	223	205	28	4.4	32	13	216	39	255	219
Lower Mississippi . . .	9.2	13	22	22	730	259	990	760	740	272	1,010	782
Souris-Red-Rainy . . .	17	3.0	20	20	0	0	0	0	17	3.0	20	20
Missouri Basin	230	157	386	386	24	16	40	5.3	253	173	426	391
Arkansas-White-Red .	178	192	370	370	12	12	24	15	190	205	395	385
Texas-Gulf	77	118	195	194	5.0	8.1	13	13	82	126	208	207
Rio Grande	26	6.3	32	31	1.0	2.2	3.2	1.2	27	8.5	35	32
Upper Colorado	3.5	9.7	13	12	.7	40	41	.3	4.2	50	54	13
Lower Colorado	33	6.8	39	39	.4	.1	.5	.5	33	6.8	40	40
Great Basin	9.0	11	20	13	.2	66	66	.4	9.2	77	86	14
Pacific Northwest . . .	43	43	86	60	1.0	1,420	1,420	1.5	44	1,470	1,510	62
California	128	165	293	293	103	58	160	32	231	222	453	325
Alaska	0	.3	.3	.3	.1	.2	.2	.2	.1	.4	.5	.5
Hawaii	2.7	1.9	4.6	4.6	4.8	.6	5.4	.1	7.5	2.6	10	4.7
Caribbean	4.5	1.8	6.3	6.3	0	0	.1	.1	4.5	1.8	6.4	6.4
Total	1,280	1,010	2,290	2,190	982	2,220	3,200	1,010	2,260	3,230	5,490	3,200

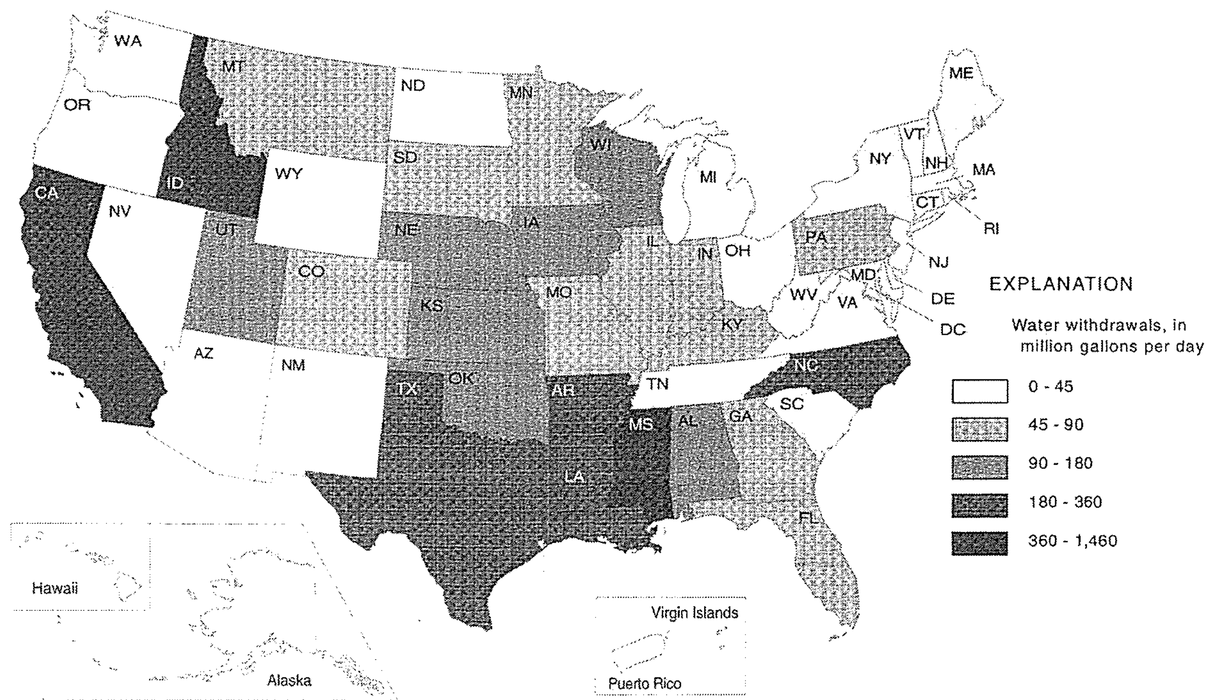


Figure 19. Total livestock freshwater withdrawals by State, 1995.

Table 18. Livestock freshwater use by State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	LIVESTOCK				ANIMAL SPECIALTIES				TOTAL LIVESTOCK			
	Withdrawals				Withdrawals				Withdrawals			
	Ground water	Surface water	Total	Consumptive use	Ground water	Surface water	Total	Consumptive use	Ground water	Surface water	Total	Consumptive use
Alabama	15	20	35	35	6.9	87	94	94	22	107	129	129
Alaska	0	.3	.3	.3	.1	.2	.2	.2	.1	.4	.5	.5
Arizona	29	2.3	31	31	.4	.1	.5	.5	29	2.4	32	32
Arkansas	15	23	39	39	228	87	315	176	244	110	354	215
California	132	167	299	299	103	58	160	32	234	225	459	331
Colorado	23	21	45	45	0	14	14	0	23	36	59	45
Connecticut	1.1	.1	1.2	1.0	.3	0	.3	.3	1.4	.1	1.4	1.3
Delaware	3.8	.4	4.1	3.7	0	0	0	0	3.8	.4	4.1	3.7
D.C.	0	0	0	0	0	0	0	0	0	0	0	0
Florida	45	4.9	50	50	5.2	1.0	6.2	6.2	50	5.9	56	56
Georgia	1.6	29	30	30	8.1	9.2	17	17	9.7	38	48	47
Hawaii	2.7	1.9	4.6	4.6	4.8	.6	5.4	.1	7.5	2.6	10	4.7
Idaho	16	11	27	5.4	.3	1,430	1,430	0	17	1,440	1,460	5.4
Illinois	45	0	45	36	9.0	2.2	11	11	54	2.2	56	47
Indiana	28	18	46	37	.6	0	.6	.5	28	18	46	37
Iowa	82	27	109	109	.5	0	.5	.5	82	27	110	110
Kansas	89	18	107	107	1.5	1.2	2.7	2.5	91	19	109	109
Kentucky	2.3	43	45	45	0	.9	.9	.9	2.3	44	46	46
Louisiana	4.2	4.8	9.0	9.0	140	176	316	316	144	181	325	325
Maine	1.4	.5	1.8	1.6	0	0	0	0	1.4	.5	1.9	1.7
Maryland	7.8	3.5	11	10	5.0	19	24	0	13	23	35	10
Massachusetts	1.0	.8	1.8	1.4	.4	7.7	8.2	6.5	1.5	8.5	10	7.9
Michigan	12	1.3	13	12	.6	.1	.6	.6	13	1.4	14	13
Minnesota	62	0	62	62	.4	0	.4	.4	62	0	62	62
Mississippi	7.0	11	18	18	370	8.8	378	280	377	19	396	298
Missouri	19	57	76	76	.8	.2	1.0	1.0	20	57	76	76
Montana	16	35	51	51	.3	.6	.9	.9	16	35	52	52
Nebraska	94	22	116	115	14	12	26	2.0	108	33	142	117
Nevada	1.0	4.2	5.1	2.1	0	.5	.5	0	1.0	4.7	5.7	2.1
New Hampshire	.6	.2	.8	.5	0	0	.1	.1	.6	.2	.8	.6
New Jersey	1.2	0	1.2	1.2	.3	0	.3	.3	1.5	0	1.5	1.5
New Mexico	26	3.6	30	28	0	0	0	0	26	3.6	30	28
New York	22	12	33	30	.4	.1	.5	.5	22	12	34	30
North Carolina	86	35	121	121	3.7	172	175	4.1	89	207	297	125
North Dakota	14	9.2	23	23	0	.6	.7	0	14	9.9	24	23
Ohio	6.9	19	26	25	.7	0	.7	0	7.6	19	27	25
Oklahoma	45	101	146	146	0	.7	.7	0	45	101	147	146
Oregon	3.3	19	23	23	.1	.5	.6	.6	3.4	20	23	23
Pennsylvania	48	7.1	55	41	.6	0	.6	.6	48	7.1	55	42
Rhode Island	.3	0	.4	.3	.2	3.1	3.2	2.6	.5	3.1	3.6	2.8
South Carolina	4.0	4.9	8.9	8.9	8.3	7.5	16	.8	12	12	25	9.7
South Dakota	18	28	46	46	0	0	0	0	18	28	46	46
Tennessee	4.0	4.4	8.4	8.4	17	11	28	28	21	15	37	37
Texas	132	166	298	298	6.7	10	17	17	139	176	315	315
Utah	6.8	9.4	16	12	.8	91	92	.5	7.6	100	108	13
Vermont	3.8	1.3	5.1	4.6	.2	0	.2	.2	4.0	1.3	5.3	4.8
Virginia	7.8	28	36	36	0	.1	.1	.1	7.8	28	36	36
Washington	23	10	34	29	.5	.2	.7	.7	24	11	34	29
West Virginia	1.6	3.5	5.1	4.4	13	.1	13	.1	15	3.6	18	4.4
Wisconsin	57	6.4	64	51	22	6.2	29	2.8	79	13	92	54
Wyoming	5.5	11	16	16	7.9	.4	8.3	.5	13	11	25	17
Puerto Rico	4.4	1.8	6.2	6.2	0	0	.1	.1	4.5	1.8	6.3	6.3
Virgin Islands	.1	0	.1	.1	0	0	0	0	.1	0	.1	.1
Total	1,280	1,010	2,290	2,190	982	2,220	3,200	1,010	2,260	3,230	5,490	3,200

Industrial — 27,100 million gallons per day

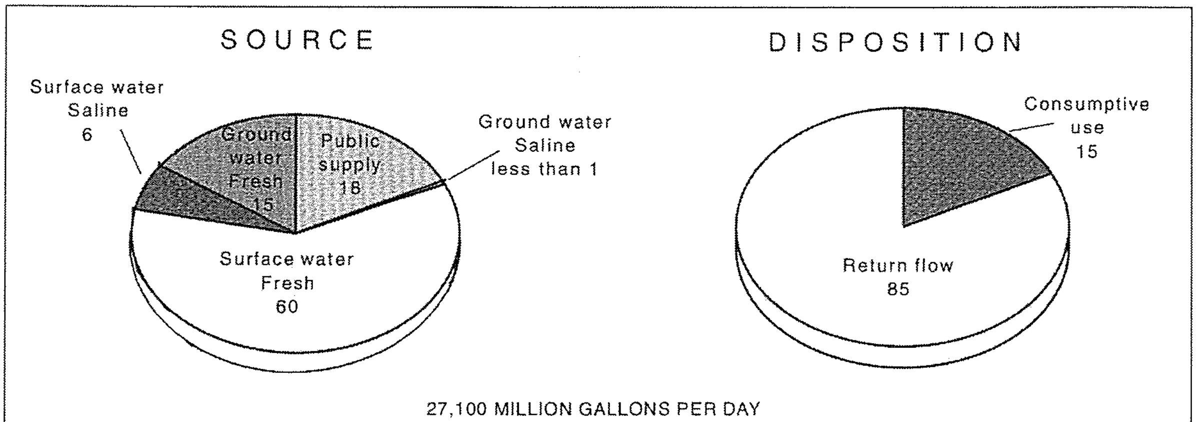
Total industrial water use during 1995 was an estimated 27,100 Mgal/d (tables 19, 20), or 2 percent less than during 1990. Most of the decrease, 1,620 Mgal/d, was in saline surface-water withdrawals. Industrial freshwater use was an estimated 25,500 Mgal/d during 1995, about 4 percent more than in 1990, and represents about 7 percent of freshwater use for all offstream categories. Self-supplied industrial withdrawals were an estimated 20,700 Mgal/d of freshwater and 1,660 Mgal/d of saline water. (See tables 19, 20.) Surface water was the source for 82 percent of self-supplied industrial withdrawals; ground water, 18 percent; and reclaimed wastewater less than 1 percent. Public-supply deliveries to industries were about 4,750 Mgal/d and accounted for 12 percent of total public-supply withdrawals.

The source and disposition of water for industrial purposes for 1995 are shown in the chart below. The consumptive use of freshwater for industrial purposes during 1995 was 3,370 Mgal/d, or 13 percent of freshwater withdrawals and deliveries; saline consumptive use was 665 Mgal/d, or 40 percent of saline withdrawals. Total consumptive use was 15 percent of combined fresh and saline withdrawals.

Industrial water use includes water for such purposes as processing, washing, and cooling in facilities that manufacture products. Major water-using industries include, but are not limited to, steel, chemical and allied products, paper and allied products, and petroleum refining.

Many States have developed permit programs that require reporting of industrial withdrawals and return flows. Information on deliveries from public suppliers to industrial users are estimated from a variety of methods if not available directly from the public suppliers. Consumptive-use estimates generally are based on coefficients, most ranging from 10 to 40 percent (depending on the type of industry) of withdrawals and deliveries.

In 1995, the Great Lakes and Ohio water-resources regions had the largest total (fresh, saline) withdrawals for industrial purposes as shown in figure 20. By State, Louisiana, Texas, Indiana, Michigan, and Pennsylvania reported the largest withdrawals for industries as shown in figure 21. Louisiana and Indiana, reported the largest freshwater use (figure 22), and Maryland and Texas reported the largest quantities of reclaimed wastewater used by industries.



INDUSTRIAL SOURCE AND DISPOSITION, 1995, IN PERCENT

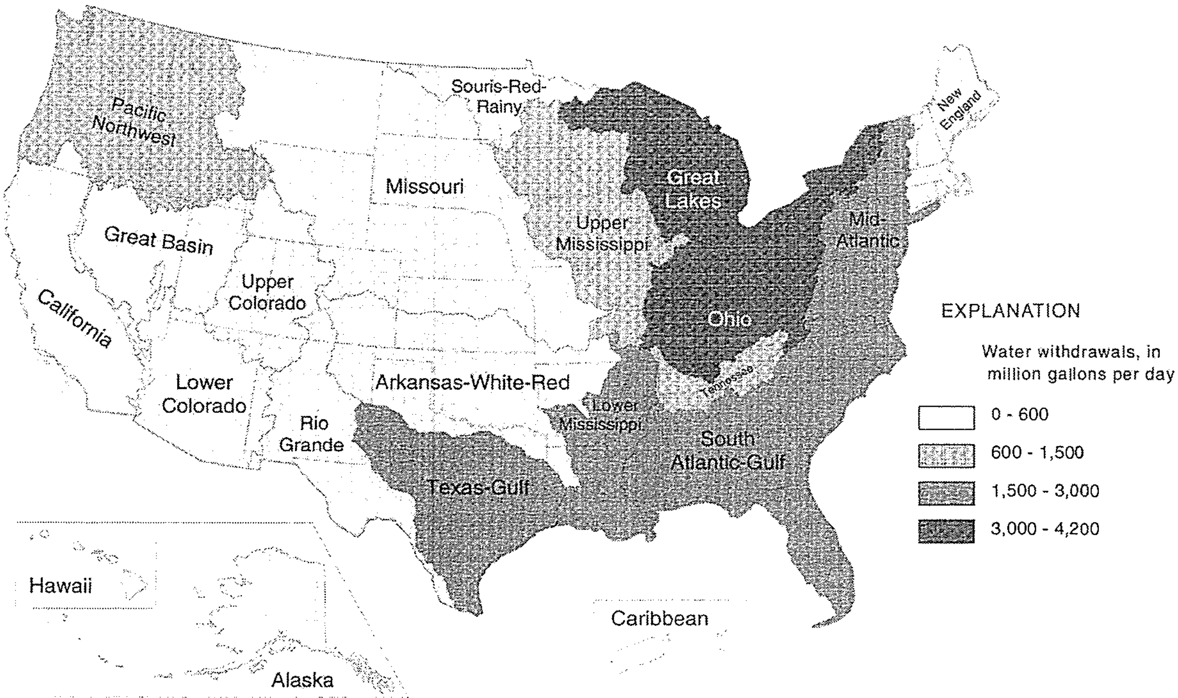


Figure 20. Industrial self-supplied water withdrawals (fresh, saline) by water-resources region, 1995.

Table 19. Industrial water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	SELF-SUPPLIED WITHDRAWALS							RECLAIMED WASTE-WATER	PUBLIC-SUPPLY DELIV-ERIES	TOTAL USE		
	By source and type				Total					With-drawals and deliveries	Consumptive use	
	Ground water		Surface water									
	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total		Fresh	Fresh	Fresh	Saline
New England	53	0	100	0	153	0	153	0	168	321	24	0
Mid-Atlantic	344	0	1,090	526	1,430	526	1,960	71	516	1,950	198	49
South Atlantic-Gulf	787	0	2,010	40	2,790	40	2,830	1.2	742	3,530	502	2.2
Great Lakes	270	3.6	3,900	0	4,170	3.6	4,180	0	775	4,950	436	.4
Ohio	379	0	3,310	0	3,690	0	3,690	.1	590	4,280	480	0
Tennessee	35	0	1,030	0	1,070	0	1,070	0	101	1,170	115	0
Upper Mississippi	328	0	660	0	988	0	988	0	361	1,350	176	0
Lower Mississippi	611	0	2,280	0	2,890	0	2,890	0	94	2,990	294	0
Souris-Red-Rainy	1.7	0	20	0	22	0	22	0	3.9	26	4.9	0
Missouri Basin	102	0	50	0	152	0	152	0	106	258	76	0
Arkansas-White-Red	78	0	360	0	438	0	438	13	291	728	119	0
Texas-Gulf	214	.5	846	996	1,060	996	2,060	17	171	1,230	375	599
Rio Grande	10	0	.1	0	10	0	10	2.1	20	30	16	0
Upper Colorado	2.4	0	4.0	0	6.4	0	6.4	0	4.2	11	3.5	0
Lower Colorado	42	0	5.5	0	47	0	47	2.3	68	115	102	0
Great Basin	60	.1	31	0	91	.1	91	0	17	109	46	0
Pacific Northwest	215	0	866	38	1,080	38	1,120	0	407	1,490	148	4.2
California	522	10	19	26	541	36	577	3.6	284	824	239	9.1
Alaska	3.8	0	51	1.8	55	1.8	57	0	12	66	9.9	.3
Hawaii	19	.9	0	0	19	.9	20	0	5.6	25	2.5	.1
Caribbean	10	.2	4.0	17	14	17	31	0	15	29	8.0	.3
Total	4,090	15	16,700	1,640	20,700	1,660	22,400	110	4,750	25,500	3,370	665

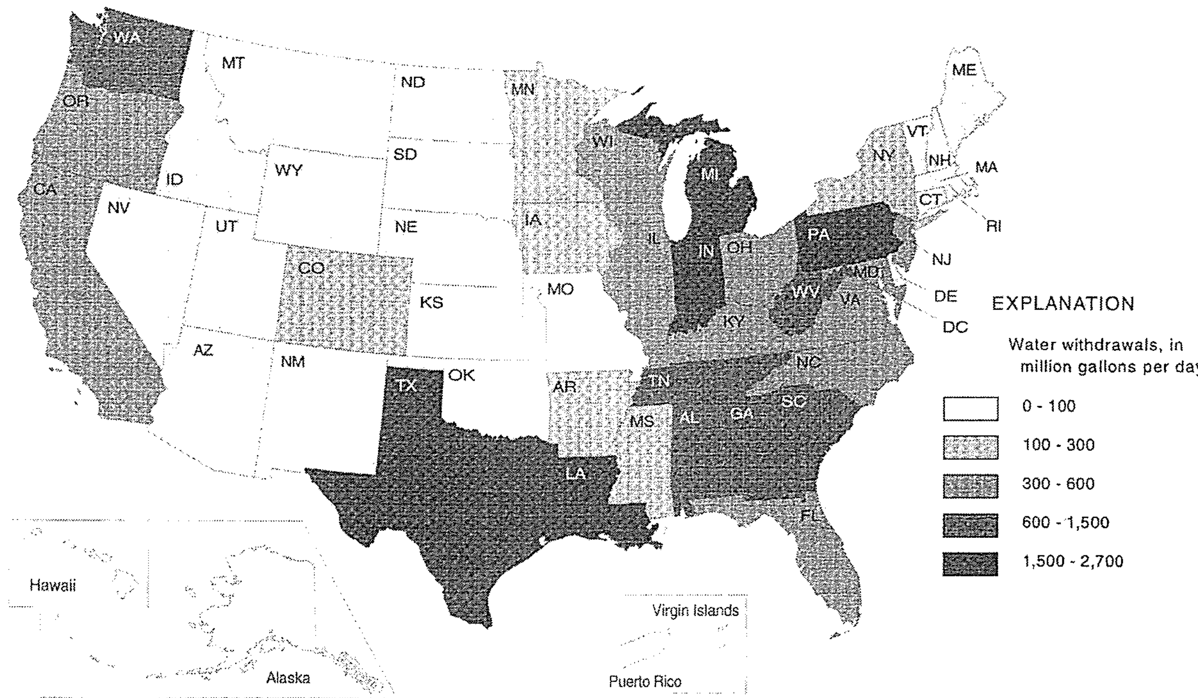


Figure 21. Industrial self-supplied water withdrawals (fresh, saline) by State, 1995.

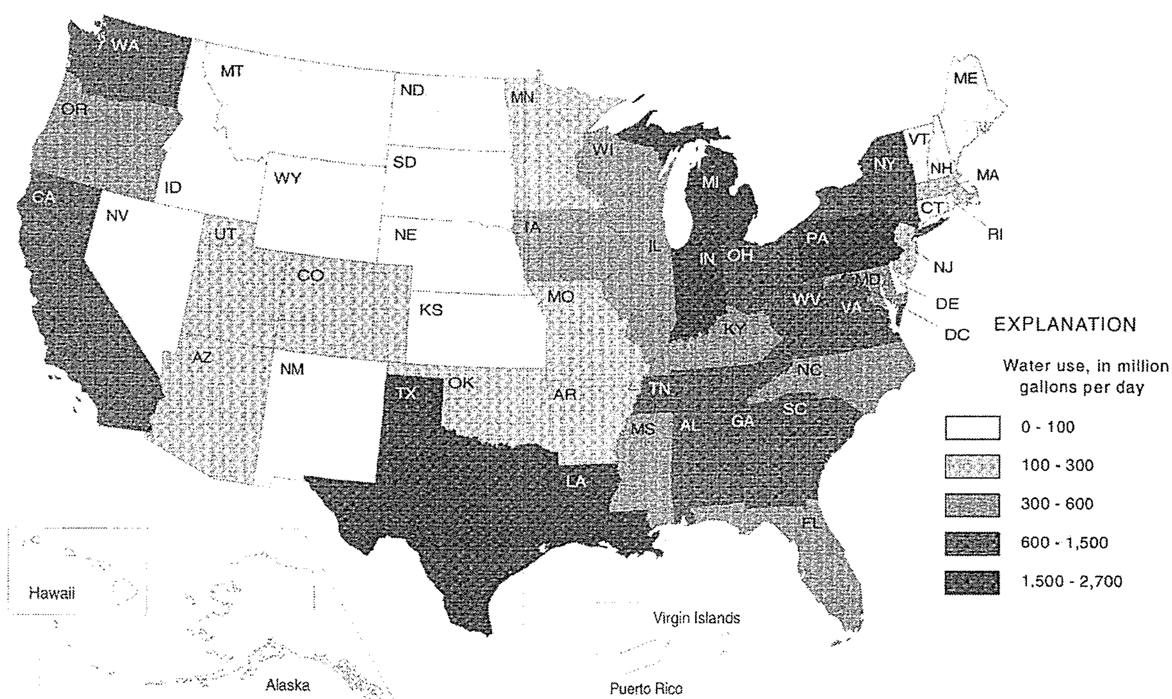


Figure 22. Industrial freshwater use (withdrawals, deliveries) by State, 1995.

Table 20. Industrial water use by State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	SELF-SUPPLIED WITHDRAWALS							RECLAIMED WASTE-WATER	PUBLIC-SUPPLY DELIV-ERIES	TOTAL USE		
	By source and type				Total					With-drawals and deliveries	Consumptive use	
	Ground water		Surface water									
	Fresh	Saline	Fresh	Saline	Fresh	Saline	Total		Fresh	Fresh	Fresh	Saline
Alabama	34	0	699	0	733	0	733	0	213	946	116	0
Alaska	3.8	0	51	1.8	55	1.8	57	0	12	66	9.9	.3
Arizona	39	0	0	0	39	0	39	2.3	66	106	98	0
Arkansas	108	0	80	0	187	0	187	0	57	245	14	0
California	522	10	16	26	538	36	575	3.6	283	821	239	9.1
Colorado	37	0	86	0	123	0	123	0	19	143	42	0
Connecticut	3.5	0	6.2	0	9.6	0	9.6	0	42	51	1.1	0
Delaware	17	0	43	3.2	61	3.2	64	0	16	76	11	0
D.C.	.5	0	0	0	.5	0	.5	0	.7	1.2	.1	0
Florida	240	0	106	8.0	345	8.0	353	.7	103	449	46	0
Georgia	295	0	337	32	633	32	664	.6	194	827	85	2.2
Hawaii	19	.9	0	0	19	.9	20	0	5.6	25	2.5	.1
Idaho	39	0	7.9	0	47	0	47	0	6.7	54	3.1	0
Illinois	162	0	290	0	452	0	452	0	118	570	63	0
Indiana	119	0	2,160	0	2,270	0	2,270	0	125	2,400	144	0
Iowa	74	0	184	0	258	0	258	0	78	335	44	0
Kansas	50	0	3.2	0	53	0	53	.2	37	90	45	0
Kentucky	92	0	255	0	347	0	347	0	197	543	22	0
Louisiana	356	0	2,230	0	2,580	0	2,580	0	35	2,620	266	0
Maine	4.6	0	5.9	0	11	0	11	0	14	25	2.5	0
Maryland	19	0	45	261	65	261	326	70	44	109	16	26
Massachusetts	38	0	47	0	85	0	85	0	86	171	13	0
Michigan	177	3.6	1,670	0	1,850	3.6	1,850	0	270	2,120	160	.4
Minnesota	58	0	83	0	140	0	140	0	41	181	26	0
Mississippi	166	0	124	0	290	0	290	0	20	310	49	0
Missouri	21	0	18	0	39	0	39	0	140	179	27	0
Montana	31	0	29	0	60	0	60	0	1.0	61	9.3	0
Nebraska	26	0	4.4	0	30	0	30	0	26	57	16	0
Nevada	7.4	0	7.5	0	15	0	15	0	2.2	17	4.9	0
New Hampshire	5.6	0	38	0	43	0	43	0	13	56	6.6	0
New Jersey	43	0	158	195	201	195	396	0	91	292	22	15
New Mexico	6.3	0	2.0	0	8.3	0	8.3	0	15	23	12	0
New York	127	0	132	0	259	0	259	0	356	615	62	0
North Carolina	61	0	308	0	369	0	369	0	193	562	112	0
North Dakota	3.6	0	7.9	0	11	0	11	0	2.5	14	9.4	0
Ohio	158	0	399	0	557	0	557	0	355	912	190	0
Oklahoma	3.8	0	17	0	21	0	21	0	122	142	8.9	0
Oregon	13	0	365	0	378	0	378	0	71	448	18	0
Pennsylvania	147	0	1,530	0	1,680	0	1,680	1.1	193	1,870	158	0
Rhode Island	1.1	0	0	0	1.1	0	1.1	0	12	13	1.3	0
South Carolina	60	0	640	0	700	0	700	0	44	744	112	0
South Dakota	4.1	0	1.0	0	5.1	0	5.1	0	7.9	13	1.9	0
Tennessee	68	0	795	0	863	0	863	0	130	993	109	0
Texas	226	.5	1,070	996	1,300	996	2,300	32	268	1,570	430	599
Utah	55	.1	31	0	86	.1	86	0	17	103	45	0
Vermont	1.9	0	7.4	0	9.4	0	9.4	0	7.7	17	1.7	0
Virginia	107	0	410	67	516	67	583	0	88	605	72	8.0
Washington	133	0	478	38	611	38	649	0	331	942	120	4.2
West Virginia	13	0	1,300	0	1,320	0	1,320	0	14	1,330	200	0
Wisconsin	78	0	363	0	441	0	441	0	151	592	95	0
Wyoming	1.6	0	1.2	0	2.8	0	2.8	0	2.4	5.1	.8	0
Puerto Rico	10	0	1.1	0	11	0	11	0	15	26	7.6	0
Virgin Islands	.1	.2	2.9	17	3.0	17	20	0	0	3.0	.4	.3
Total	4,090	15	16,700	1,640	20,700	1,660	22,400	110	4,750	25,500	3,370	665

Mining | 3,770 million gallons per day

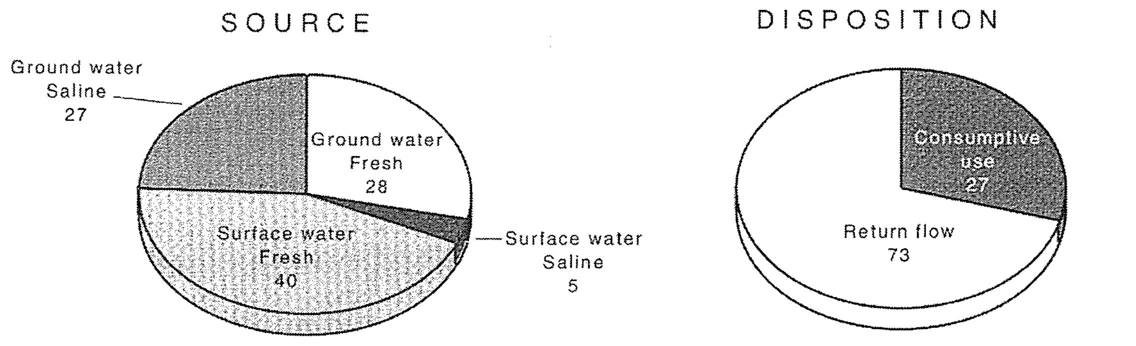
Total mining water use during 1995 was an estimated 3,770 Mgal/d and included 1,210 Mgal/d of saline water (table 21). Mining freshwater use during 1995 was 22 percent less than during 1990, and represents less than 1 percent of freshwater use for all offstream categories. Much of the decrease can be attributed to not including dewatering as a mining water use.

The source and disposition of water for mining purposes for 1995 are shown in the chart below. Ground water was the source for about 55 percent of total mining withdrawals, and surface water was the source for the remaining 45 percent. Saline water accounted for approximately one-third of total mining withdrawals. Total consumptive use in 1995 was about 1,020 Mgal/d or 27 percent of total withdrawals.

Mining water use includes water for the extraction of naturally occurring minerals; solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. The category includes quarrying, milling (crushing, screening, washing, and flotation), and other operations as part of mining activity. All water is self supplied, and saline water is significant. Dewatering is no longer considered as a mining water use unless the water is put to a beneficial use, such as washing or dust control.

Water used in mining is difficult to quantify. Except for some washing and milling, water used at mining sites tends to be an impediment to or a by-product of the extraction process. Unless water is needed for the mining operation, little attention is paid to quantities withrawn. Estimates for mining withdrawals were obtained from State agencies that regulate discharges, or by use of coefficients for the relation between the quantity of water withdrawn and the quantity of material extracted. Consumptive-use estimates were based on coefficients, ranging from 10 to 90 percent of withdrawals, depending on the type of mining activity.

Most water withdrawn for mining use during 1995 was in the Texas-Gulf water-resources region, followed by the Great Lakes region, as shown in figure 23 and table 21. By State, Texas, Minnesota, and Florida had the most freshwater and saline water withdrawn for mining (figure 24; table 22), and accounted for about 32 percent of the Nation's total mining withdrawals. Minnesota, Florida, Texas and Pennsylvania had the most freshwater withdrawn for mining. (See figure 25 and table 22.)



3,770 MILLION GALLONS PER DAY

MINING SOURCE AND DISPOSITION, 1995, IN PERCENT

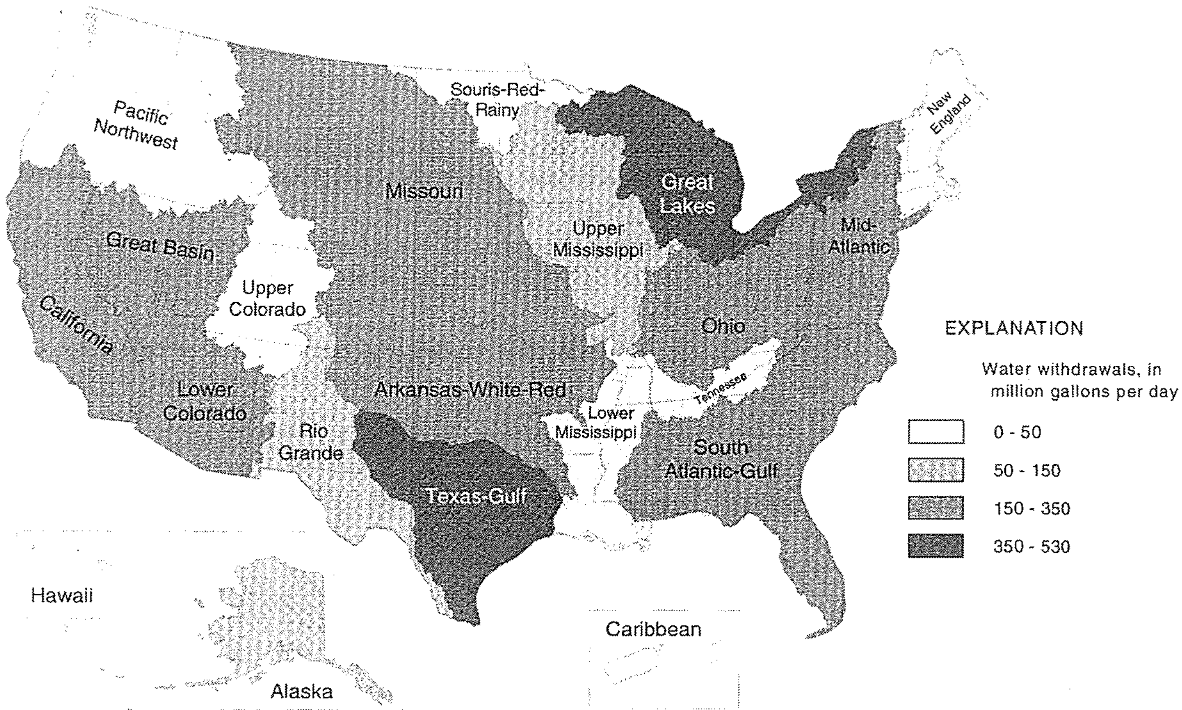


Figure 23. Mining water withdrawals (fresh, saline) by water-resources region, 1995.

Table 21. Mining water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	WITHDRAWALS: By source and type: Ground water: Fresh	Ground water: Saline	Ground water: Total	Surface water: Fresh	Surface water: Saline	Surface water: Total	Total: Fresh	Total: Saline	Total: Total	CONSUMPTIVE USE: Fresh	Saline	Total
New England	2.9	0	2.9	21	0	21	24	0	24	3.8	0	3.8
Mid-Atlantic	159	1.0	160	163	7.5	170	321	8.6	330	34	2.2	36
South Atlantic-Gulf	177	9.1	186	162	0	162	339	9.1	348	26	0	26
Great Lakes	34	1.0	35	356	6.5	363	390	7.6	398	35	1.9	37
Ohio	115	22	137	212	.6	213	327	23	349	54	22	76
Tennessee	3.7	0	3.7	7.2	0	7.2	11	0	11	1.4	0	1.4
Upper Mississippi	22	4.2	26	112	0	112	134	4.2	138	19	4.2	24
Lower Mississippi	3.1	0	3.1	2.2	0	2.2	5.3	0	5.3	.7	0	.7
Souris-Red-Rainy	.4	0	.4	1.0	0	1.0	1.4	0	1.4	.4	0	.4
Missouri Basin	104	38	143	201	0	201	306	38	344	58	8.6	66
Arkansas-White-Red	30	284	314	26	0	26	56	284	340	25	0	25
Texas-Gulf	118	324	442	79	0	79	197	324	521	194	0	194
Rio Grande	53	60	113	2.1	0	2.1	55	60	115	36	0	36
Upper Colorado	20	14	34	3.5	0	3.5	23	14	38	12	1.7	14
Lower Colorado	126	12	138	26	2.3	28	152	14	166	116	11	126
Great Basin	71	19	90	2.8	143	146	74	162	236	71	145	216
Pacific Northwest	6.5	0	6.5	29	0	29	35	0	35	12	0	12
California	16	151	167	62	0	62	78	151	229	77	34	110
Alaska	0	75	75	24	41	65	24	116	140	1.3	9.7	11
Hawaii	.5	0	.5	.1	0	.1	.5	0	.5	.5	0	.5
Caribbean	3.4	0	3.4	1.1	0	1.1	4.5	0	4.5	1.4	0	1.4
Total	1,070	1,010	2,080	1,490	201	1,690	2,560	1,210	3,770	780	240	1,020

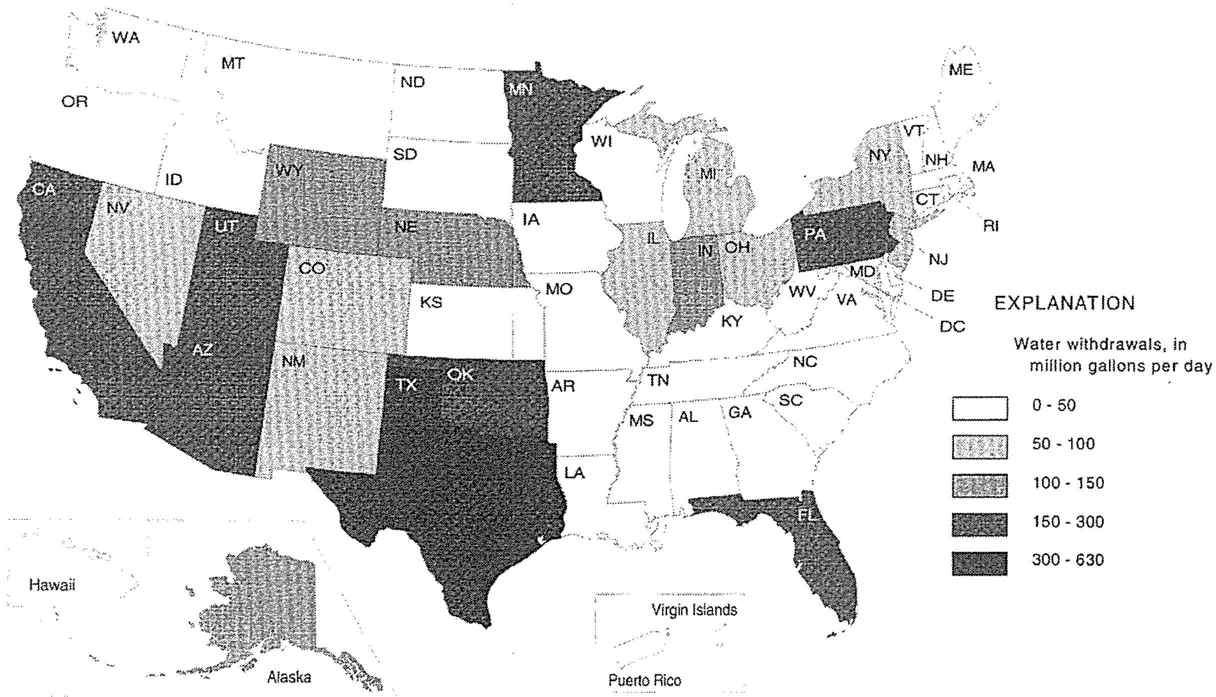


Figure 24. Mining withdrawals (fresh, saline) by State, 1995.

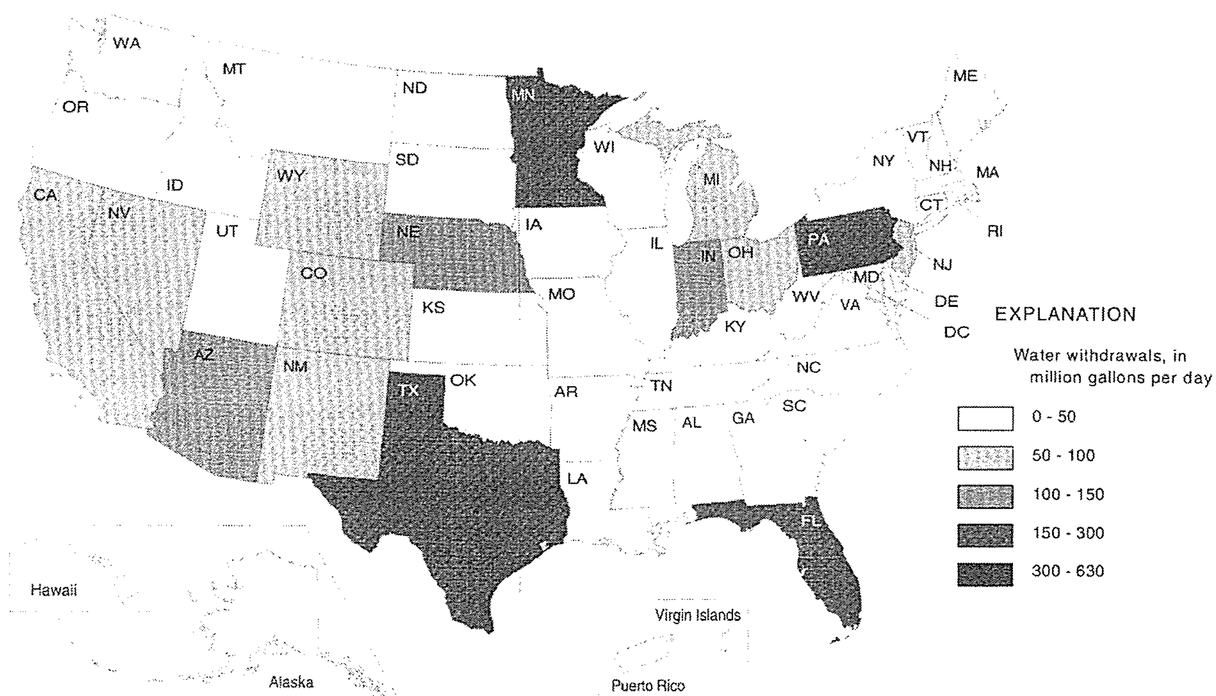


Figure 25. Mining freshwater withdrawals by State, 1995.

Table 22. Mining water use by State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	WITHDRAWALS									CONSUMPTIVE USE		
	By source and type						Total					
	Ground water			Surface water								
	Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total	Fresh	Saline	Total
Alabama	4.0	9.1	13	7.0	0	7.0	11	9.1	20	0	0	0
Alaska	0	75	75	24	41	65	24	116	140	1.3	9.7	11
Arizona	119	12	131	25	2.3	27	144	14	158	109	11	120
Arkansas	0	0	0	.1	0	.1	.1	0	.1	0	0	0
California	14	151	165	62	0	62	76	151	227	75	34	109
Colorado	25	17	41	27	0	27	52	17	68	20	2.8	23
Connecticut	.3	0	.3	1.4	0	1.4	1.7	0	1.7	.3	0	.3
Delaware	0	0	0	0	0	0	0	0	0	0	0	0
D.C.	0	0	0	0	0	0	0	0	0	0	0	0
Florida	148	0	148	148	0	148	296	0	296	15	0	15
Georgia	8.7	0	8.7	2.9	0	2.9	12	0	12	1.4	0	1.4
Hawaii	.5	0	.5	.1	0	.1	.5	0	.5	.5	0	.5
Idaho	1.2	0	1.2	27	0	27	29	0	29	10	0	10
Illinois	5.5	25	31	44	0	44	50	25	75	10.0	25	35
Indiana	10	0	10	126	0	126	137	0	137	8.2	0	8.2
Iowa	1.1	0	1.1	42	0	42	43	0	43	0	0	0
Kansas	13	0	13	11	0	11	24	0	24	5.1	0	5.1
Kentucky	7.4	0	7.4	21	0	21	28	0	28	.8	0	.8
Louisiana	.4	0	.4	1.4	0	1.4	1.8	0	1.8	0	0	0
Maine	1.3	0	1.3	3.7	0	3.7	5.0	0	5.0	.9	0	.9
Maryland	.9	0	.9	4.3	0	4.3	5.2	0	5.2	1.0	0	1.0
Massachusetts	.5	0	.5	2.7	0	2.7	3.2	0	3.2	.3	0	.3
Michigan	7.1	.8	7.9	51	0	51	58	.8	58	2.9	.1	3.0
Minnesota	6.3	0	6.3	292	0	292	298	0	298	12	0	12
Mississippi	3.5	0	3.5	.2	0	.2	3.7	0	3.7	.9	0	.9
Missouri	8.6	0	8.6	15	0	15	24	0	24	2.4	0	2.4
Montana	2.8	13	16	3.8	0	3.8	6.6	13	20	1.1	0	1.1
Nebraska	6.1	4.7	11	134	0	134	141	4.7	145	2.1	0	2.1
Nevada	65	11	76	3.5	0	3.5	68	11	80	68	11	80
New Hampshire	0	0	0	7.0	0	7.0	7.0	0	7.0	1.4	0	1.4
New Jersey	2.4	0	2.4	87	0	87	90	0	90	7.2	0	7.2
New Mexico	61	0	61	.7	0	.7	61	0	61	39	0	39
New York	11	1.5	13	34	15	49	45	16	62	13	4.4	17
North Carolina	12	0	12	4.3	0	4.3	16	0	16	9.3	0	9.3
North Dakota	3.8	0	3.8	2.0	0	2.0	5.8	0	5.8	.7	0	.7
Ohio	47	0	47	46	0	46	93	0	93	52	0	52
Oklahoma	5.4	259	264	0	0	0	5.4	259	264	1.5	0	1.5
Oregon	1.2	0	1.2	0	0	0	1.2	0	1.2	.6	0	.6
Pennsylvania	211	0	211	41	0	41	252	0	252	25	0	25
Rhode Island	.5	0	.5	5.7	0	5.7	6.2	0	6.2	.8	0	.8
South Carolina	2.9	0	2.9	0	0	0	2.9	0	2.9	.3	0	.3
South Dakota	7.8	0	7.8	20	0	20	27	0	27	6.8	0	6.8
Tennessee	2.8	0	2.8	2.7	0	2.7	5.5	0	5.5	.6	0	.6
Texas	128	409	538	83	0	83	211	409	621	211	0	211
Utah	16	7.3	23	.9	143	144	16	150	167	12	133	145
Vermont	.3	0	.3	2.8	0	2.8	3.0	0	3.0	.6	0	.6
Virginia	2.6	0	2.6	37	0	37	39	0	39	4.7	0	4.7
Washington	2.8	0	2.8	.7	0	.7	3.5	0	3.5	.5	0	.5
West Virginia	3.7	.5	4.2	7.5	0	7.5	11	.5	12	2.2	.5	2.7
Wisconsin	7.9	0	7.9	4.3	0	4.3	12	0	12	2.5	0	2.5
Wyoming	71	18	90	25	0	25	96	18	115	40	7.5	47
Puerto Rico	2.8	0	2.8	1.4	0	1.4	4.2	0	4.2	1.3	0	1.3
Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0
Total	1,070	1,010	2,080	1,490	201	1,690	2,560	1,210	3,770	780	240	1,020

Thermoelectric Power — 190,000 million gallons per day

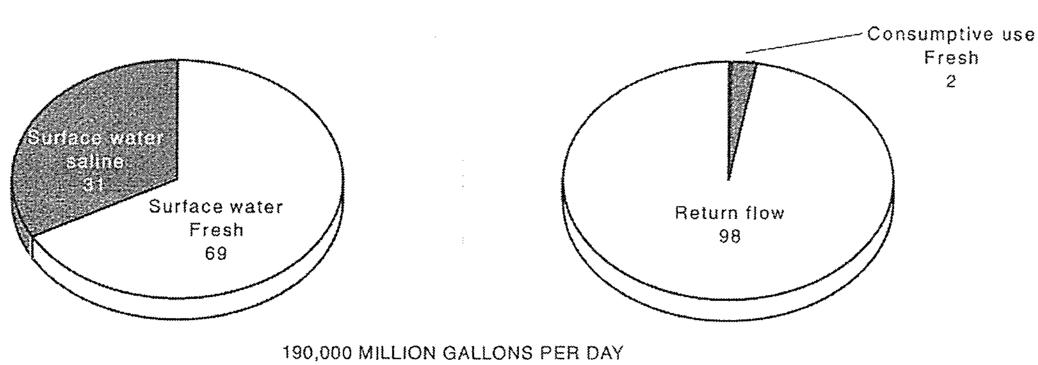
The total quantity of water used for thermoelectric power generation during 1995 was an estimated 190,000 Mgal/d, or about 3 percent less than during 1990. This use included 57,900 Mgal/d of saline water, or 10 percent less than during 1990). (See tables 23, 24.) Withdrawals for thermoelectric power generation account for 39 percent of freshwater use for all off-stream categories and represent 47 percent of combined fresh and saline withdrawals. Public suppliers only delivered about 100 Mgal/d of water to thermoelectric plants during 1995; this accounted for less than 1 percent of total public-supply withdrawals. Fossil-fuel thermoelectric plants account for about 71 percent of total thermoelectric withdrawals; nuclear plants, 29 percent; and geothermal plants, less than 1 percent.

The source and disposition of water for thermoelectric power are shown in the chart below. Surface water was the source for more than 99 percent of total thermoelectric withdrawals, and about 31 percent of the surface-water withdrawal was saline. About 2 percent of the water withdrawn for thermoelectric power during 1995 was consumptively used as a result of once-through, cooling-tower, or pond cooling.

The thermoelectric power category includes water used in the generation of electric power with fossil-fuel, nuclear, or geothermal energy. The estimates of water withdrawals for thermoelectric power estimates should be reliable because relatively complete files on power generation are maintained by Federal and State agencies. The Electric Power Annual is prepared by the U.S. Department of Energy, Energy Information Administration, and contains information about electric power net generation. Most of the water withdrawn by thermoelectric plants is used for condenser and reactor cooling. Plants vary widely as to the techniques used in the disposal of the cooling water after it is passed through the condensers. Less water is required when cooling water is recycled through cooling towers or ponds, but a higher percentage of the cooling water is evaporated (consumptive use), usually more than 60 percent. When the water withdrawn for cooling is used only once before it is returned to a surface water body, significantly more water is required, but evaporation is low (less than 3 percent). Withdrawal estimates generally are based on power generation. Consumptive use is based on coefficients ranging from 1 to 100 percent of withdrawals.

Thermoelectric power is by far the largest water use in the East. The eight eastern water-resources regions, led by the Mid-Atlantic region, account for 75 percent of the total water withdrawn for thermoelectric power cooling (figure 26; table 23). The highly populated States of Illinois, Texas, New York, Florida, and California use the most water for thermoelectric power. Illinois leads the Nation, nearly double Texas, in the use of freshwater for thermoelectric power.

Saline ground water was only reported for geothermal plants in California (22 Mgal/d), Nevada (30 Mgal/d), and Utah (6.7 Mgal/d), and is not listed in the tables or included in the totals.



THERMOELECTRIC POWER SOURCE AND DISPOSITION, 1995, IN PERCENT

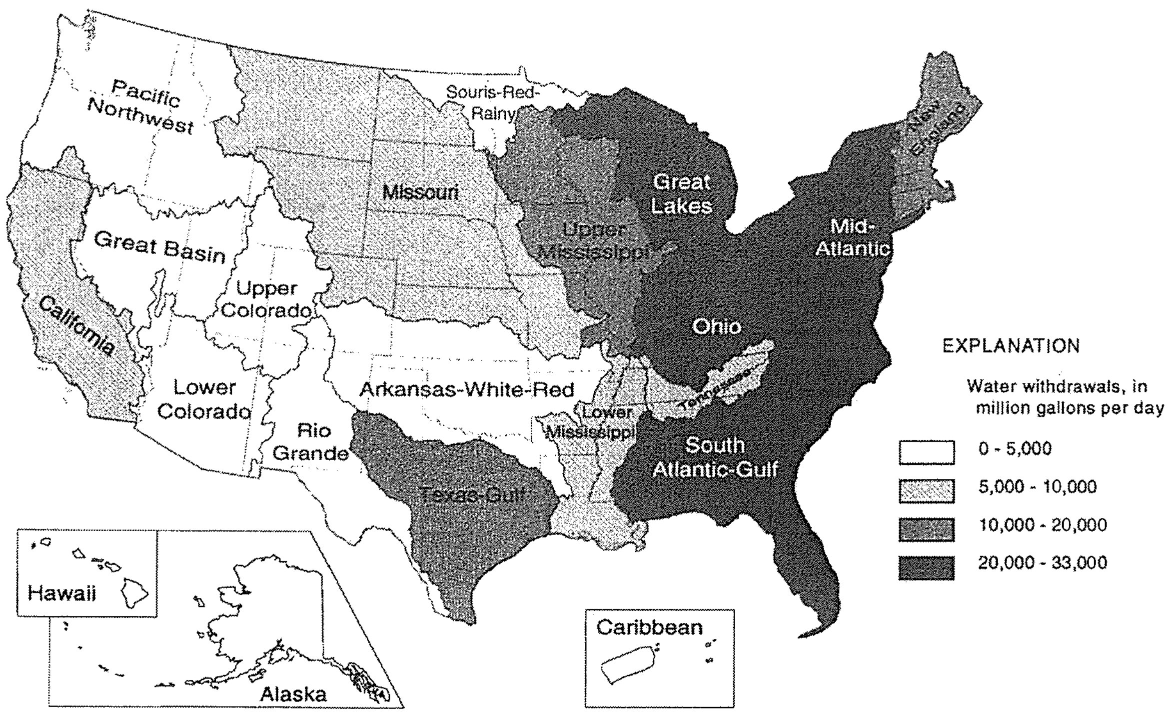


Figure 26. Thermoelectric power water withdrawals (fresh, saline) by water-resources region, 1995.

Table 23. Thermoelectric power water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; kWh = kilowatthour]

REGION	ALL THERMOELECTRIC POWER WATER USE, in Mgal/d									POWER GENERATED, in million kWh
	Self-supplied withdrawals, by source and type					Total use				
	Ground water	Surface water			Public-supply deliveries	Withdrawals and deliveries	Consumptive use			
	Fresh	Fresh	Saline	Total	Fresh	Fresh	Fresh	Saline	Total	
New England	48	1,620	8,800	10,400	2.3	1,670	17	88	105	84,600
Mid-Atlantic	11	12,600	19,700	32,400	27	12,700	188	213	401	259,000
South Atlantic-Gulf	79	17,500	12,700	30,200	5.6	17,600	344	20	365	478,000
Great Lakes	7.6	22,800	0	22,800	.1	22,800	429	0	429	219,000
Ohio	70	22,600	0	22,600	.3	22,600	838	0	838	451,000
Tennessee	0	6,990	0	6,990	0	6,990	13	0	13	76,600
Upper Mississippi	24	19,000	0	19,000	7.4	19,100	388	0	388	211,000
Lower Mississippi	69	6,670	0	6,670	1.1	6,740	253	0	253	78,100
Souris-Red-Rainy	0	38	0	38	0	38	0	0	0	396
Missouri Basin	30	8,770	0	8,770	4.7	8,810	172	0	172	167,000
Arkansas-White-Red	37	4,140	0	4,140	28	4,200	163	0	163	143,000
Texas-Gulf	50	7,630	3,870	11,500	13	7,700	252	12	264	224,000
Rio Grande	16	2.2	0	2.2	0	18	14	0	14	7,780
Upper Colorado	0	146	0	146	0	146	130	0	130	94,000
Lower Colorado	45	17	0	17	1.5	64	57	0	57	62,400
Great Basin	2.6	21	0	21	0	24	23	8.6	32	16,300
Pacific Northwest	.5	384	0	384	0	385	18	0	18	17,000
California	3.6	202	9,430	9,630	5.3	211	9.7	19	29	76,000
Alaska	4.2	26	0	26	.6	31	3.1	0	3.1	3,770
Hawaii	67	0	903	903	.3	67	.7	9.0	9.7	6,370
Caribbean	2.2	0	2,440	2,440	2.2	4.3	.9	0	.9	16,500
Total	565	131,000	57,900	189,000	100	132,000	3,310	369	3,680	2,690,000

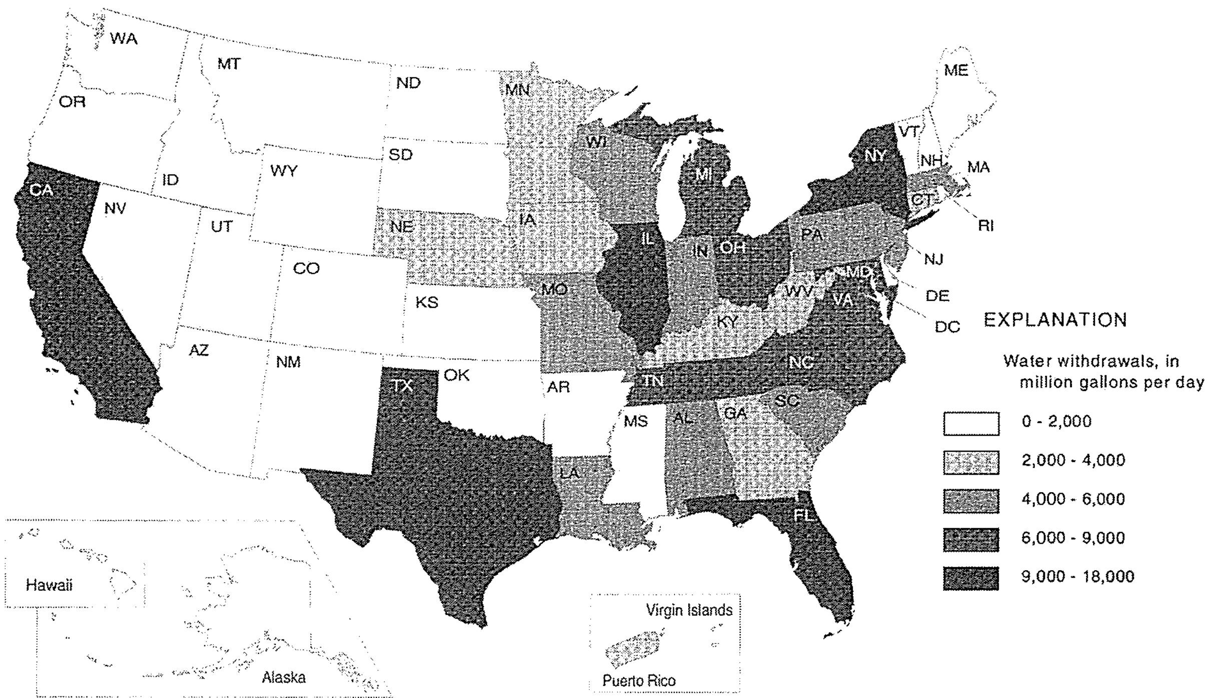


Figure 27. Thermoelectric power water withdrawals (fresh, saline) by State, 1995.

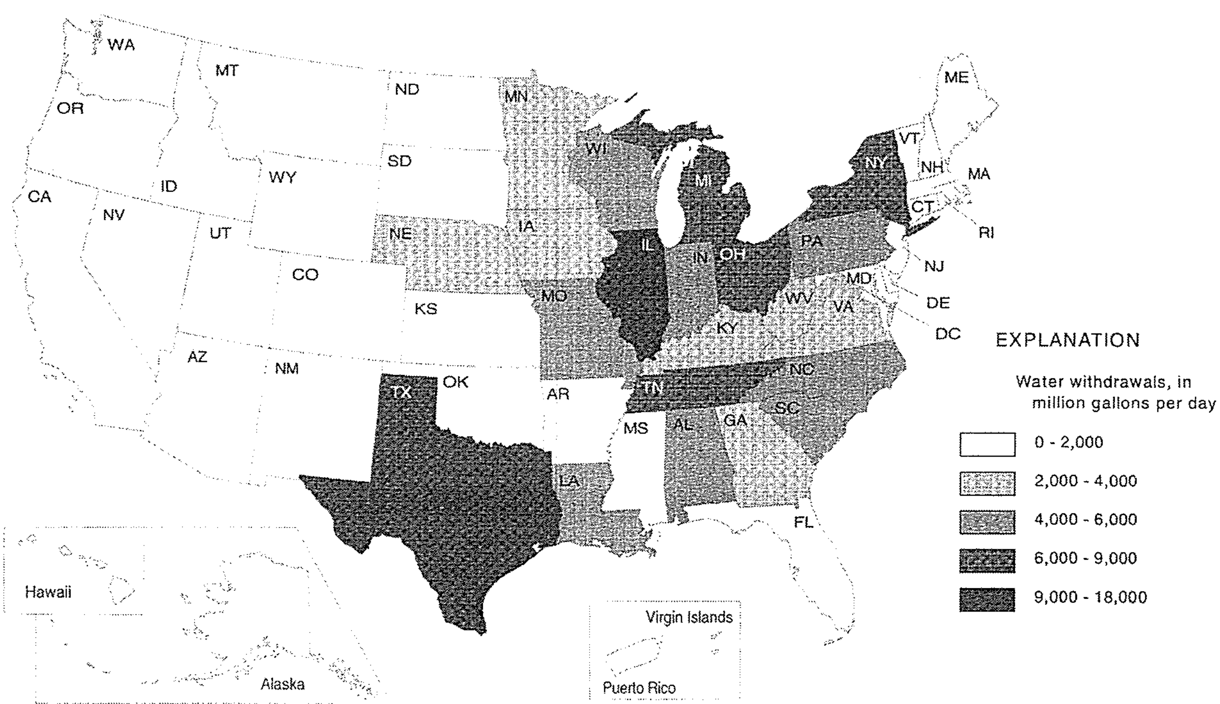


Figure 28. Thermoelectric power freshwater withdrawals by State, 1995.

Table 24. Thermoelectric power water use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; kWh = kilowatthour]

STATE	ALL THERMOELECTRIC POWER WATER USE, in Mgal/d									POWER GENERATED, in million kWh
	Self-supplied withdrawals, by source and type				Public-supply deliveries	Total use				
	Ground water	Surface water				Withdrawals and deliveries	Consumptive use			
	Fresh	Fresh	Saline	Total	Fresh	Fresh	Fresh	Saline	Total	
Alabama	6.0	5,190	0	5,190	0	5,200	32	0	32	85,300
Alaska	4.2	26	0	26	.6	31	3.1	0	3.1	3,770
Arizona	42	20	0	20	0	62	54	0	54	65,300
Arkansas	5.2	1,770	0	1,770	0	1,770	28	0	28	37,400
California	3.6	202	9,430	9,630	5.3	211	9.7	19	29	76,000
Colorado	22	93	0	93	14	128	41	0	41	30,600
Connecticut	.2	760	3,180	3,940	1.0	761	5.9	74	80	27,500
Delaware	.2	534	740	1,270	.5	535	.2	2.9	3.1	6,060
D.C.	0	9.7	0	9.7	0	9.7	.8	0	.8	189
Florida	21	615	11,000	11,600	3.6	640	56	0	56	149,000
Georgia	4.8	3,040	33	3,070	0	3,040	145	0	145	92,700
Hawaii	67	0	903	903	.3	67	.7	9.0	9.7	6,370
Idaho	0	0	0	0	0	0	0	0	0	0
Illinois	11	17,100	0	17,100	5.2	17,100	407	0	407	147,000
Indiana	11	5,680	0	5,680	0	5,690	114	0	114	105,000
Iowa	15	2,110	0	2,110	3.0	2,130	10	0	10	32,600
Kansas	14	1,250	0	1,250	.8	1,270	58	0	58	38,100
Kentucky	38	3,410	0	3,410	0	3,440	203	0	203	70,600
Louisiana	31	5,450	0	5,450	0	5,480	222	0	222	54,200
Maine	.7	30	105	135	.9	31	3.5	1.7	5.2	4,600
Maryland	1.8	358	6,000	6,360	0	360	3.7	48	52	43,200
Massachusetts	46	150	4,370	4,520	0	196	0	6.0	6.0	34,000
Michigan	3.0	8,370	0	8,370	0	8,370	126	0	126	96,700
Minnesota	1.9	2,090	0	2,090	.1	2,090	48	0	48	41,300
Mississippi	42	220	112	333	2.2	265	27	3.6	31	26,100
Missouri	9.5	5,540	0	5,540	.2	5,550	51	0	51	63,600
Montana	0	22	0	22	0	22	22	0	22	8,770
Nebraska	4.4	2,350	0	2,350	0	2,350	12	0	12	23,800
Nevada	6.3	21	0	21	1.5	28	28	8.3	37	18,900
New Hampshire	.8	228	877	1,110	.3	229	4.3	0	4.3	14,000
New Jersey	1.9	578	3,780	4,360	25	605	4.4	32	36	23,600
New Mexico	9.3	46	0	46	.1	56	48	0	48	29,100
New York	0	6,570	6,490	13,100	0	6,570	170	130	300	76,100
North Carolina	.1	5,860	1,550	7,420	.4	5,860	57	17	74	93,400
North Dakota	.3	879	0	879	0	880	25	0	25	26,300
Ohio	19	8,170	0	8,170	0	8,190	336	0	336	135,000
Oklahoma	3.5	121	0	121	1.2	126	60	0	60	44,700
Oregon	0	9.0	0	9.0	0	9.0	7.8	0	7.8	3,620
Pennsylvania	6.2	5,920	0	5,920	1.6	5,930	239	0	239	168,000
Rhode Island	0	0	275	275	0	0	0	5.5	5.5	278
South Carolina	39	4,770	0	4,770	0	4,810	51	0	51	74,200
South Dakota	3.4	1.9	0	1.9	0	5.4	.1	0	.1	2,800
Tennessee	0	8,300	0	8,300	.5	8,300	.5	0	.5	73,800
Texas	59	9,530	3,870	13,400	29	9,620	297	12	309	259,000
Utah	0	48	0	48	0	48	47	.3	47	31,600
Vermont	.4	452	0	452	0	453	4.0	0	4.0	4,400
Virginia	.4	3,890	2,730	6,620	.5	3,890	8.8	0	8.8	50,900
Washington	.5	375	0	375	0	376	10	0	10	13,300
West Virginia	.5	3,010	0	3,010	.2	3,010	122	0	122	79,100
Wisconsin	5.8	5,820	0	5,820	.1	5,830	58	0	58	44,700
Wyoming	1.0	219	0	219	0	220	50	0	50	38,600
Puerto Rico	2.2	0	2,260	2,260	2.2	4.4	.7	0	.7	15,800
Virgin Islands	0	0	173	173	.8	.8	.2	0	.2	771
Total	565	131,000	57,900	189,000	100	132,000	3,310	369	3,680	2,690,000

Table 25. Thermoelectric power water use by energy source and water-resources region, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

REGION	FOSSIL FUEL						NUCLEAR					
	Withdrawals, by source and type				Consumptive use		Withdrawals, by source and type				Consumptive use	
	Ground water	Surface water					Ground water	Surface water				
	Fresh	Fresh	Saline	Total	Fresh	Saline	Fresh	Fresh	Saline	Total	Fresh	Saline
New England	48	684	5,460	6,150	14	82	0.1	936	3,340	4,270	3.2	6.0
Mid-Atlantic	9.6	8,490	10,900	19,400	95	155	1.2	4,140	8,790	12,900	93	58
South Atlantic-Gulf ...	39	11,200	9,290	20,500	220	3.6	40	6,340	3,360	9,700	124	17
Great Lakes	7.4	15,300	0	15,300	180	0	.2	7,520	0	7,520	249	0
Ohio	70	22,500	0	22,500	810	0	0	65	0	65	29	0
Tennessee	0	4,750	0	4,750	11	0	0	2,240	0	2,240	1.5	0
Upper Mississippi	20	12,300	0	12,300	163	0	3.4	6,690	0	6,690	225	0
Lower Mississippi	37	5,650	0	5,650	223	0	32	1,020	0	1,020	30	0
Souris-Red-Rainy	0	38	0	38	0	0	0	0	0	0	0	0
Missouri Basin	28	7,700	0	7,700	161	0	.4	1,080	0	1,080	11	0
Arkansas-White-Red ..	37	3,150	0	3,150	149	0	0	989	0	989	14	0
Texas-Gulf	49	4,820	3,870	8,680	226	12	.8	2,820	0	2,820	26	0
Rio Grande.........	16	2.2	0	2.2	14	0	0	0	0	0	0	0
Upper Colorado	0	146	0	146	130	0	0	0	0	0	0	0
Lower Colorado	45	17	0	17	57	0	0	0	0	0	0	0
Great Basin	2.5	21	0	21	23	0	0	0	0	0	0	0
Pacific Northwest	.4	26	0	26	8.2	0	.1	358	0	358	9.8	0
California	3.5	190	4,730	4,920	9.4	2.8	.1	12	4,690	4,710	.3	1.3
Alaska	4.2	26	0	26	3.1	0	0	0	0	0	0	0
Hawaii	67	0	903	903	.7	9.0	0	0	0	0	0	0
Caribbean	2.2	0	2,440	2,440	.9	0	0	0	0	0	0	0
Total	486	97,000	37,600	135,000	2,500	263	78	34,300	20,200	54,500	815	82

Table 26. Thermoelectric power water use by energy source and State, 1995

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

STATE	FOSSIL FUEL						NUCLEAR					
	Withdrawals, by source and type				Consumptive use		Withdrawals, by source and type				Consumptive use	
	Ground water	Surface water					Ground water	Surface water				
	Fresh	Fresh	Saline	Total	Fresh	Saline	Fresh	Fresh	Saline	Total	Fresh	Saline
Alabama	6.0	4,330	0	4,330	30	0	0	862	0	862	1.7	0
Alaska	4.2	26	0	26	3.1	0	0	0	0	0	0	0
Arizona	42	20	0	20	54	0	0	0	0	0	0	0
Arkansas	5.2	798	0	798	27	0	0	967	0	967	1.2	0
California	3.5	190	4,730	4,920	9.4	2.8	.1	12	4,690	4,710	.3	1.3
Colorado	22	93	0	93	41	0	0	0	0	0	0	0
Connecticut	.1	276	882	1,160	5.9	74	.1	484	2,300	2,780	0	0
Delaware	.2	534	740	1,270	.2	2.9	0	0	0	0	0	0
D.C.	0	9.7	0	9.7	.8	0	0	0	0	0	0	0
Florida	21	615	9,140	9,760	54	0	.3	0	1,810	1,810	1.2	0
Georgia	3.9	2,910	33	2,950	52	0	1.0	122	0	122	93	0
Hawaii	67	0	903	903	.7	9.0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0	0	0	0
Illinois	9.5	9,570	0	9,570	144	0	1.3	7,520	0	7,520	263	0
Indiana	11	5,680	0	5,680	114	0	0	0	0	0	0	0
Iowa	13	2,100	0	2,100	7.8	0	2.0	8.1	0	8.1	2.6	0
Kansas	14	1,230	0	1,230	45	0	0	22	0	22	13	0
Kentucky	38	3,410	0	3,410	203	0	0	0	0	0	0	0
Louisiana	31	4,430	0	4,430	212	0	.1	1,020	0	1,020	10	0
Maine	.7	30	105	135	3.5	1.7	0	0	0	0	0	0
Maryland	1.6	358	2,780	3,140	3.7	32	.2	0	3,220	3,220	0	16
Massachusetts	46	150	3,910	4,060	0	0	0	0	454	454	0	6.0
Michigan	3.0	6,030	0	6,030	50	0	.1	2,340	0	2,340	76	0
Minnesota	1.8	1,210	0	1,210	28	0	.1	886	0	886	20	0
Mississippi	10	220	112	333	8.0	3.6	32	0	0	0	19	0
Missouri	9.1	5,520	0	5,520	40	0	.4	21	0	21	11	0
Montana	0	22	0	22	22	0	0	0	0	0	0	0
Nebraska	4.4	1,290	0	1,290	12	0	0	1,060	0	1,060	0	0
Nevada	6.2	21	0	21	28	0	0	0	0	0	0	0
New Hampshire	.8	228	292	521	4.3	0	0	0	585	585	0	0
New Jersey	1.2	578	980	1,560	3.7	9.9	.7	0	2,800	2,800	.7	22
New Mexico	9.3	46	0	46	48	0	0	0	0	0	0	0
New York	0	5,140	5,470	10,600	103	109	0	1,420	1,010	2,440	68	20
North Carolina	.1	3,210	0	3,210	56	0	0	2,660	1,550	4,210	1.5	17
North Dakota	0	879	0	879	25	0	0	0	0	0	0	0
Ohio	19	8,040	0	8,040	309	0	0	137	0	137	27	0
Oklahoma	3.5	121	0	121	60	0	0	0	0	0	0	0
Oregon	0	9.0	0	9.0	7.8	0	0	0	0	0	0	0
Pennsylvania	6.2	3,870	0	3,870	120	0	0	2,050	0	2,050	119	0
Rhode Island	0	0	275	275	0	5.5	0	0	0	0	0	0
South Carolina	.4	1,290	0	1,290	23	0	39	3,470	0	3,470	28	0
South Dakota	2.6	1.9	0	1.9	.1	0	0	0	0	0	0	0
Tennessee	0	6,830	0	6,830	.5	0	0	1,470	0	1,470	0	0
Texas	58	6,710	3,870	10,600	271	12	.8	2,820	0	2,820	26	0
Utah	0	48	0	48	47	0	0	0	0	0	0	0
Vermont	.4	.5	0	.5	.7	0	0	452	0	452	3.2	0
Virginia	.1	1,820	973	2,790	8.8	0	.3	2,080	1,760	3,830	0	0
Washington	.4	17	0	17	.4	0	.1	358	0	358	9.8	0
West Virginia	.5	3,010	0	3,010	122	0	0	0	0	0	0	0
Wisconsin	5.6	3,860	0	3,860	39	0	.1	1,970	0	1,970	20	0
Wyoming	1.0	219	0	219	50	0	0	0	0	0	0	0
Puerto Rico	2.2	0	2,260	2,260	.7	0	0	0	0	0	0	0
Virgin Islands	0	0	173	173	.2	0	0	0	0	0	0	0
Total	486	97,000	37,600	135,000	2,500	263	78	34,300	20,200	54,500	815	82

INSTREAM USE

Hydroelectric Power 3,160,000 million gallons per day

Water used for hydroelectric power generation in 1995 was an estimated 3,160,000 Mgal/d, or 4 percent less than during 1990. (See tables 27, 28.) This total is 2.6 times the average annual runoff in the conterminous United States. (Graczyk and others, 1986). It is possible for the hydroelectric power water use to exceed average annual runoff because some water is used several times as it passes through several hydroelectric dams on a river.

Water used for hydroelectric power generation is classified as an instream use and refers to the water used in the generation of electricity at plants where the turbine generators are driven by falling water. Estimates of water used for hydroelectric power generation may vary because of the way individual estimates are made of the quantities of water passed through the plants. If the water is passed through the plants only one time, then accurate estimates of water use can be obtained by streamflow measurements and gate openings. However, it is difficult to define and obtain net water use at pumped-storage hydroelectric plants because the same water is recycled a number of times. Pumped-storage plants usually generate electric energy during peak-load periods by using water previously pumped into an elevated storage reservoir during off-peak periods when excess generating capacity is available to do so. When additional generating capacity is needed, the water can be released from the pumped-storage reservoir through a conduit to turbine generators located in a power plant at a lower level.

State agencies were asked in 1995 for the first time to report offstream hydroelectric power generation. Offstream hydroelectric power generation water use was reported for ten states and totaled 90,000 Mgal/d. California reported the most water use (69,000 Mgal/d), followed by Maine (6,290 Mgal/d), Oregon (5,880 Mgal/d) and Pennsylvania (5,260 Mgal/d). The reported offstream uses were included in the instream uses to be consistent with previous reports in this series.

Estimates of hydroelectric power water use and power generation, as with the thermoelectric power category, are based on more information and fewer extrapolations than for the other water-use categories. Most of the information is obtained from hydroelectric utility companies. If information is not available from utilities, then records of the power generated are obtained from the U.S. Department of Energy's Energy Information Administration (1996). The power-generation data are multiplied by water-use coefficients to obtain estimates of hydroelectric power water use. In this report, it is assumed that none of the water used for hydroelectric power generation is consumptively used. Although the quantity of water evaporated in the actual generation of hydroelectric power (consumptive use) is small, considerable depletion of the available water supply for hydroelectric power generation occurs as an indirect result of evaporation from reservoirs and repeated reuse of water within a pumped-storage power facility.

Fresh surface water provides virtually all water for hydroelectric power generation. The Pacific Northwest water-resources region had by far the largest use of water for hydroelectric power generation during 1995, more than triple the use in the Great Lakes region (figure 29), and accounts for about 40 percent of the water use for hydroelectric power generation in the Nation. Almost one-half of the water use for hydroelectric power generation in the United States occurs in Washington; Oregon, primarily on the Columbia River system; and New York (figure 30), on the Niagara and the St. Lawrence River systems.

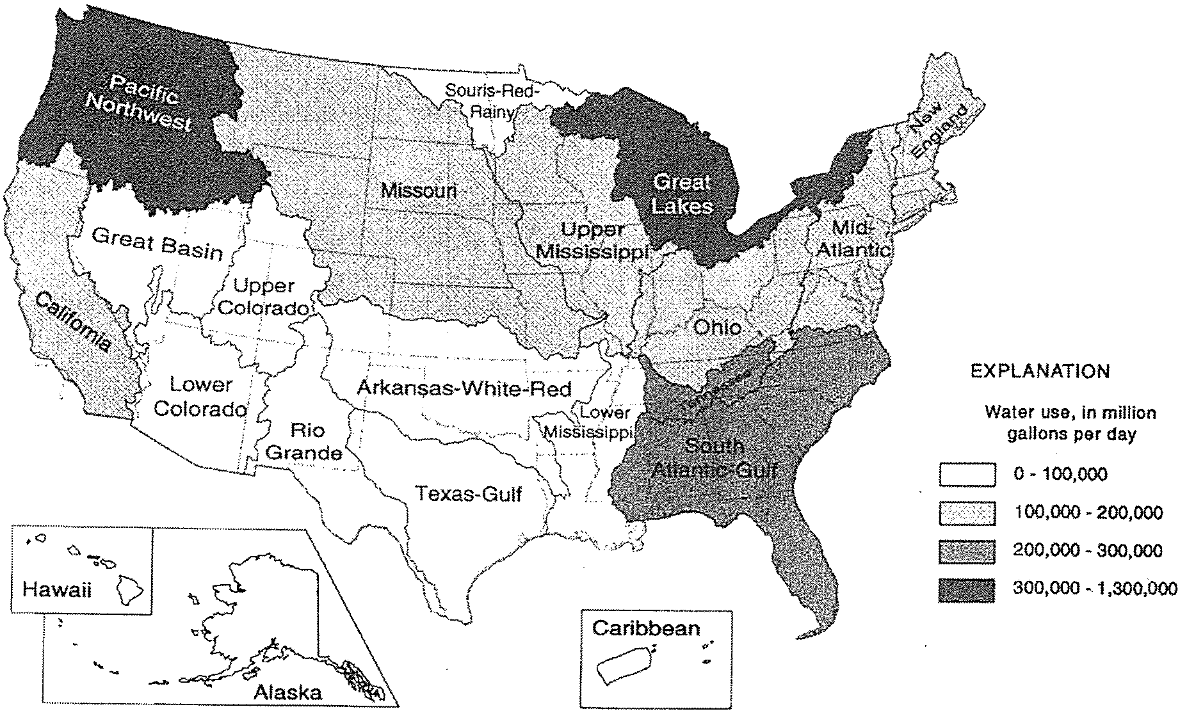


Figure 29. Hydroelectric power water use by water-resources region, 1995.

Table 27. Hydroelectric power water use by water-resources region, 1995

[Figures may not add to totals because of independent rounding.
Mgal/d = million gallons per day; kWh = kilowatthour]

REGION	WATER USE: Mgal/d	WATER USE: Thousand acre-feet per year	POWER GENERATED, in million kWh
New England	156,000	175,000	6,720
Mid-Atlantic	144,000	162,000	5,260
South Atlantic-Gulf	229,000	256,000	17,100
Great Lakes	340,000	382,000	24,200
Ohio	172,000	192,000	5,250
Tennessee	209,000	235,000	16,000
Upper Mississippi	119,000	133,000	2,990
Lower Mississippi	78,200	87,700	1,320
Souris-Red-Rainy	3,970	4,450	100
Missouri Basin	141,000	159,000	16,000
Arkansas-White-Red	95,400	107,000	6,740
Texas-Gulf	14,500	16,300	1,050
Rio Grande	3,860	4,320	464
Upper Colorado	17,900	20,000	7,220
Lower Colorado	23,400	26,300	9,740
Great Basin	5,060	5,670	633
Pacific Northwest	1,260,000	1,410,000	140,000
California	140,000	157,000	47,000
Alaska	2,090	2,340	1,440
Hawaii	229	256	148
Caribbean	349	391	101
Total	3,160,000	3,540,000	310,000

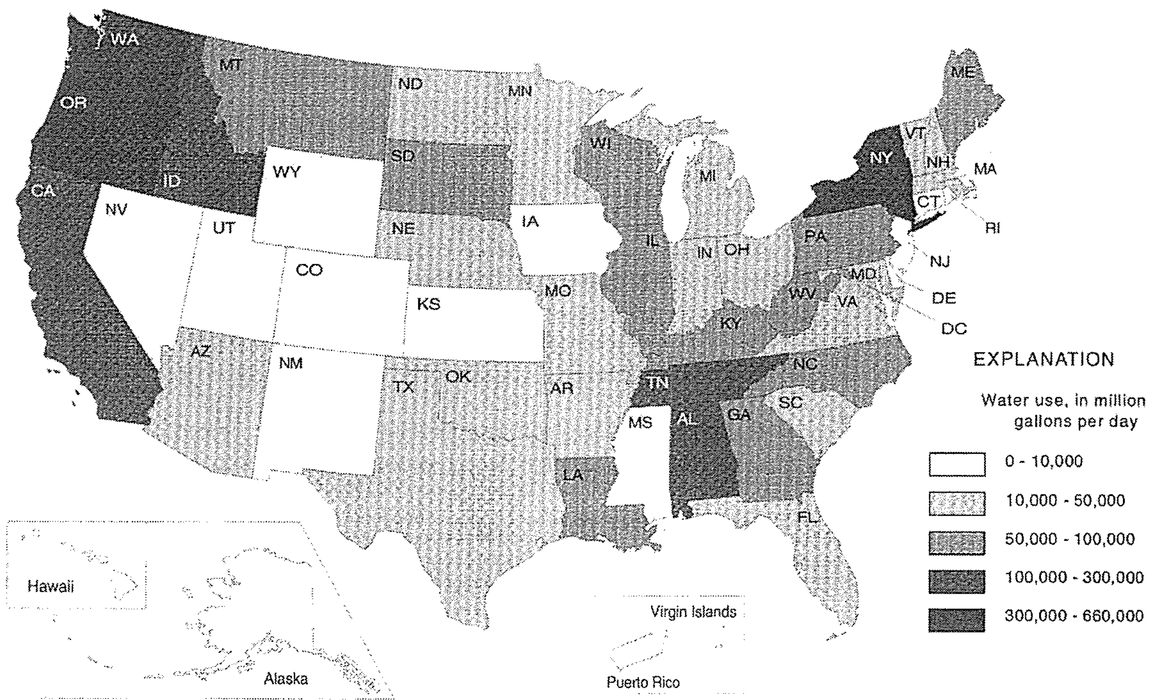


Figure 30. Hydroelectric power water use by State, 1995.

Table 28. Hydroelectric power water use by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day; kWh = kilowatthour]

STATE	WATER USE		POWER GENERATED, in million kWh
	Mgal/d	Thousand acre-feet per year	
Alabama	157,000	177,000	9,510
Alaska	2,090	2,340	1,440
Arizona	21,200	23,700	7,960
Arkansas	42,700	47,900	2,630
California	146,000	164,000	47,100
Colorado	6,810	7,630	2,140
Connecticut	3,610	4,050	317
Delaware	0	0	0
D.C.	0	0	0
Florida	16,900	19,000	443
Georgia	50,900	57,100	4,850
Hawaii	229	256	148
Idaho	115,000	129,000	11,300
Illinois	55,800	62,500	1,010
Indiana	12,300	13,800	467
Iowa	2,350	2,630	21
Kansas	1,250	1,410	11
Kentucky	83,000	93,100	2,880
Louisiana	76,100	85,400	1,110
Maine	85,200	95,500	3,440
Maryland	14,400	16,100	1,450
Massachusetts	24,200	27,100	992
Michigan	39,800	44,600	1,410
Minnesota	19,800	22,200	1,030
Mississippi	0	0	0
Missouri	17,100	19,200	1,920
Montana	66,200	74,200	10,400
Nebraska	15,000	16,800	1,040
Nevada	6,080	6,810	6,320
New Hampshire	33,000	37,000	1,460
New Jersey	309	346	241
New Mexico	2,750	3,090	353
New York	356,000	399,000	24,600
North Carolina	56,400	63,200	5,810
North Dakota	13,900	15,600	2,480
Ohio	14,200	15,900	227
Oklahoma	49,100	55,100	3,300
Oregon	456,000	511,000	40,400
Pennsylvania	55,900	62,600	352
Rhode Island	339	380	6.1
South Carolina	42,200	47,300	3,070
South Dakota	62,400	69,900	6,420
Tennessee	122,000	137,000	9,430
Texas	18,600	20,900	1,520
Utah	3,720	4,170	931
Vermont	17,500	19,600	983
Virginia	14,800	16,600	922
Washington	653,000	733,000	82,300
West Virginia	51,500	57,700	1,210
Wisconsin	50,800	57,000	1,600
Wyoming	5,150	5,770	793
Puerto Rico	349	391	101
Virgin Islands	0	0	0
Total	3,160,000	3,540,000	310,000

Wastewater Release

Wastewater Treatment

In addition to water withdrawals, public-supply deliveries, and consumptive use, the term "water use" also includes wastewater releases and return flow. Because quality as well as quantity considerations are increasingly important in water management, more information is needed concerning the location of wastewater-treatment facilities and the quantities of treated wastewater released from the facilities and returned to the hydrologic system.

The wastewater treatment category includes information on facilities engaged primarily in the collection, treatment, and disposal of wastewater conveyed through a sewer system. Return of treated water generally is to surface waters. Treatment facilities are separated into two categories in this report: publicly owned (municipal) treatment works and "other." Publicly-owned treatment works are publicly owned or receive some form of public funding, and receive and treat wastewater from various users such as domestic, commercial, and industrial. Other wastewater facilities are privately owned and include commercial and industrial facilities that treat their own wastewater. Information on the quantities of water treated and released from publicly-owned treatment facilities and returned directly to the hydrologic system, or released for beneficial reuse (reclaimed wastewater), are given in this report, along with the number of public and other wastewater-treatment facilities.

The release information usually is obtained from wastewater-treatment facility operators, utility departments, or from discharge permit files maintained by State or Federal agencies. Return flows to surface water usually are regulated by State or Federal agencies. The number of wastewater-treatment facilities typically is available from permit files at State or Federal agencies. The reliability of the data varies by State depending on available information.

About 16,400 publicly-owned treatment facilities released some 41,000 Mgal/d of treated wastewater nationwide during 1995. (See tables 29, 30.) Nationally, an average of from 1 million to 2 million gallons of treated wastewater per public-treatment facility was returned daily to streams or other surface-water bodies. In addition, over 2 percent (983 Mgal/d) of the treated wastewater that was released was reclaimed for beneficial uses such as irrigation of golf courses and public parks. The largest return flows occurred in regions (figure 31) and States (figure 32) that have large populations and large public-supply withdrawals. Illinois and Ohio, which have large public-supply withdrawals, reported the largest releases of treated wastewater. Florida, California, and Arizona reported large uses of reclaimed wastewater.

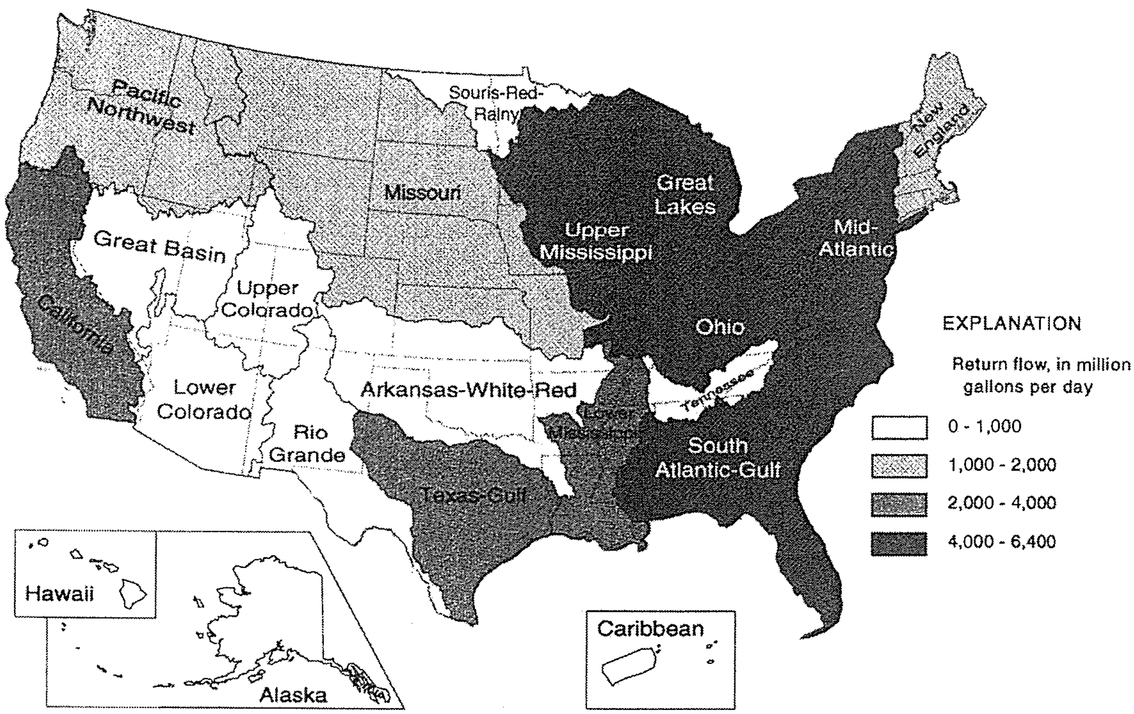


Figure 31. Wastewater treatment return flow by water-resources region, 1995.

Table 29. Wastewater treatment water releases by water-resources region, 1995

[Figures may not add to totals because of independent rounding.
Mgal/d = million gallons per day]

REGION	NUMBER OF FACILITIES		PUBLIC RELEASES	
	Public	Other	Return flow, in Mgal/d	Reclaimed wastewater, in Mgal/d
New England	488	490	1,670	0
Mid-Atlantic	1,066	1,543	5,260	71
South Atlantic-Gulf	1,798	3,154	4,520	298
Great Lakes	1,152	1,537	5,030	0
Ohio	2,144	5,002	5,310	.1
Tennessee	224	301	645	.1
Upper Mississippi	1,950	1,480	6,330	0
Lower Mississippi	598	1,041	1,850	0
Souris-Red-Rainy	251	41	61	0
Missouri Basin	2,103	1,555	1,360	12
Arkansas-White-Red	1,047	1,133	868	26
Texas-Gulf	1,106	2,686	2,030	71
Rio Grande	116	127	165	10
Upper Colorado	193	90	62	1.8
Lower Colorado	179	344	500	217
Great Basin	101	73	287	59
Pacific Northwest	636	1,850	1,390	0
California	1,040	827	3,250	211
Alaska	127	108	61	0
Hawaii	32	171	137	6.2
Caribbean	78	0	189	0
Total	16,428	23,700	41,000	983

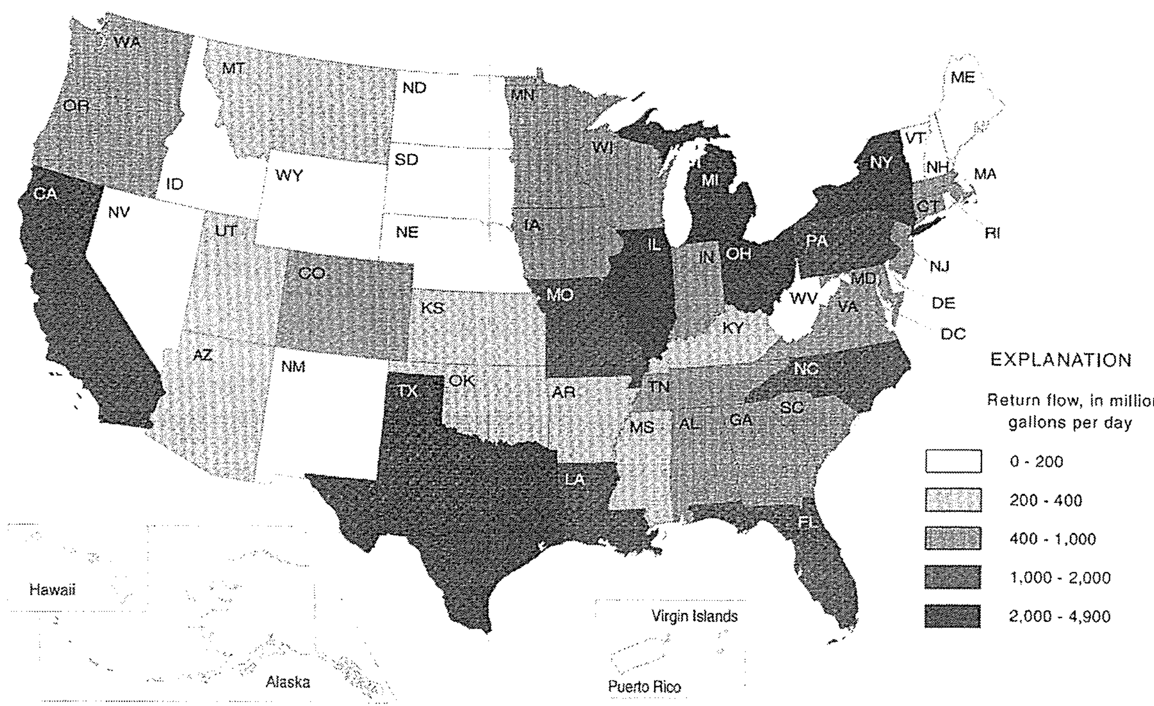


Figure 32. Wastewater treatment return flow by State, 1995.

Table 30. Wastewater treatment water releases by State, 1995

[Figures may not add to totals because of independent rounding. Mgal/d = million gallons per day]

STATE	NUMBER OF FACILITIES		PUBLIC RELEASES	
	Public	Other	Return flow, in Mgal/d	Reclaimed wastewater, in Mgal/d
Alabama	255	0	474	0
Alaska	126	107	61	0
Arizona	150	300	359	209
Arkansas	313	442	241	0
California	1,049	857	3,250	216
Colorado	393	179	422	11
Connecticut	94	47	411	0
Delaware	15	48	103	0
D.C.	1	6	309	0
Florida	387	228	1,540	271
Georgia	501	370	777	4.0
Hawaii	32	171	137	6.2
Idaho	76	6	99	0
Illinois	532	610	4,850	0
Indiana	407	422	762	0
Iowa	754	475	522	0
Kansas	442	343	217	7.4
Kentucky	223	1,465	341	0
Louisiana	153	159	1,450	0
Maine	71	0	115	0
Maryland	161	870	422	70
Massachusetts	86	443	867	0
Michigan	295	698	2,540	0
Minnesota	436	0	516	0
Mississippi	307	1,575	307	0
Missouri	1,164	1,284	1,030	0
Montana	228	118	202	0
Nebraska	290	285	181	1.0
Nevada	68	67	179	24
New Hampshire	79	0	89	0
New Jersey	209	467	915	0
New Mexico	46	59	99	5.6
New York	596	0	2,760	0
North Carolina	307	1,348	1,330	1.5
North Dakota	277	99	45	0
Ohio	1,236	2,510	4,690	0
Oklahoma	332	159	312	0
Oregon	189	23	483	0
Pennsylvania	289	140	1,340	.6
Rhode Island	115	0	182	0
South Carolina	274	481	404	22
South Dakota	207	0	64	0
Tennessee	251	0	739	.1
Texas	1,308	3,113	2,180	96
Utah	50	10	236	39
Vermont	95	0	42	0
Virginia	67	1	561	0
Washington	329	1,791	736	0
West Virginia	594	1,342	199	0
Wisconsin	411	231	653	0
Wyoming	79	203	50	0
Puerto Rico	70	0	185	0
Virgin Islands	8	0	4.1	0
Total	16,428	23,700	41,000	983

TRENDS IN WATER USE, 1950-1995

These national water-use compilations began in 1950 and are conducted at 5-year intervals. To facilitate the following discussion of trends in water use, the estimates for some categories used in this report have been combined to correspond to the categories used in previous water-use compilations (public supply, rural use, irrigation, industrial, thermoelectric power, hydroelectric power). Self-supplied domestic withdrawals are combined with livestock withdrawals in this section to compare to the rural-use category listed in some previous water-use circulars; and self-supplied industrial withdrawals are combined with commercial and mining withdrawals to compare to "other industries," which were listed with thermoelectric power generation under "industrial" in some previous water-use circulars.

Estimates in table 31summarize the water use—withdrawals, source of water, reclaimed wastewater, consumptive use, and instream use (hydroelectric power)—at 5-year intervals from 1950 to 1995. Table 31 also shows the percentage change in the 1990 and 1995 summary estimates.

Estimates in table 31 and figure 33 show that after continual increases in the Nation's total water withdrawals for offstream use for the years reported from 1950 to 1980, withdrawals declined from 1980 to 1995. The 1995 estimate of total withdrawals (402,000 Mgal/d) is 2 percent less than the 1990 estimate and nearly 10 percent less than the 1980 estimate, which is the peak year of water use documented in this 5-year compilation series. This decline in water withdrawals occurred even though population increased 16 percent from 1980 to 1995.

The "Public supply" and "Rural domestic and livestock" categories are the only two categories to show continual increases from 1950 to 1995, largely because of continual increases in population (figure 34). The 4-percent increase in public-supply withdrawals from 1990 to 1995, compared to a 7-percent increase in population served by public supply, indicates that conservation programs have been effective in lowering public supply per-capita use from about 184 gal/d in 1990 to 179 gal/d in 1995. The 13-percent increase in rural domestic and livestock withdrawals is attributable to an increase in livestock withdrawals, especially animal specialities withdrawals, which were 43 percent higher during 1995 than during 1990. Rural (self-supplied) domestic withdrawals were the same in 1995 (3,390 Mgal/d) as in 1990.

More water (fresh, saline) continues to be withdrawn for thermoelectric power generation than for any other category (figure 34). Withdrawals for thermoelectric power generation peaked in 1980 at 210,000 Mgal/d and fluctuated around 190,000 Mgal/d during 1985, 1990, and 1995.

The estimate of total self-supplied withdrawals (fresh, saline) for "other" industrial uses for 1995 is 29,100 Mgal/d, or about 3 percent less than for 1990. Industrial withdrawals declined from 1980 to 1995 after remaining about the same for the years reported between 1965 and 1980. In fact, self-supplied withdrawals for "other" industrial use during 1995 are the lowest in this series since records began in 1950. Lower industrial withdrawals are the result of new industries and technologies that require less water, improved plant efficiencies, increased water recycling, changes in laws and regulations to reduce the discharge of pollutants, and conservation measures.

Total irrigation withdrawals were about the same during 1955 and 1960, then steadily increased for the individual years reported from 1965 to 1980, and gradually decreased from 1980 to 1995 (figure 34; table 31). Estimated irrigation withdrawals during 1995 (134,000 Mgal/d) were about 2 percent less than during 1990 and 1985. Irrigation application rates vary from year to year and depend on annual rainfall, surface water availability, energy costs, farm commodity prices, application technologies, and conservation practices. The average amount of water applied per acre for irrigation in the United States during 1995 was about 2.1 acre-feet, which is about the same as in 1990, slightly less than the 1985 average of 2.2 acre-feet, and well below the 1975 and 1980 average of 2.5 acre-feet. This decline in application rates is the result of implementation of improved and more efficient irrigation systems and techniques. Also, application rates in the more humid Eastern United States tend to be lower than in the dryer Western United States and the amount of irrigated acreage continues to increase in the Eastern United States.

The total number of acres irrigated in the United States steadily increased for the individual years reported from 1950 to 1980 and remained fairly constant at around 58 million acres for the years reported from 1980 to 1995. The increase in acres irrigated from 1950 to 1980 was the result of increases in both the Western and Eastern United States. Acres irrigated in the 19 western states decreased from 1980 to 1995 as a result of irrigated acreage being replaced by dry land farming and urban development, and irrigation water rights being sold to municipal water suppliers. Acres irrigated in the eastern United States, however, continued to increase more than offsetting the decrease in the western states.

Instream use (hydroelectric power) during 1995 was 4 percent less than during 1990. Water used for hydroelectric power generation increased steadily from 1950 to 1975, but, during 1980, it was about the same as during 1975. Hydroelectric power water use during 1985, 1990, and 1995 fluctuated above 3,000 billion gallons per day. Changes in hydroelectric power water use are closely related to the availability of surface water. The use of reclaimed wastewater is estimated to have been about 1,020 Mgal/d in 1995, which is 36 percent more than the estimated 750 Mgal/d used in 1990.

Table 31. Trends of estimated water use in the United States, 1950-95

[Data for 1950-90 adapted from MacKichan (1951, 1957), MacKichan and Kammerer (1961), Murray (1968), Murray and Reeves (1972, 1977), and Solley and others (1983, 1988, 1993). The water-use data are in thousands of million gallons per day and are rounded to two significant figures for 1950-80, and to three significant figures for 1985-95; percentage change is calculated from unrounded numbers]

	Year										Percentage change
	[1]1950	[1]1955	[2]1960	[2]1965	[3]1970	[4]1975	[4]1980	[4]1985	[4]1990	[4]1995	1990-95
Population, in millions	150.7	164.0	179.3	193.8	205.9	216.4	229.6	242.4	252.3	267.1	+6
Offstream use:											
Total withdrawals	180	240	270	310	370	420	[5]440	399	408	402	-2
Public supply	14	17	21	24	27	29	34	36.5	38.5	40.2	+4
Rural domestic and livestock	3.6	3.6	3.6	4.0	4.5	4.9	5.6	7.79	7.89	8.89	+13
Irrigation	89	110	110	120	130	140	150	137	137	134	-2
Industrial:											
Thermoelectric power use	40	72	100	130	170	200	210	187	195	190	-3
Other industrial use	37	39	38	46	47	45	45	30.5	29.9	29.1	-3
Source of water:											
Ground:											
Fresh	34	47	50	60	68	82	[5]83	73.2	79.4	76.4	-4
Saline	([6])	.6	.4	.5	1	1	.9	.652	1.22	1.11	-9
Surface:											
Fresh	140	180	190	210	250	260	290	265	259	264	+2
Saline	10	18	31	43	53	69	71	59.6	68.2	59.7	-12
Reclaimed wastewater	([6])	.2	.6	.7	.5	.5	.5	.579	.750	1.02	+36
Consumptive use	([6])	([6])	61	77	[7]87	[7]96	[7]100	[7]92.3	[7]94.0	[7]100	+6
Instream use:											
Hydroelectric power	1,100	1,500	2,000	2,300	2,800	3,300	3,300	3,050	3,290	3,160	-4

[1]48 States and District of Columbia.
[2]50 States and District of Columbia.
[3]50 States and District of Columbia, and Puerto Rico.
[4]50 States and District of Columbia, Puerto Rico, and Virgin Islands.
[5]Revised
[6]Data not available.
[7]Freshwater only.

The general increase in water use from 1950 to 1980 and the decrease from 1980 to 1995 can be attributed, in part, to the following major factors:

- Most of the increases in water use from 1950 to 1980 were the result of expansion of irrigation systems and increases in energy development.
- The development of center-pivot irrigation systems and the availability of plentiful and inexpensive ground-water resources supported the expansion of irrigation systems.
- Higher energy prices in the 1970's, and large drawdown in ground-water levels in some areas increased the cost of irrigation water. In the 1980's, improved application techniques, increased competition for water, and a downturn in the farm economy reduced demands for irrigation water.
- The transition from water-supply management to water-demand management encouraged more efficient use of water.
- New technologies in the industrial sector that require less water, improved plant efficiencies, increased water recycling, higher energy prices, and changes in laws and regulations to reduce the discharge of pollutants resulted in decreased water use and less water being returned to the natural system after use.
- The enhanced awareness by the general public to water resources and active conservation programs in many States have contributed to reduced water demands.

Projections of future water use are beyond the scope of this report, although the trends established over the past 45 years from these national compilations provide some basis for estimating future water demands. It seems likely that water withdrawals for public supply and domestic uses will continue to increase as population increases. Higher water prices and active water conservation programs, however, may reduce the per-capita use rates. With increased competition for water for instream uses, such as river-based recreation, esthetic enjoyment, fish and wildlife habitat, and hydroelectric power, along with higher municipal uses, irrigators will have increasing difficulty competing economically for available water supplies. Thus, a leveling in the rate of agricultural water use combined with growing population and urbanization suggests that, for the foreseeable future, new balances will have to be struck in water use between the rural and urban areas, especially in the Western United States (Moore and others, 1990, p. 97). It seems likely that, for the foreseeable future, industrial water use and use per unit of production will continue to decline in most sectors, although probably not as sharply as in the recent past (David, 1990, p. 85).

Regardless of which projection proves correct, major attention needs to be given to water-management problems to ensure that maximum benefits will be obtained from use of the Nation's water resources. This has become more evident, because, in addition to the need for an adequate water supply, water-quality conditions need to be suitable if supply and demand are to be kept in balance.

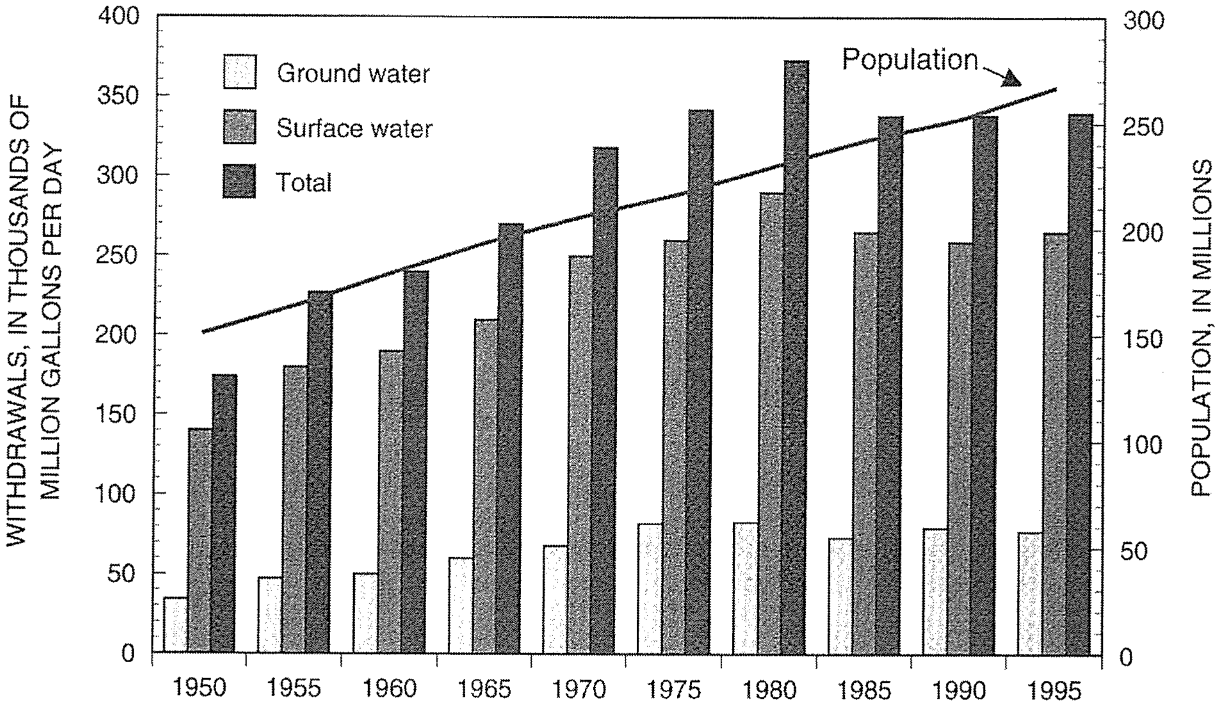


Figure 33. Trends in fresh ground- and surface-water withdrawals, and population, 1950-95.

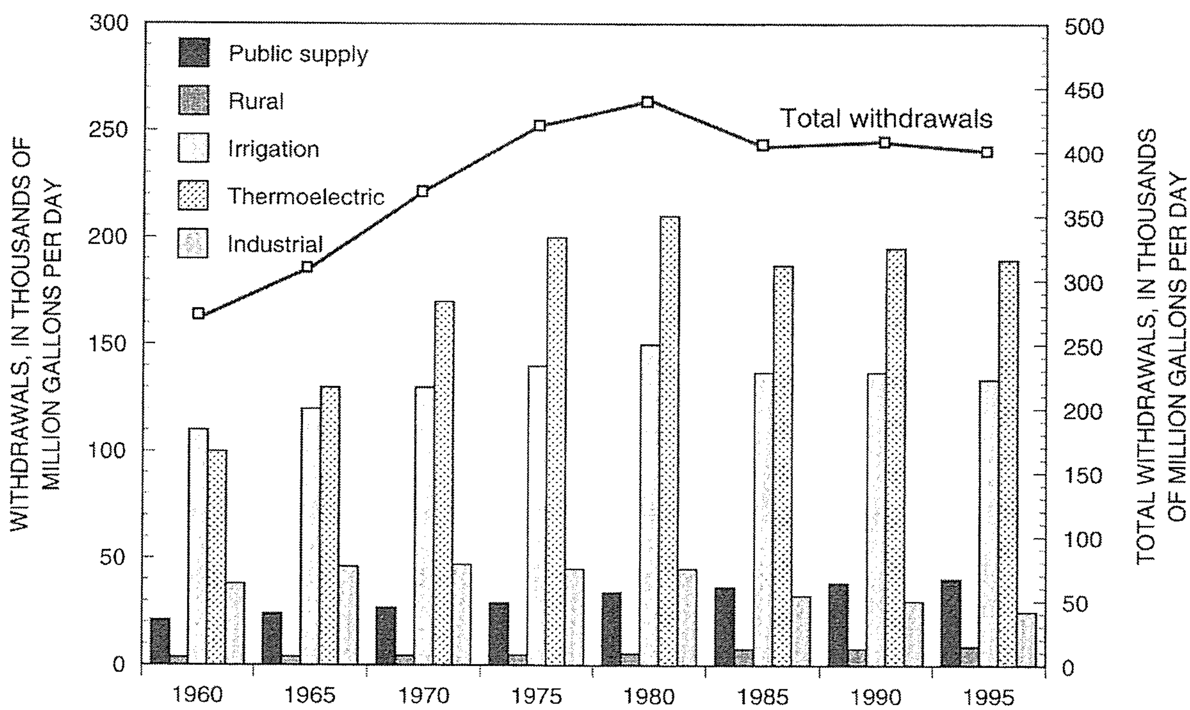


Figure 34. Trends in water withdrawals (fresh and saline) by water-use category and total (fresh and saline) withdrawals, 1960-95.

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BEFORE THE COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAI`I

`Īao Ground Water Management Area High-Level Source Water Use Permit Applications and Petition to Amend Interim Instream Flow Standards of Waihe`e, Waiehu, `Īao, & Waikapū Streams Contested Case Hearing	Case No. CCH-MA-06-01 FOURTH STIPULATION AND ORDER (ORIGINAL STIPULATION FILED AUGUST 30, 2010)

FOURTH STIPULATION AND ORDER

The Parties to the above-entitled contested case, by and through their respective attorneys, hereby stipulate as follows:

WHEREAS, the Commission on Water Resource Management ("Commission") issued its Findings of Fact, Conclusions of Law, and Decision and Order on June 10, 2010 ("6/10/10 D&O"); and

WHEREAS, the 6/10/10 D&O amended the Interim Instream Flow Standards ("IIFS") for Waihe`e River, North Waiehu Stream, and South Waiehu Stream; and

WHEREAS, the 6/10/10 D&O required implementation of the amended IIFS to occur in no more than two months from the date of the 6/10/10 D&O unless the existing diversions require re-engineering; and

WHEREAS, the release of water to Waihe`e River, North Waiehu Stream, and South Waiehu Stream to implement the IIFS commenced on August 9 and 10, 2010; and

WHEREAS, some Parties raised concerns that full implementation of the amended IIFS for South Waiehu Stream would result in certain offstream users who use water from the ditch system on their kuleana lands to cultivate kalo or for other agricultural or domestic purposes ("kuleana users") being harmed due to the loss of or a serious reduction in their water supply; and

WHEREAS, these certain kuleana users did not appear in these proceedings, but have contacted the Parties and the Commission with their concerns about the impacts of implementing the IIFS for South Waiehu Stream on their kuleana water uses; and

WHEREAS, Petitioners HUI O NA WAI 'EHA, MAUI TOMORROW FOUNDATION, INC. and OFFICE OF HAWAIIAN AFFAIRS ("Petitioners") requested the other Parties and the Commission to enter into a series of Stipulations and Orders suspending full implementation of the 6/10/10 D&O with respect to South Waiehu Stream to facilitate the gathering of more data to assess and address the impact on certain kuleana users; and

Exhibit E-R15

WHEREAS, the Petitioners requested the other Parties and the Commission to enter into the Third Stipulation and Order filed on January 3, 2011, which suspended the full implementation of the 6/10/10 D&O with respect to South Waiehu Stream for a period of one year and provided that, during that period (a) the entire flow of South Waiehu Stream would be diverted into the diversion ditch, which would allow Commission staff to gather stream flow data and assure the kuleana users of sufficient water, (b) Hawaiian Commercial and Sugar Company (HC&S) would proceed with the repair of the concrete apron of the South Waiehu Stream diversion structure, and (c) the Parties would continue to explore improvements to the stream and kuleana diversion structures; and

WHEREAS, South Waiehu Stream flow has been measured continuously for eight months, HC&S has completed the concrete apron repair and the Commission staff and Parties conducted a site visit in which they met with the South Waiehu kuleana users and inspected the kuleana 'auwai from its intake in HC&S's ditch to its return flow into South Waiehu Stream; and

WHEREAS, the Commission is currently in the process of determining the appurtenant rights of kuleana users in Nā Wai `Ehā, including South Waiehu Stream, after which it will quantify those rights; and

WHEREAS, the Parties and the Commission staff have met several times and consulted with the South Waiehu kuleana users to discuss improvements to the kuleana intake to make delivery more efficient; and

WHEREAS, the Parties and the Commission staff have discussed a provisional ditch modification to maximize the amount of water diverted from South Waiehu Stream that can be delivered to the kuleana users during low ditch flows, and the kuleana users on the parcel designated as TMK No. 3-3-2-9 have been informed of and approve the ditch modification notwithstanding that they may need to clear the grate of debris more than is currently required; and

WHEREAS, it may be premature to attempt the development of a longer term engineering solution until the appurtenant rights and any associated surface water use permits of the South Waiehu kuleana users are determined and quantified;

NOW, THEREFORE, the Parties stipulate and the Commission orders as follows:

1. Full implementation of the 6/10/10 D&O with respect to South Waiehu Stream shall be suspended until January 3, 2013 (the suspension period);

2. During the suspension period the Parties will undertake measures designed to achieve the delivery of 250,000 gallons per day, during low flow periods, to the kuleana users through the South Waiehu diversion ditch, with stream flow in excess of that amount needed to deliver 250,000 gallons per day during low flow periods to remain in South Waiehu Stream.

3. To implement that goal, as soon as practicable HC&S will modify the diversion ditch as discussed on December 5, 2011, to channel the diverted water in the ditch toward the grate of the kuleana users' intake to minimize the flow that bypasses the grate during periods of low ditch flows(the "ditch modification"). HC&S shall provide the kuleana users, either directly

or through the Parties or Commission staff, with as much advance notice as practicable before the kuleana water is cut off to implement the ditch modification.

4. As soon as practicable after the ditch modification is completed, HC&S, in coordination with the Commission staff, will reset the sluice gate on the South Waiehu diversion structure to a point (the "baseline setting") that will allow sufficient water to enter the diversion ditch to result in approximately 250,000 gallons per day being delivered to the kuleana intake during periods of low stream flows, and the remainder being returned to the stream.

5. The baseline setting shall be maintained during the suspension period subject to temporary adjustments as may be necessary to facilitate system maintenance and the periodic taking of stream and ditch flow measurements and to otherwise insure that the goal set forth in paragraph 2 hereof is met.

DATED: ~~December 30, 2012.~~ I.M.
December 30, 2011.

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DATED: ~~December 30, 2012.~~ December 30, 2011. JEL

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GOOD CAUSE APPEARING, IT IS SO ORDERED.

WILLIAM J. AILA, JR., Chairperson

WILLIAM D. BALFOUR, JR., Commissioner

SUMNER ERDMAN, Commissioner

NEAL S. FUJIWARA, Commissioner

LORETTA J. FUDDY, Commissioner

LAWRENCE H. MIIKE, M.D., J.D., Commissioner

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LAWRENCE H. MIIKE, M.D., J.D., Commissioner

COMMISSION ON WATER RESOURCE MANAGEMENT

STATE OF HAWAII

\`Iao Ground Water Management Area ) High-Level Source Water-Use ) Permit Applications and ) Petition to Amend Interim Instream ) Flow Standards of Waihe\`e River) and Waiehu, \`Iao, & Waikapū) Streams Contested Case Hearing)	Case No. CCH-MA06-01

CERTIFICATE OF SERVICE

The undersigned hereby certifies that on this date a copy of the foregoing was served by U.S. mail, postage pre-paid or via State Messenger to the following parties addressed as follows:

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Dated: Honolulu, HI January 3, 2012.

KATHY YODA, Commission on Water Resource Management

MONTHLY GROUND WATER USE - 2007

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	0.0	0.0	19.2	0.0	0.0	139.7	104.1	280.9	0.0	0.0	36.8	0.0	580.8
	7B		0.0	0.0	0.0	0.0	0.0	0.0	14.2	0.0	0.0	0.0	0.0	0.0	14.2

MONTHLY GROUND WATER USE - 2008

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	0.0	12.2
	7B		0.0	0.0	0.0	0.0	0.0	0.0	47.1	0.0	0.0	0.0	0.0	0.0	47.1

MONTHLY GROUND WATER USE - 2009

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	0.0	0.0	0.0	0.0	0.0	301.8	331.4	0.0	57.0	0.0	0.0	0.0	690.1
	7B		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MONTHLY GROUND WATER USE - 2010

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	0.0	0.4	0.0	0.0	10.8	460.3	224.1	544.9	432.9	482.8	0.0	55.5	2211.6
	7B		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

MONTHLY GROUND WATER USE - 2011

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	0.0	337.7	266.4	517.7	413.8	473.8	414.9	112.8	513.9	561.4	371.6	343.0	4327.0
	7B		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2

MONTHLY GROUND WATER USE - 2012

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	371.0	444.2	10.6	0.0	413.1	82.7	473.8	473.8	361.1	159.1	0.0	66.8	2856.2
	7B		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	397.4	464.9	160.0	1033.8

MONTHLY GROUND WATER USE - 2013

WELL	PUMP	STATE #	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL
7	7A	5128-02	3.9	0.0	0.0	0.0	368.2	523.9	281.0	0.0	315.3	210.3	104.1		
	7B		0.0	0.0	309.3	507.8	60.0	0.0	164.1	332.7	184.2	90.5	87.4		

IIFS releases done on Waihee and North/South Waiehu streams on 8/9 & 10/ 2010

Exhibit E-R16

Well 7 Data

Date	Gage Height in Feet	Pump Running
2/28/2011	3.66'	No
3/29/2011	3.58'	No
3/29/2011	3.40'	Yes -7AC
4/28/2011	2.70'	Yes -7AC
5/31//2011	2.59'	Yes -7AC
6/6/2011	3.43'	No
6/23/2011	3.48'	No
7/18/2011	3.52'	No
7/19/2011	2.70'	Yes -7AC
8/4/2011	2.74'	Yes -7AC
9/17/2011	2.60'	Yes -7AC
10/10/2011	2.68'	Yes -7AC
11/9/2011	2.59'	Yes -7AC
12/6/2011	2.62'	Yes -7AC
1/11/2012	2.62'	Yes -7AC
2/12/2012	2.67'	Yes -7AC
3/5/2012	3.50'	No
4/23/2012	3.76'	No
5/21/2012	2.66'	Yes -7AC
6/8/2012	3.64'	No
7/9/2012	3.60'	No
8/5/2012	2.72'	Yes -7AC
9/10/2012	2.67'	Yes -7AC
10/23/2012	2.68'	Yes -7AC
11/9/2012	2.06'	Yes -7BD
12/12/2012	3.62'	No
1/10/2013	3.66'	No
2/7/2013	3.70'	No
3/11/2013	2.10'	Yes -7BD
4/20/2013	1.88'	Yes -7BD
5/28/2013	2.61'	Yes -7AC
6/12/2013	3.34'	No
6/17/2013	2.76'	Yes -7AC
7/1/2013	2.74'	Yes -7AC
7/15/2013	2.71'	Yes -7AC
9/19/2013	2.74'	Yes -7AC
9/24/2013		Yes -7AC

Exhibit E-R17

10/23/2013		Yes -7AC
10/27/2013	2.66'	Yes -7AC
11/6/2013		Yes -7AC
11/9/2013	2.55'	Yes 7BD

Chlorides ug/ml (ppm)
260.09
263.38
292.15
292.15
250.72
245.02
294.92
289.81
323.38
295.40
291.60
279.0
285.0
290.0
311.0
320.0
330.0
296.0
300.0
375.2
285.3
347.4
345.0

369.1
333.3

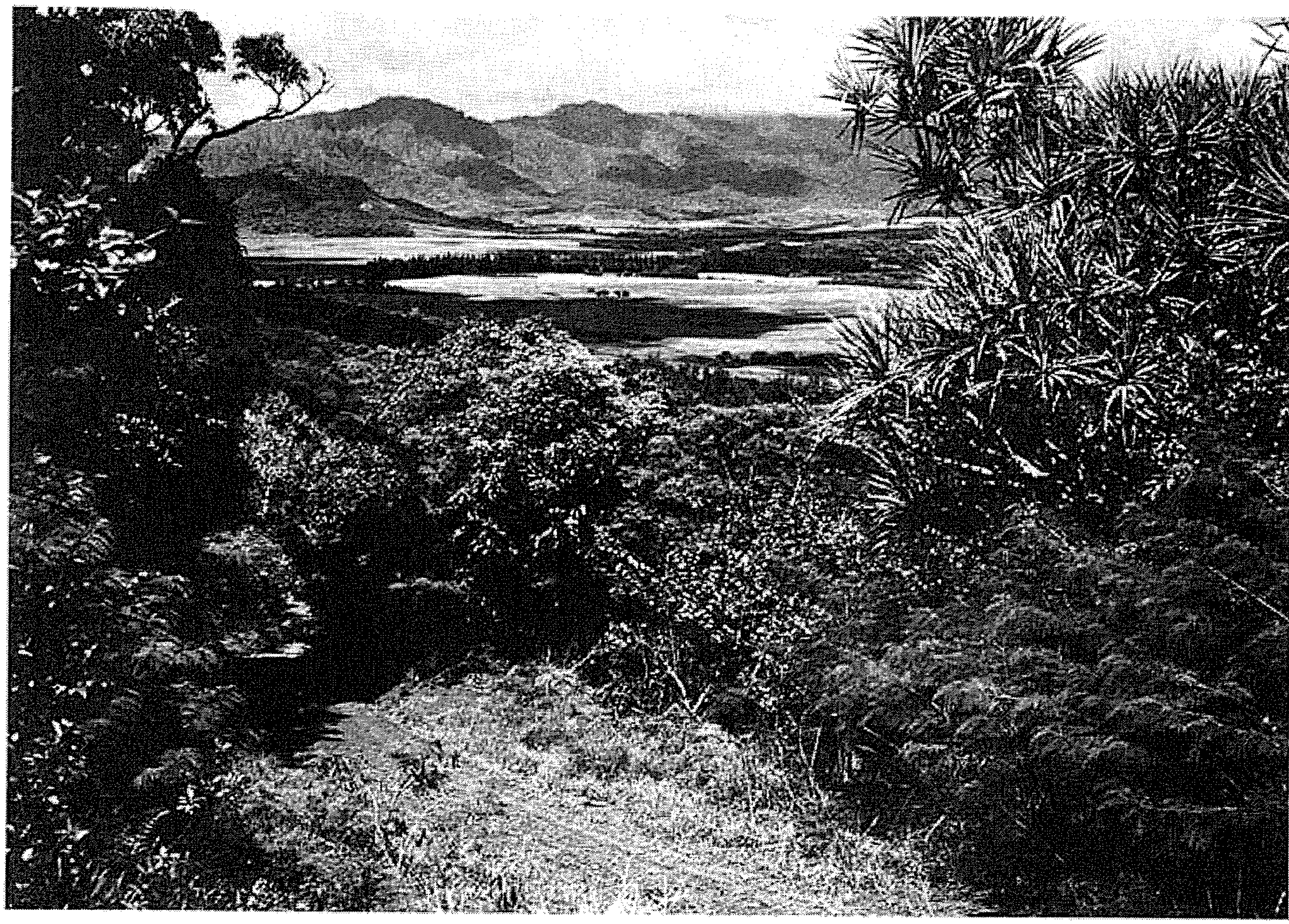
Exhibit E-R18

Exhibit E-R19

Exhibit E-R20

SOIL SURVEY OF

Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii



United States Department of Agriculture
Soil Conservation Service
in cooperation with
The University of Hawaii
Agricultural Experiment Station

Issued August 1972

Exhibit E-R21

Major fieldwork for this soil survey was completed in 1965. Soil names and descriptions were approved in 1967. Unless otherwise indicated, statements in the publication refer to conditions on the islands in 1965. This survey was made cooperatively by the Soil Conservation Service and The University of Hawaii Agricultural Experiment Station. It was part of the technical assistance furnished to the nine Soil and Water Conservation Districts on the islands.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased, on individual order, from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the suitability of tracts of land for farming, ranching, industry, or community development.

Locating Soils

All the soils on the islands of Kauai, Oahu, Maui, Molokai, and Lanai are shown on the detailed map at the back of this survey. This map consists of many sheets that are made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in this publication. This guide lists all of the soils on the islands in alphabetic order by map symbol. It shows the page where each kind of soil is described, the classification of the soil by capability class and subclass, and also the page for the sugarcane group, the pineapple group, the pasture group, and the woodland group in which the soil has been placed.

Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with them can learn about use and management of the soils from the soil descriptions and from the discussions of the sugarcane groups, the pineapple groups, the pasture groups, and the woodland groups.

Ranchers and others interested in pasture can find under "Pasture Management," information about the suitability of the soils for pasture and the kind of plants that grow on the islands.

Foresters and others can refer to "Woodland Management" to learn about the suitability of the soils for trees.

Engineers and builders will find under "Engineering Uses of the Soils," tables that describe soil properties that affect engineering and show the relative stability of the soil for specific engineering purposes.

Scientists and others can read about how the soils are classified and how they formed in the section "Classification, Genesis, and Morphology of the Soils."

Newcomers on the islands may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the Islands" where history, geography, climate, and other general information are given.

Cover picture: **Mt. Kahili forms backdrop for part of fertile, green grazing paddocks on island of Kauai. Steep mountain slopes are maintained in tree and shrub cover for soil protection. Grazing paddocks are Puhi silty clay loams. Steep slopes are Rough broken land.**

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Contents

Issued August 1972

SOIL SURVEY OF THE ISLANDS OF KAUAI, OAHU, MAUI, MOLOKAI, AND LANAI, STATE OF HAWAII

BY DONALD E. FOOTE, ELMER L. HILL, SAKUICHI NAKAMURA, AND FLOYD STEPHENS, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY DONALD E. FOOTE, CARL W. GURNSEY, ELMER L. HILL, BURTON R. LAUX, ROBERT C. MALMGREN, SAKUICHI NAKAMURA, GEORGE OTT, ERNEST ROBELLO, JR., FLOYD E. STEPHENS, AND DURWARD W. WOMACK, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE UNIVERSITY OF HAWAII AGRICULTURAL EXPERIMENT STATION

KAUAI, OAHU, MAUI, MOLOKAI, and LANAI—five of the eight major islands in the State of Hawaii—make up the survey area (fig. 1). The Hawaiian Islands, the 50th State of the United States, lie in the Pacific Ocean about 2,100 miles west southwest of San Francisco, California. Honolulu, on the island of Oahu is the principal city and the State capital. It is on the crossroads of the Pacific and serves as a gateway to Asia and the South Pacific.

The area surveyed covers 1,463,820 acres, or 2,287 square miles. The total land area of Kauai is 355,000 acres, or 555 square miles; Oahu 386,500 acres, or 604 square miles;

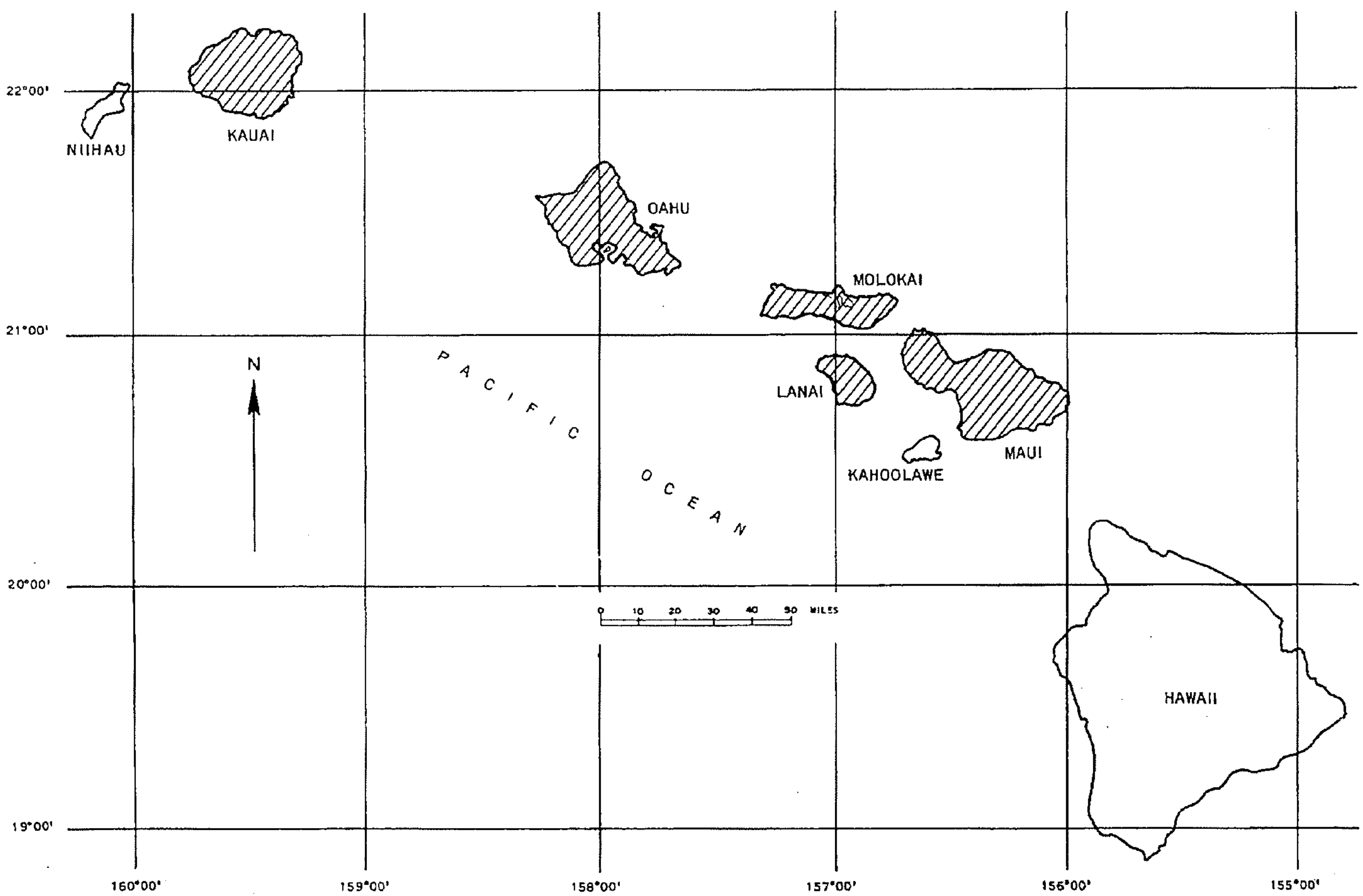

Figure 1.—Location of the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii.

Maui 465,920 acres, or 728 square miles; Molokai 166,400 acres, or 260 square miles; and Lanai 90,000 acres, or 140 square miles.

Most of the soils on the islands formed in volcanic material. A few formed in organic material and coral sand. The climate is characterized by mild temperatures. Annual rainfall, most of which occurs during the period October to April, ranges from 10 inches to more than 400 inches.

The economy of the islands depends mainly on farming and ranching and on tourism. Sugarcane and pineapple are the principal crops. Cattle ranching is the principal livestock industry.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are on the islands, where they are located, and how they can be used. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those on other islands of the United States and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey (*16*).[1]

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Molokai and Lahaina, for example, are the names of two soil series. All the soils of the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Molokai silty clay loam, 7 to 15 percent slopes, severely eroded, is one of several phases within the Molokai series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of the islands: soil complexes and soil associations.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Kemoo-Badland complex is an example.

A soil association is made up of adjacent soils that occur as areas large enough to be shown individually on the soil map but are shown as one unit because the time and effort of delineating them separately cannot be justified. There is a considerable degree of uniformity in pattern and relative extent of the dominant soils, but the soils may differ greatly one from another. The name of an association consists of the names of the dominant soils, joined by a hyphen. Amalu-Olokui association is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gullied land is a land type on the islands.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm or plantation records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil maps at the back of this survey show, in color, the soil associations on the islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii. A

[1] Italic numbers in parentheses refer to Literature Cited, page 230.

soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils on the Hawaiian Islands, who want to compare different parts of the islands, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The islands of Kauai, Oahu, Maui, Molokai, and Lanai, and the soil associations on each are described in the following pages.

Island of Kauai

Kauai is the northernmost and the fourth largest island in the State. It is 33 miles long and 25 miles wide. The land area is 355,000 acres, or 555 square miles. The island rises to its highest point, 5,170 feet, at Kawaikini Peak, which is near the center of the island. The Kauai volcano is believed to have formed late in the Tertiary period (7). After the completion of the Kauai shield cone, there was a long period of erosion during which no volcanic activity occurred. The Koloa volcanics occurred later and covered many of the eroded areas. Waves cut high cliffs around the island and streams cut deep canyons. The north and central parts of the islands are not easily accessible. They consist chiefly of canyons and steep mountain slopes and the Alakai swamp.

Nearly all the farm and ranch land and the populated areas on the island are on the low uplands along the coast. These low coastal uplands circle the island except for part of the northwest coast.

Because of its lush vegetation and beautiful mountains, Kauai is commonly referred to as the Garden Island. Lihue is the population, business, and cultural center. It has an airport. Nawiliwili and Hanapepe have deep-water harbors.

Two of the island's three pineapple canneries were closed in recent years. Some of the abandoned pineapple land is used for sugarcane, some for pasture, and some for papayas.

During the last few years, hotels have been built in the Wailua, Nawiliwili, and Poipu areas to accommodate the increasing number of tourists.

1. Jaucas-Mokuleia association

Deep, nearly level to moderately sloping, excessively drained and well-drained soils that have coarse-textured underlying material; on coastal plains

This association consists of excessively drained and well-drained soils in dunes and on former beach areas on the island of Kauai. These soils are nearly level to moderately sloping. They developed in coral or basaltic sand. The association makes up about 1 percent of the island.

The elevation ranges from near sea level to 150 feet. The annual rainfall is 20 to 100 inches. The mean annual soil temperature is 74° or 75° F. The natural vegetation is kiawe, klu, feather fingergrass, sandbur, koa haole, and bermudagrass.

Jaucas soils make up about 60 percent of the association and Mokuleia soils 25 percent. Dune land and Jaucas soils, dark variant, make up the rest.

Jaucas soils have a surface layer of pale-brown to grayish-brown, very friable loamy fine sand to sand. The substratum is light-colored loose sand. Mokuleia soils have a surface layer of very dark-brown, friable fine sandy loam. The substratum is dark-brown to dark grayish-brown, loose fine sand to sand.

This association is used for irrigated sugarcane, irrigated alfalfa, pasture, and wildlife habitat. Mokuleia and Jaucas soils are used mainly for pasture. Irrigated areas of Jaucas soils are used for sugarcane and alfalfa. Jaucas soils are also used as a source of sand. Upland game birds are the principal kinds of wildlife.

2. Hanalei-Kolokolo-Pakala association

Deep, nearly level, poorly drained to well-drained soils that have dominantly moderately fine textured or medium-textured subsoil or underlying material; on bottom land

This association consists of poorly drained to well-drained soils on bottom land on the island of Kauai. These soils are nearly level. They developed in alluvium. The association makes up about 2 percent of the island.

The elevation ranges from near sea level to 500 feet. The annual rainfall is 25 to 150 inches. The mean annual soil temperature is about 74° F. The natural vegetation is koa haole, kiawe, bermudagrass, mango, californiagrass, sensitiveplant, honohono, java plum, pangolagrass, kikuyugrass, guava, pandanus, glenwoodgrass, ricegrass, and hau.

Hanalei soils make up about 45 percent of the association, Kolokolo soils 25 percent, and Pakala soils 20 percent. Mokuleia soils, poorly drained variant, make up the rest.

Hanalei soils have a surface layer of mottled dark grayish-brown to mottled very dark gray, firm silty clay, silty clay loam, or peaty silty clay loam. Their subsoil is mottled, dark-gray to dark grayish-brown, firm silty clay or silty clay loam. The substratum is stratified alluvium. Kolokolo soils have a surface layer of very dark brown, friable silty clay loam, loam, or extremely stony clay loam. This layer is underlain by brown to very dark-brown, friable loam to silty clay loam. The substratum is stratified alluvium. Pakala soils have a surface layer of dark reddish-brown, firm clay loam or extremely stony clay loam. Below this is very dusky red to dark reddish-brown, very friable very fine sandy loam to silt loam. The substratum is stratified alluvium.

This association is used for irrigated sugarcane, irrigated taro, irrigated truck crops, pasture, and wildlife habitat. All of the soils are used for pasture. Irrigated areas of Hanalei and Pakala soils are used for sugarcane and truck crops. Hanalei soils are also used for taro.

Upland game birds make up most of the wildlife population.

3. *Kekaha-Nohili association*

Deep, nearly level, well-drained and poorly drained soils that have a fine-textured subsoil; on coastal plains

This association consists of well-drained and poorly drained, medium-textured to very fine textured soils on the Mana coastal plain on the island of Kauai. These soils are nearly level. They developed in alluvium. The association makes up about 2 percent of the island.

The elevation ranges from near sea level to 80 feet. The annual rainfall is 20 to 23 inches. The mean annual soil temperature is about 75° F. The natural vegetation is koa haole, kiawe, klu, and fingergrass.

Kekaha soils make up about 45 percent of the association and Nohili soils 15 percent. Fill land and Kaloko, Lualualei, and Mamala soils make up the rest.

Kekaha soils have a surface layer of dark reddish-brown, friable silty clay, clay, or extremely stony silty clay loam. The subsoil is dark reddish-brown, firm silty clay or clay. The substratum is stratified alluvium and marine clay. Nohili soils have a surface layer of dark reddish-brown, firm clay and a subsoil of dark-brown to very dark-gray, mottled, firm clay. The substratum is marly clay.

This association is used for irrigated sugarcane, irrigated truck crops, and pasture. Sugarcane is the chief crop and is grown on all of the soils. Extremely stony phases of Kekaha soils are used for pasture. Nohili soils require drainage.

4. *Kapaa-Pooku-Halii-Makapili association*

Deep, nearly level to steep, well drained and moderately well drained soils that have a fine textured or moderately fine textured subsoil; on uplands

This association consists of well drained and moderately well drained, fine-textured soils on the uplands of East Kauai. These soils are nearly level to steep. They developed in material weathered from basic igneous rock. The association makes up about 10 percent of the island.

The elevation ranges from 100 to 1,000 feet. The annual rainfall is 70 to 200 inches. The mean annual soil temperature is between 72° and 74° F. The natural vegetation is melastoma, rhodomyrtus, guava, ricegrass, hilograss, yellow foxtail, Christmas berry, false staghorn-fern, pangolagrass, kikuyugrass, kaimiclover, sensitive-plant, java plum, and joee.

Kapaa soils make up about 40 percent of the association, Pooku soils 25 percent, Halii soils 20 percent, and Makapili soils 5 percent. Rough broken land and other soils make up the rest.

Kapaa soils have a surface layer of dark-brown to dark yellowish-brown, friable silty clay. The subsoil is yellowish-red to reddish-brown, friable silty clay and clay loam. The substratum is soft, weathered basic igneous rock. Pooku soils have a surface layer of dark-brown to dark yellowish-brown, friable silty clay. The subsoil is a dark-red to dark reddish-brown, friable silty clay loam to silty clay. The substratum is soft, weathered basic igneous rock. Halii soils have a surface layer of very dark grayish-brown, friable gravelly silty clay loam to gravelly silty clay and a subsoil of dark reddish-brown to dark-brown, friable clay loam to silty clay. The substratum is soft, weathered basic igneous rock. Makapili soils have a surface layer of dark-brown to very dark grayish-brown, friable silty clay and a subsoil of dark reddish-brown, firm clay loam to silty clay. The substratum is soft, weathered basic igneous rock.

This association is used for sugarcane, pasture, pineapple, woodland, wildlife habitat, and water supply. Pooku and Makapili soils are used mainly for pasture, Kapaa soils for sugarcane, and Halii soils for water supply. Upland game birds and wild pigs are the principal kinds of wildlife.

5. *Lihue-Puhi association*

Deep, nearly level to steep, well-drained soils that have a fine textured or moderately fine textured subsoil; on uplands

This association consists of well-drained, medium-textured and fine-textured soils on the uplands of South and East Kauai. These soils are nearly level to steep. They developed in material weathered from basic igneous rock. The association makes up about 12 percent of the island.

The elevation ranges from near sea level to 800 feet. The annual rainfall is 40 to 80 inches. The mean annual soil temperature is about 73° F. The natural vegetation is guava, java plum, pangolagrass, kikuyugrass, elephantopus, joee, yellow foxtail, rhodomyrtus, lantana, koa haole, molassesgrass, guineagrass, and bermudagrass.

Lihue soils make up about 40 percent of the association and Puhi soils 35 percent. Ioleau, Koloa, and other soils, and areas of Rough broken land make up the rest.

Lihue soils have a surface layer of dusky-red to dark reddish-brown, firm to friable silty clay. The subsoil is dark-red to dark reddish-brown, firm silty clay. The substratum is soft, weathered basic igneous rock. Puhi soils have a surface layer of brown to very dark-brown, friable silty clay loam. The subsoil is reddish-brown to dark-brown, friable silty clay loam and silty clay. The substratum is soft, weathered basic igneous rock.

This association is used for irrigated sugarcane, pineapple, pasture, woodland, and wildlife habitat. Sugarcane is the main crop. Upland game birds make up most of the wildlife population.

6. *Makaweli-Waiawa-Niu association*

Deep, gently sloping to steep, well-drained soils that have a dominantly moderately fine textured or fine textured subsoil and shallow, steep and very steep, well-drained soils over basalt bedrock; on uplands

This association consists of well-drained, moderately fine textured and fine textured soils on the uplands of South and West Kauai. These soils are gently sloping to very steep. They developed in material weathered from basic igneous rock. The association makes up about 9 percent of the island.

The elevation ranges from near sea level to 2,000 feet. The annual rainfall is 20 to 40 inches. The mean annual soil temperature is between 69° and 74° F. The natural vegetation is kiawe, lantana, fingergrass, klu, koa haole, piligrass, aalii, guineagrass, indigo, and cactus.

Makaweli soils make up about 45 percent of the association, Waiawa soils 30 percent, and Niu soils 10 percent. Rough broken land and other soils make up the rest.

Makaweli soils have a surface layer of dusky-red to dark reddish-brown, friable silty clay loam or stony silty clay loam. The subsoil is dusky-red, friable silt loam and silty clay loam. The substratum is soft, weathered basic igneous rock that in places contains hard boulders. Waiawa soils have a surface layer of dark reddish-brown, very firm very rocky clay loam or very rocky clay. This layer is underlain by hard basic igneous rock. Niu soils have a surface layer of dusky-red to dark reddish-brown, friable silty clay loam to silty clay. The subsoil is dark-red, friable silty clay loam or silty clay. The substratum is soft, weathered basic igneous rock.

This association is used for irrigated sugarcane, pasture, woodland, and wildlife habitat. Makaweli and Niu soils are used mainly for sugarcane. A small acreage of Makaweli soils is used for irrigated pasture. Waiawa soils are used only for pasture. Upland game birds, wild pigs, and wild goats are the principal kinds of wildlife.

7. Waikomo-Kalihi-Koloa association

Moderately deep, gently sloping, well-drained upland soils that have a moderately fine textured or fine textured subsoil; deep, nearly level, poorly drained, bottom-land soils that have a fine-textured subsoil

This association consists of well-drained, fine-textured soils that developed in material weathered from basic igneous rock and poorly drained, very fine-textured soils that developed in alluvium. These soils are gently sloping to nearly level and are on the uplands and bottom lands of Southeast Kauai. The association makes up about 2 percent of the island.

The elevation ranges from near sea level to 360 feet. The annual rainfall is 35 to 60 inches. The mean annual soil temperature is between 72° and 74° F. The natural vegetation is lantana, koa haole, java plum, cactus, swollen fingergrass, bermudagrass, and guineagrass.

Waikomo soils make up about 70 percent of the association, Kalihi soils 20 percent, and Koloa soils 10 percent.

Waikomo soils have a surface layer of dark-brown to very dark grayish-brown, very firm stony silty clay. The subsoil is reddish-brown to dark yellowish-brown, firm heavy silty clay loam. The substratum is hard basic igneous rock. Kalihi soils have a surface layer of very dark-gray to mottled dark-brown, firm clay. The subsoil is dark-gray, mottled, firm clay. The substratum is grayish-brown and dark-gray, firm clay. Koloa soils have a surface layer of dark reddish-brown, firm stony silty clay. The subsoil is dusky-red to dark reddish-brown, firm silty clay. The substratum is hard rock.

This association is used for irrigated sugarcane, pasture, and wildlife habitat. Sugarcane is the chief crop and is grown on all the soils. Pasture is grown only on Waikomo soils. Upland game birds are the principal kinds of wildlife.

8. Rough broken land-Mahana-Kokee association

Shallow to deep, very steep, rough broken land and deep, moderately sloping to very steep, well-drained soils that have a medium-textured to fine-textured subsoil; on uplands

This association consists of well-drained, medium-textured and fine-textured soils on the uplands of South and West Kauai. These soils are moderately sloping to very steep. They developed in material weathered from volcanic ash and basic igneous rock. The association makes up about 9 percent of the island.

The elevation ranges from 1,500 to 4,200 feet. The annual rainfall is 30 to 70 inches. The mean annual soil temperature is between 58° and 66° F. The natural vegetation is ohia lehua, pukiawe, blackberry, yellow foxtail, koa, plantain, uki uki, redwood, aalii, ricegrass, molassesgrass, silver oak, lantana, joee, Japanese tea, passion flower, Boston fern, and uki.

Rough broken land makes up about 35 percent of the association, Mahana soils 20 percent, and Kokee soils 20 percent. Oli, Paaiki, and Puu Opae soils make up the remaining 25 percent.

Rough broken land is very steep. The soil material ranges from very shallow to deep over hard, weathered basic igneous rock.

Mahana soils have a surface layer of dusky-red to dark reddish-brown, friable loam to silty clay loam. The subsoil is dark-red to dusky-red, very friable very fine sandy loam to silty clay loam. The substratum is soft, weathered basic igneous rock. Kokee soils have a surface layer of dark-brown to very dark brown, friable silty clay loam. The subsoil is strong-brown to dark yellowish-brown, friable silty clay loam to silty clay. The substratum is hard and soft, weathered basic igneous rock.

This association is used for pasture, woodland, wildlife habitat, water supply, and irrigated sugarcane. Mahana soils are used chiefly for pasture. Small acreages are irrigated and are in sugarcane. Kokee soils are used chiefly for woodland. Upland game birds, wild pigs, wild goats, and deer are the principal kinds of wildlife.

9. Waialeale-Alakai association

Moderately deep, very steep, somewhat poorly drained soils that have a moderately fine textured subsoil and level to moderately steep, very poorly drained organic soils over fine-textured material; on uplands

This association consists of somewhat poorly drained to very poorly drained, organic soils on the uplands of Central Kauai. These soils are level to very steep. They developed in organic debris deposited on basic igneous rock. The association makes up about 3 percent of the island.

The elevation ranges from 3,500 to 5,000 feet. The annual rainfall is 100 to 450 inches. The mean annual soil temperature is between 56° and 59° F. The natural vegetation is ohia lehua, Hawaiian lobelia, mokihana, pukiawe, treefern, lapalapa, brackenfern, and uki uki.

Waialeale soils make up about 50 percent of the association and Alakai soils 35 percent. Rough broken land makes up the rest.

Waialeale soils have a surface layer of dark reddish-brown, friable mucky peat. The subsoil is dark-brown to strong-brown, friable gravelly silty clay loam. The substratum is hard, weathered basic igneous rock. Alakai soils have a surface layer of dark reddish-brown to very dusky-red, friable mucky peat. Below this is black, friable muck, and below the muck, gray to greenish-gray, firm clay.

This association is used for water supply and wildlife habitat. Wild goats and wild pigs are the chief kinds of wildlife.

10. Rough mountainous land-Rough broken land-Rock outcrop association

Well-drained to excessively drained, very steep to precipitous lands of mountains and gulches

This association consists of well-drained to excessively drained land types on uplands on the island of Kauai. The areas are very steep to precipitous. The association makes up about 50 percent of the island.

The elevation ranges from near sea level to 5,170 feet. The annual rainfall amounts to as little as 22 inches in leeward lowlands and as much as 450 inches over windward slopes of Mt. Waialeale. The mean annual soil temperature is between 56° and 74° F. The natural vegetation is false staghornfern, ohia lehua, java plum, kiawe, and koa haole.

Rough mountainous land makes up about 45 percent of the association, Rough broken land 30 percent, and Rock outcrop 25 percent.

Rough mountainous land is very steep. In most places elevations exceed 500 feet. The soil material is generally shallow over hard, weathered basic igneous rock. Rough broken land is very steep. The soil material is very shallow to deep over hard, weathered basic igneous rock. Rock outcrop is more than 90 percent bedrock. It occurs on very steep slopes or on precipitous cliffs.

This association is used for water supply, pasture, woodland, and wildlife habitat. Rough mountainous land and Rock outcrop serve mainly as watershed. Upland game birds, wild goats, and wild pigs are the principal kinds of wildlife.

Island of Oahu

Oahu, the third largest island in the State, is 44 miles long and 30 miles wide. The land area is 386,560 acres, or 604 square miles. The island is divided into four main areas—the Waianae Range, the Koolau Range, the Schofield Plateau, and the coastal plains.

The Waianae Range, on the western part of the island, is about 22 miles long. It is rough and mountainous and has narrow ridges and very steep slopes. It rises to 4,025 feet, which is the highest point on the island.

The Koolau Range, on the eastern part of the island, is 37 miles long. It is deeply dissected by numerous drainageways. Along the northern side is a sheer cliff that rises from the ocean's edge to a height of as much as 2,500 feet.

The Schofield Plateau lies between the two mountain ranges. The soils on the plateau are well suited to cultivation, and a large acreage is used for sugarcane and pineapple.

The coastal plains adjacent to the ocean formed from coral reefs and alluvial sediments. They have smooth, gentle slopes. They are used mostly for farming and ranching or for urban development. There are several volcanic cones, such as Diamond Head, Salt Lake Crater, and Punchbowl, near Honolulu.

An important source of water supply is an exceptional lens of basal ground water in the Honolulu-Pearl Harbor area. Smaller accumulations of basal ground water occur in other parts of the island. Another important source of water on Oahu is the high-level ground water that is confined between lava dikes. The supply of ground water is replenished by abundant rainfall in the mountainous areas.

Honolulu, the principal city on Oahu, is the business, cultural, and political center of the State of Hawaii. More than four-fifths of the population of Hawaii lives on Oahu. This is the only island where farming and ranching are not the major economic activities. The visitor industry and federal expenditures exceed the production of pineapple and sugar as the top sources of income.

1. Lualualei-Fill land-Ewa association

Deep, nearly level to moderately sloping, well-drained soils that have a fine textured or moderately fine textured subsoil or underlying material, and areas of fill land; on coastal plains

This association consists of well-drained, fine textured and moderately fine textured soils on fans and in drainageways on the southern and western coastal plains on the island of Oahu. The soils are nearly level to moderately sloping. They formed in alluvium. The areas of Fill land consist of many kinds of material. The association makes up about 14 percent of the island.

The elevation ranges from sea level to 400 feet. The annual rainfall is 15 to 30 inches in most places but is as much as 50 inches in some of the valleys. Most of the rain falls between November and April. Summers are hot and dry. The mean annual soil temperature is between 73° and 75° F. The natural vegetation is kiawe, koa haole, and fingergrass.

Lualualei soils make up about 20 percent of the association, Fill land about 20 percent, and Ewa soils 15 percent. Honouliuli, Jaucas, Kawaihapai, Makalapa, Mamala, and Pulehu soils make up the rest.

Lualualei soils have a surface layer of very dark grayish-brown, very sticky and very plastic clay that cracks widely upon drying. They are underlain by coral, gravel, sand, or clay at a depth below 40 inches. Fill land consists of various kinds of fill material. Ewa soils have a surface layer and subsoil of dark reddish-brown, friable silty clay loam. The substratum is gravelly alluvium or coral limestone.

This association is used for sugarcane, truck crops, pasture, and urban development. Fill land is used mainly for airports and industrial and homesites. Areas that have been built up from mill wastes are used for sugarcane.

2. Helemano-Wahiawa association

Deep, nearly level to moderately sloping, well-drained soils that have a fine-textured subsoil; on uplands

This association consists of well-drained, moderately fine textured and fine textured soils on uplands on the island of Oahu. These soils are nearly level to moderately sloping and occur in broad areas dissected by very steep gulches. They formed in material weathered from basalt. The association makes up about 18 percent of the island.

The elevation ranges from 100 to 1,200 feet. The annual rainfall is 25 to 50 inches in most areas but is as much as 60 inches in some. Most of it falls in winter. The mean annual soil temperature is between 71° and 73° F. The natural vegetation is guava, koa haole, lantana, joee, and bermudagrass.

Helemano soils make up about 40 percent of the association, and Wahiawa soils 30 percent. Kunia, Lahaina, and Molokai soils make up the rest.

Helemano soils are dark reddish-brown silty clays. They occur on the sides of very steep gulches and have slopes of 30 to 90 percent. Wahiawa soils have a surface layer of very dusky red silty clay, a subsoil of dark reddish-brown silty clay, and a substratum of soft weathered rock. They are on uplands and have slopes of 0 to 25 percent.

Helemano soils are used for pasture. Large acreages of Wahiawa soils are used for sugarcane and pineapple. Sugarcane is grown under irrigation. Pineapple is irrigated only in the driest areas.

3. *Tropohumults-Dystrandepts association*

Gently sloping to very steep, well-drained soils that are underlain by soft weathered rock, volcanic ash, or colluvium; on narrow ridges and side slopes

This association consists of the mountainous areas and lower slopes of the Waianae Range on the island of Oahu. The soils are gently sloping to very steep, well drained, and fine textured to moderately fine textured. The association makes up about 8 percent of the island.

The elevation ranges from 600 to 4,000 feet. The annual rainfall is 30 to 75 inches. The mean annual soil temperature is between 56° and 71° F. Lantana, yellow foxtail, molassesgrass, and Japanese tea grow at the lower elevations, and ohia lehua, pukiawe, koa, aalii, and ferns at the upper elevations.

Tropohumults and Dystrandepts make up about 55 percent of the association. The rest is made up of Mahana, Kolekole, Halawa, Helemano, and Alakai soils and areas of Rock land, Rock outcrop, and Stony land.

Tropohumults occur on the narrow ridges at the upper elevations. They have a surface layer and subsoil of reddish-brown silty clay. They are underlain by soft weathered rock. Dystrandepts occur in concave positions on the steep side slopes. They were derived dominantly from volcanic ash mixed with colluvium. They are dark colored and have a surface layer of silt loam or silty clay loam. Their subsoil is massive.

Most of this association is very steep and inaccessible. It is used mainly for watershed. Some of the minor soils are used for woodland and pasture, and some for pineapple and sugarcane.

4. *Rough mountainous land-Kapaa association*

Very steep land broken by numerous drainageways and deep, well-drained soils that have a fine textured or moderately fine textured subsoil; in gullies and on narrow ridges

This association consists of very steep land broken by numerous drainageways. It occurs on Oahu and makes up about 20 percent of the island.

The elevation ranges from 1,000 to 3,000 feet. Rainfall is fairly well distributed throughout the year. The annual amount ranges from 70 inches at the lowest elevations to 250 inches near the mountain summit. The mean annual soil temperature is between 60° and 71° F. The natural vegetation is ohio lehua, koa, treefern, false staghorn, fern, hilograss, and sedges.

Rough mountainous land makes up about 80 percent of the association and Kapaa soils about 15 percent. Rock land and Rock outcrop make up the rest.

Rough mountainous land consists of very steep gulches and narrow ridges. The soil material is very shallow, very dark grayish-brown, smeary silty clay. Kapaa soils are in very steep gulches and on narrow ridges at the northern end of the island. They have a surface layer and subsoil of dark reddish-brown silty clay that contains gibbsite nodules.

This association is inaccessible except for a few trails used by hunters and hikers. It is used for watershed and wildlife habitat. Gently sloping areas of Kapaa soils are suited to timber. The heavy rainfall is an important factor in recharging the supply of ground water. The most important wildlife species is wild pigs.

5. *Rock land-Stony steep land association*

Steep to precipitous, well-drained to excessively drained, rocky and stony land

This association consists of stony and rocky, steep to precipitous slopes. It occurs on Oahu and makes up about 15 percent of the island.

The elevation ranges from sea level to 2,800 feet. The annual rainfall is 15 to 50 inches in most areas but is as much as 200 inches along the windward cliffs of the Koolau Range. The mean annual soil temperature is between 67° and 75° F. Kiawe, buffelgrass, and fingergrasses grow in the drier areas, and ohia lehua, ferns, and sedges in the wetter areas.

Rock land makes up about 60 percent of the association, and Stony steep land 15 percent. Rock outcrop, Stony land, and areas of Kawaihapai, Lualualei, and Pulehu soils make up the rest.

Rock land is 25 to 90 percent rock outcrop. It is very steep and occurs in gulches and on mountainsides. The soil material is very shallow. Stony steep land is a mass of boulders and stones deposited by water or gravity in valley bottoms or on side slopes of drainageways. Slopes are very steep.

This association is used mainly for pasture, wildlife habitat, and recreation. Some areas are used for homesites. Upland game birds and wild pigs are the principal kinds of wildlife.

6. *Kaena-Waialua association*

Deep, mainly nearly level and gently sloping, poorly drained to excessively drained soils that have a fine-textured to coarse-textured subsoil or underlying material; on coastal plains and talus slopes and in drainageways

This association occurs as a narrow band along the northern and eastern coastline on the island of Oahu. The soils occur in drainageways, on coastal plains, and on talus slopes. They are nearly level and gently sloping for the most part but are steeper on talus slopes. They formed in alluvium and vary widely in texture and drainage. The association makes up about 10 percent of the island.

The elevation ranges from sea level to 200 feet. The annual rainfall is generally 30 to 45 inches but ranges from 20 to 80 inches. Most of the rain falls in winter. Summer showers are common. The mean annual soil temperature is about 74° F. Kiawe, koa haole, and fingergrasses grow in the drier areas, and guava, java plum, and californiagrass in the wetter areas.

Kaena and Waialua soils make up about 50 percent of the association. Hanalei, Kawaihapai, Jaucas, Haleiwa, Kaloko, Keaau, Mokuleia, Pearl Harbor, and Pulehu soils, and areas of Coral outcrop and Marsh make up the rest.

Kaena soils are poorly drained, dark-colored silty clays or clays underlain by alluvium. Waialua soils are moderately well drained, dark reddish-brown silty clays or clays underlain by alluvium.

This association is used for sugarcane, truck crops, pasture, orchard, recreation, and urban development. Kaena soils need to be drained before they can be cultivated.

7. Lolekaa-Waikane association

Deep, nearly level to very steep, well-drained soils that have a dominantly fine-textured subsoil; on fans, terraces, and uplands

This association consists of well-drained, fine textured and moderately fine textured soils on uplands, fans, and terraces on the island of Oahu. These soils are nearly level to very steep. They formed in old alluvium and material weathered from basic igneous rock. The association makes up about 15 percent of the island.

The elevation ranges from near sea level to 1,500 feet. Rainfall is fairly well distributed throughout the year. The annual amount is 40 to 90 inches. The mean annual soil temperature is between 70° and 73° F. The natural vegetation is guava, java plum, hilograss, and ricegrass.

Lolekaa soils make up 20 percent of the association and Waikane soils about 20 percent. Paumalu, Kemoo, Leilehua, Alaeloa, Kaneohe, Paaloa, Pohakupu, and Manana soils make up the rest.

Lolekaa soils have a surface layer of dark-brown silty clay and a dominantly silty clay subsoil. Their substratum is gravelly alluvium. Waikane soils have a surface layer of dark-brown silty clay and a subsoil of dark reddish-brown silty clay. Their substratum is gravelly alluvium.

This association is used mainly for pasture. Small areas are used for homesites, truck crops, and orchard crops. Areas of the minor soils in the association are used for sugarcane and pineapple. The potential for timber is high.

Island of Maui

Maui, the second largest island in the State, is 48 miles long and 26 miles wide. The land area is 465,920 acres, or 728 square miles. The island formed through the merging of two volcanoes—the East Maui volcano, or Haleakala, and the West Maui volcano. It is divided into three main areas—West Maui, East Maui, and Central Maui, or the isthmus.

West Maui is a deeply dissected volcano that rises to 5,788 feet at Puu Kukui. The central part of West Maui consists of canyons and steep ridges and is not easily accessible. It is surrounded by a moderately sloping, smooth narrow belt. There are a few gulches.

East Maui is dominated by the 10,025-foot Haleakala volcano. The volcano is dormant. The last eruption was about 1790 (*8*). Near the summit and on the eastern and southwestern slopes, the land is rough and rocky. The western and northern slopes are relatively smooth but are sloping to moderately steep.

Central Maui, the isthmus that connects West and East Maui, is smooth and nearly level. It is used mainly for sugarcane. Much of the isthmus is covered with alluvium.

Rainfall is heavy in the mountainous areas. Basal ground water occurs at the eastern end of East Maui and across the isthmus and along the coast of West Maui. Perched water also occurs on East Maui.

The business activity, the population, and the seat of government are centered in Wailuku and Kahului. Kahului has an airport and a deep-water harbor.

1. Pulehu-Ewa-Jaucas association

Deep, nearly level to moderately sloping, well-drained and excessively drained soils that have a moderately fine textured to coarse-textured subsoil or underlying material; on alluvial fans and in basins

This association consists of well-drained and excessively drained, medium-textured, moderately fine textured, and coarse-textured soils on alluvial fans and in basins on the island of Maui, mainly Central Maui. These soils are nearly level to moderately sloping. They developed in alluvium weathered from basic igneous rock, coral, and seashells. The association makes up about 4 percent of the island.

The elevation ranges from near sea level to 600 feet. The annual rainfall is 10 to 30 inches. The mean annual soil temperature is about 75° F. The natural vegetation is bermudagrass, bristly foxtailgrass, kiawe, and lantana.

Pulehu soils make up about 40 percent of the association, Ewa soils about 15 percent, and Jaucas soils 10 percent. Alae, Iao, Kealia, and Puuone soils make up the rest.

Pulehu soils have a surface layer of dark-brown, friable silt loam. Their substratum is dark-brown and dark yellowish-brown alluvium weathered from basic igneous rock. Ewa soils have a surface layer and subsoil of dark reddish-brown, friable silty clay loam. Their substratum is alluvium weathered from basic igneous rock. Jaucas soils have a pale-brown calcareous sand surface layer. Their substratum is yellowish-brown sand weathered from coral and seashells.

This association is used for sugarcane, truck crops, pasture, wildlife habitat, and homesites. Most of the sugarcane is grown on Ewa, Jaucas, and Pulehu soils. Upland game birds and native water birds are the principal kinds of wildlife.

2. Waiakoa-Keahua-Molokai association

Moderately deep and deep, nearly level to moderately steep, well-drained soils that have a moderately fine textured subsoil; on low uplands

This association consists of well-drained, moderately fine textured soils on low uplands on Central Maui. The soils are nearly level to moderately steep. They formed in material weathered from basic igneous rocks. The association makes up about 15 percent of the island.

The elevation ranges from nearly sea level to 1,500 feet. The annual rainfall is 12 to 25 inches. The mean annual soil temperature is between 73° and 75° F. The natural vegetation is buffelgrass, feather fingergrass, guineagrass, ilima, kiawe, lantana, and uhaloa.

Waiakoa soils make up about 30 percent of the association, Keahua soils about 20 percent, and Molokai soils about 10 percent. The rest of the association consists of Alaeloa, Haliimaile, Kahana, Koele, Lahaina, Paia, Wahikuli, Wailuku, and Wainee soils.

Waiakoa soils have a surface layer of dark reddish-brown, friable silty clay loam. Their subsoil is dark reddish-brown and very dark grayish-brown, friable silty clay loam. They have a substratum of hard, basic igneous rock at a depth of 20 to 40 inches. Keahua soils have a surface layer of dark reddish-brown, friable silty clay loam. Their subsoil is dark reddish-brown, firm silty clay loam. The substratum is soft, weathered basic igneous rock. Molokai soils have a surface layer of dark reddish-brown, friable silty clay loam. Their subsoil is dark-red and dusky-red, friable silty clay loam and clay loam. The substratum is soft, weathered basic igneous rock.

This association is used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. Upland game birds make up most of the wildlife population.

3. Honolua-Olelo association

Deep, gently sloping to moderately steep, well-drained soils that have a fine-textured subsoil; on intermediate uplands

This association consists of well-drained, fine-textured soils on the intermediate uplands of West Maui. These soils are gently sloping to moderately steep. They developed in material weathered from basic igneous rock. The association makes up about 1 percent of the island.

The elevation ranges from 500 to 3,500 feet. The annual rainfall is 30 to 80 inches. The mean annual soil temperature is between 67° and 71° F. The natural vegetation is guava, ferns, hilograss, koa, lantana, ohia lehua, and pukiawe.

Honolua soils make up about 40 percent of the association, and Olelo soils about 35 percent. Halawa, Naiwa, and Oli soils make up the rest.

Honolua soils have a surface layer of dark-brown, friable silty clay. Their subsoil is dark reddish-brown to reddish-brown, friable silty clay. Their substratum is soft, weathered basic igneous rock. Olelo soils have a surface layer of dark reddish-brown to dusky-red, friable silty clay, and their substratum is soft, weathered basic igneous rock.

This association is used for pineapple, pasture, woodland, wildlife habitat, and water supply. Olelo soils are used mainly for pasture, and Honolua soils for pineapple and woodland. Upland game birds make up most of the wildlife population.

4. Rock land-Rough mountainous land association

Very shallow, steep and very steep, rock land and rough mountain land

This association consists of very shallow soils on intermediate and high uplands on East and West Maui. These soils are steep and very steep. The association makes up about 41 percent of the island.

The elevation ranges from sea level to 10,000 feet. The annual rainfall is 20 to 150 inches. The natural vegetation on Rock land is kiawe, klu, piligrass, and ilima in the lower, drier areas and guava, pukiawe, and molassesgrass in the higher, wetter areas. Rough mountainous land is thickly vegetated with ferns, guava, hilograss, kukui, and ohia lehua.

Rock land makes up about 50 percent of the association and Rough mountainous land about 30 percent. Cinder land, Lava flows, Aa, Rock outcrop, Rough broken land, and Rough broken and stony land make up the rest.

Rock land consists of areas where rock outcrop covers 60 to 80 percent of the surface and the soil is 2 to 10 inches thick over bedrock. Rough mountainous land has very shallow soils, and local relief is generally more than 500 feet. There are many small streams throughout the area.

Upland game birds make up most of the wildlife population.

This association is used mainly for wildlife habitat and water supply. Small acreages of Rock land are used for pasture.

5. Puu Pa-Kula-Pane association

Deep, gently sloping to steep, well-drained soils that have a medium-textured or moderately fine textured subsoil or underlying material; on intermediate and high uplands

This general soil area consists of well-drained, medium-textured soils on intermediate and high uplands on East Maui. These soils are gently sloping to steep. They developed in material weathered from volcanic ash. The association makes up about 9 percent of the island.

The elevation ranges from 1,000 to 6,000 feet. The annual rainfall is 20 to 50 inches. The mean annual soil temperature is between 55° and 69° F. The natural vegetation is bermudagrass, black wattle, cactus, guineagrass, ilima, kikuyugrass, lantana, and rattailgrass.

Puu Pa soils make up about 35 percent of the association, Kula about 20 percent, and Pane soils about 10 percent. Io, Kaimu, Ulupalakua, and Uma soils make up the rest.

Puu Pa soils have a surface layer of very dark brown, very friable very stony silt loam. This layer is underlain by very dark grayish-brown and dark-brown, very friable silt loam. Cobblestone- and stone-size fragmental Aa lava is at a depth of 20 to 50 inches. Kula soils have a surface layer of dark reddish-brown, friable loam. The subsoil is dark reddish-brown, friable loam to silty clay loam. The substratum is weathered basic igneous rock. The depth to rock ranges from 24 to 60 inches. Pane soils have a surface layer of dark reddish-brown, very friable silt loam. The subsoil is dark reddish-brown, reddish-brown, and dark-brown, very friable silt loam and loam. The substratum is brown loam. It is 50 to 70 percent soft weathered rock fragments the size of gravel and cobblestones.

This association is used for truck crops, orchards, pasture, and wildlife habitat. Puu Pa and Pane soils are used mainly for pasture, and Kula soils for truck crops and orchards. Upland game birds are the main kinds of wildlife.

6. *Hydrandepts-Tropaquods association*

Gently sloping to steep, well-drained to poorly drained soils that have a moderately fine textured or fine textured subsoil; on intermediate and high uplands

This association consists of well-drained to poorly drained soils on the intermediate and high uplands of East and West Maui. These soils are gently sloping to steep. They developed in material weathered from volcanic ash, cinders, and basic igneous rock. The association makes up about 10 percent of the island.

The elevation ranges from 1,000 to 6,000 feet. The annual rainfall is 100 to 350 inches. The mean annual soil temperature is between 58° and 74° F. The natural vegetation is ape, clubmoss, eucalyptus, guava, koa, lapalapa, ohelo, ohia lehua, pamakani, ricegrass, false staghorn-fern, treefern, and sedges.

Hydrandepts make up about 60 percent of the association, and Tropaquods about 40 percent.

Hydrandepts are moderately well drained to well drained soils that have a surface layer high in organic-matter content. The subsoil is dark-brown or dark yellowish-brown silty clay loam or silty clay. Tropaquods are poorly drained soils that have a peaty and mucky surface layer and a mottled silty clay subsoil. The subsoil contains an ironstone sheet 1/4 to 1 inch thick. These soils are smeary and harden irreversibly.

This association is used for pasture, wildlife habitat, and water supply. Upland game birds are the principal kinds of wildlife.

7. *Hana-Makaalae-Kailua association*

Moderately deep and deep, gently sloping to steep, well-drained soils that have a moderately fine textured or fine textured subsoil or underlying material; on intermediate uplands

This association consists of well-drained, moderately fine textured and fine textured soils on the intermediate uplands of East Maui. These soils are gently sloping to steep. They developed in material weathered from volcanic ash. The association makes up about 7 percent of the island.

The elevation ranges from near sea level to 2,500 feet. The annual rainfall is 40 to 160 inches. The mean annual soil temperature is between 69° and 75° F. The natural vegetation is Christmas berry, ferns, guava, guineagrass, hilograss, kaimiclover, and kikuyugrass.

Hana soils make up about 30 percent of the association, Makaalae soils about 25 percent, and Kailua soils about 20 percent. Kaupo, Makawao, Malama, and Opihikao soils make up the rest.

Hana soils have a surface layer of very dark brown and very dark grayish-brown, friable silty clay loam. The subsoil is dark-brown, friable silty clay loam. The substratum is moderately weathered gravel-size cinders. Stone- and boulder-size fragmental Aa lava is at a depth of 34 to 48 inches. Makaalae soils have a surface layer of very dark-brown, firm silty clay. Below this is very dark grayish-brown, firm silty clay. Hard, stone- and boulder-size fragmental Aa lava is at a depth of 24 to 48 inches. Kailua soils have a surface layer of dark-brown, friable silty clay. The subsoil is dark-brown and dark reddish-brown, friable silty clay and silty clay loam. The substratum is soft, weathered basic igneous rock. The surface layer of Hana and Makaalae soils ranges from nonstony to extremely stony.

This association is used for pineapple, truck crops, orchards, pasture, woodland, wildlife habitat, homesites, and water supply. Hana, Kailua, and Makaalae soils are used mainly for pasture. Most of the pineapple, truck crops, and woodland is on Kailua soils. Wildlife consists mainly of upland game birds.

8. *Pauwela-Haiku association*

Deep, gently sloping to moderately steep, well-drained soils that have a fine textured subsoil; on low uplands

This association consists of well-drained, fine-textured soils on low uplands on the north-facing slopes of East Maui. These soils are gently sloping to moderately steep. They developed in material weathered from basic igneous rock. The association makes up about 3 percent of the island.

The elevation ranges from near sea level to 1,500 feet. The annual rainfall is 50 to 120 inches. The mean annual soil temperature is between 70° and 75° F. The natural vegetation is californiagrass, Christmas berry, guava, hilograss, and ricegrass.

Pauwela soils make up about 45 percent of the association and Haiku about 40 percent. Hamakuapoko soils make up the rest.

Pauwela soils have a surface layer of dark grayish-brown, firm clay. The subsoil is dark reddish-brown, firm clay. The substratum is soft, weathered basic igneous rock. Haiku soils have a surface layer of dark-brown, firm clay. The subsoil is yellowish-red, dark reddish-brown, and dark-red, friable clay and silty clay. The substratum is soft, weathered basic igneous rock. The surface layer of both soils has high bulk density because of the concentration of heavy minerals.

This association is used for pineapple, pasture, homesites, and water supply. Pauwela soils are used mainly for pasture. Only a small acreage is in pineapple. Most of the pineapple is grown on Haiku soils. Wildlife consists mainly of upland game birds.

9. *Laumaia-Kaipoioi-Olinda association*

Deep, gently sloping to very steep, well-drained soils that have a moderately fine textured or medium-textured subsoil; on intermediate and high uplands

This association consists of well-drained, medium-textured soils on the intermediate and high uplands of East Maui. These soils are gently sloping to very steep. They developed in material weathered from volcanic ash. The association makes up about 5 percent of the island.

The elevation ranges from 2,500 to 8,000 feet. The annual rainfall is 30 to 60 inches. The mean annual soil temperature is between 50° and 56° F. The natural vegetation is black wattle, eucalyptus, gosmore, kikuyugrass, pukiawe, sweet vernalgrass, white clover, and Yorkshire foggrass.

Laumaia soils make up about 45 percent of the association, Kaipoioi soils about 40 percent, and Olinda soils about 15 percent.

Laumaia soils have a surface layer of black, very friable loam. The subsoil is very dark brown, friable silty clay loam and silt loam. The substratum consists of moderately consolidated bands of volcanic ash and cinders. Kaipoioi soils have a surface layer of black, very friable loam. The subsoil is black and very dark brown, very friable silt loam and silty clay loam. The substratum consists of layers of ash and cinders. Olinda soils have a surface layer of dark reddish-brown, friable loam. The subsoil is dark reddish-brown and yellowish-red, friable silty clay loam. The substratum is soft, weathered basic igneous rock. It occurs at a depth of 40 to 60 inches or more.

This association is used for truck crops, orchards, pasture, woodland, and wildlife habitat. Laumaia and Kaipoioi soils are used mainly for pasture. Most of the truck crops, the orchards, and the woodland is on Olinda soils. Upland game birds are the principal kinds of wildlife.

10. Keawakapu-Makena association

Gently sloping to moderately steep, well-drained soils that have a fine-textured to medium-textured subsoil and are shallow to deep over fragmental lava; on low uplands

This association consists of well-drained, medium-textured soils on the low uplands of East Maui. These soils are gently sloping to moderately steep. They developed in material weathered from volcanic ash. The association makes up about 2 percent of the island of Maui.

The elevation ranges from 100 to 800 feet. The annual rainfall is 10 to 20 inches. The mean annual soil temperature is about 75° F. The natural vegetation is feather fingergrass, ilima, kiawe, and uhaloa.

Keawakapu soils make up about 60 percent of the association, and Makena about 40 percent.

Keawakapu soils have a surface layer of dark reddish-brown, very friable extremely stony silt loam. The subsoil is dark reddish-brown, friable silty clay loam and silty clay. The substratum is cobblestone- and stone-size fragmental Aa lava. It is at a depth of 12 to 30 inches. Makena soils have a surface layer of very dark brown, very friable loam. The subsoil is very dark grayish-brown and yellowish-brown, very friable silt loam. The substratum is cobblestone- and stone-size fragmental Aa lava. It is at a depth of 40 to 60 inches.

This association is used for pasture and wildlife habitat. Wildlife consists of upland game birds.

11. Kamaole-Oanapuka association

Gently sloping to moderately steep, well-drained, very stony and extremely stony soils that have a fine-textured or medium-textured subsoil and are shallow to deep over fragmental lava; on low and intermediate uplands

This association consists of well-drained, very stony and extremely stony, moderately fine textured and medium-textured soils on the low and intermediate uplands of East Maui. These soils are gently sloping to moderately steep. They developed in material weathered from volcanic ash. The association makes up about 3 percent of the island.

The elevation ranges from 100 to 2,300 feet. The annual rainfall is 15 to 25 inches. The mean annual soil temperature is between 69° and 73° F. The natural vegetation is bermudagrass, feather fingergrass, ilima, kiawe, koa haole, lantana, and Natal redtop.

Kamaole soils make up about 55 percent of the association, and Oanapuka soils about 45 percent.

Kamaole soils have a surface layer of dark-brown and dark reddish-brown, friable silty clay loam. The subsoil is dark reddish-brown, firm silty clay. The substratum is cobblestone- and stone-size fragmental Aa lava. It is at a depth of 16 to 24 inches. Oanapuka soils have a surface layer of very dark brown and very dark grayish-brown very friable silt loam. The subsoil is very dark grayish-brown, friable silt loam. The substratum is cobblestone- and stone-size fragmental Aa lava. It is at a depth of 40 to 60 inches or more.

This association is used for pasture and wildlife. Wildlife consists mainly of upland game birds.

Islands of Molokai and Lanai

Molokai, the fifth largest island in the State, is 38 miles long and 10 miles wide. The land area is 166,400 acres, or 260 square miles. Molokai is divided into three main sections—West Molokai, East Molokai, and Central Molokai, or the Hoolehua Plain.

West Molokai makes up about 30 percent of the total area of the island. It rises to 1,380 feet above sea level. About 8,000 acres is cultivated to pineapple, and the rest is in pasture.

East Molokai makes up nearly half the total land area. It is mostly mountainous and has many gulches and canyons. The northern side is inaccessible. The highest point on the island is 4,970 feet, at Kamakou.

Central Molokai is relatively level and makes up about 20 percent of the total area. About 15,000 acres is deep stone-free soils, mostly in pineapple. The rest is stony and eroded and is used for pasture.

Along the northern coast of Molokai is a sheer cliff 3,000 feet high. At its base is the Kalaupapa Peninsula, which was formed from a volcanic eruption after the main part of the island formed. Along the southern coast is a narrow level strip that formed in marine and alluvial sediments.

The only perennial streams that reach the sea are on East Molokai. Most are on the windward side. Nearly all of the island is underlain by basal ground water. The water is fresh below most of East Molokai but brackish below West and Central Molokai. Fresh water is also confined between lava dikes at high elevations on East Molokai (*13*).

Kaunakakai, which is centrally located on the southern coast, is the principal town. It has a shallow-water harbor. There is an airport in Hoolehua.

Lanai, the sixth largest island in the State, is 18 miles long and 13 miles wide. The land area is 90,000 acres, or 141 square miles. The island rises to 3,370 feet at the Lanaihale summit. Southwest of the summit, at an elevation of 1,000 to 2,000 feet, is the Central Plateau of Lanai. On this plateau is the largest pineapple plantation in the world. Below the 1,200-foot elevation the soils are eroded and stony. The north end of Lanai, at an elevation of 1,500 to 1,800 feet, consists of broad areas of severely windblown soils. The north and east sides of the island are dissected by many deep gulches and are inaccessible in many places.

Because Lanai is located on the leeward side of West Maui, the rainfall is low. As a result, the recharge of ground water is slow. Norfolk Island pines are planted along the ridges near Lanaihale to improve the watershed. These trees collect fog drip, which supplements the 38 inches of annual rainfall. There are no perennial streams on Lanai. Domestic water and irrigation water are obtained from water confined between lava dikes at high elevations.

Nearly the entire population lives in Lanai City, the only town on the island. An airport is located nearby. Kaumalapau Harbor, a shallow-water harbor, is on the southwestern coast.

1. Jaucas-Mala-Pulehu association

Deep, nearly level and gently sloping, excessively drained and well-drained soils that have coarse-textured to fine-textured underlying material; on alluvial fans and in drainageways

This association occurs as a narrow band along the coastal plains on the islands of Molokai and Lanai. It consists of soils that formed in alluvium and coral sand and vary widely in texture and drainage. The soils are on alluvial fans and in drainageways. They are nearly level and gently sloping. The association makes up about 5 percent of the islands.

The elevation ranges from sea level to 250 feet. The annual rainfall is 10 to 40 inches. Most of the rain falls between November and April; there is very little rain during the summer. The mean annual soil temperature is between 73° and 75° F. The natural vegetation is kiawe, bristly foxtail, lantana, and bermudagrass.

Jaucas soils make up about 20 percent of the association, Mala soils 20 percent, and Pulehu soils 10 percent. Kealia, Kawaihapai, and Lualualei soils and areas of Stony alluvial land and Sandy alluvial land make up the rest.

Jaucas soils are excessively drained, pale-brown sandy soils that formed in coral sand. Mala and Pulehu soils are well drained. Mala soils are stratified with dark reddish-brown silty clay throughout the profile. Pulehu soils are dark colored and have a stratified sand to silty clay subsoil.

This association is used for alfalfa, pasture, truck crops, orchards, and wildlife habitat. Alfalfa is grown on the Mala soils. Truck crops and orchard crops are grown on Mala and Pulehu soils. Water for irrigation is obtained from wells 10 to 20 feet deep. The water in most places is brackish. For this reason, heavy applications of irrigation water are needed to prevent accumulation of salt in the soil. Most of the forage from buffelgrass and annual grasses is produced in winter and spring. In summer the main source of feed is kiawe pods. Deer, quail, pheasant, and dove are the principal kinds of wildlife.

2. Molokai-Lahaina association

Deep, nearly level to moderately steep, well-drained soils that have a moderately fine textured or fine textured subsoil; on uplands

This association consists of well-drained, fine textured and moderately fine textured soils on Central and West Molokai (fig. 2) and on the Central Plateau of Lanai. The soils occur as broad, nearly level areas and moderately steep slopes. They formed in material weathered from basic igneous rocks. The association makes up about 25 percent of the two islands.

The elevation ranges from 100 to 1,300 feet on Molokai and from 500 to 1,750 feet on Lanai. The annual rainfall amounts to 15 to 40 inches. Most of it falls between November and April; there is little rainfall in summer. The mean annual soil temperature is between 69° and 73° F. The natural vegetation is kiawe, ilima, uhaloa, and fingergrass.

Molokai soils make up about 35 percent of the association and Lahaina soils 15 percent. Hoolehua, Holomua, Uwala, Waihuna, and Waikapu soils make up the rest.

Molokai soils have a surface layer and subsoil of dark reddish-brown, friable silty clay loam. The substratum is soft weathered rock. Lahaina soils are similar to Molokai soils, except that the texture is dominantly silty clay.

This association is used for pineapple, pasture, truck crops, and wildlife habitat. Pineapple is the principal crop. At the higher elevations irrigation is not needed for pineapple; at the lower elevations it is needed during the dry season. Many kinds of truck crops can be grown on irrigated soils. Where irrigation water is not available, areas that are too dry for pineapple are used for pasture. Most of this association is subject to strong winds, and windbreaks are necessary. Deer, pheasant, quail, and francolin are the main kinds of wildlife.

3. Kahanui-Kalae-Kanepuu association

Deep, gently sloping to moderately steep, well-drained soils that have a dominantly fine-textured subsoil; on uplands

This association consists of well-drained, fine textured and moderately fine textured soils on uplands on the islands of Molokai and Lanai. These soils are gently sloping to moderately steep. They developed in volcanic ash and in material weathered from basic igneous rock. The association makes up about 5 percent of the islands.

The elevation ranges from 500 to 3,750 feet. The annual rainfall is 30 to 80 inches and is fairly well distributed throughout the year. The mean annual soil temperature is between 62° and 70° F. The natural vegetation is guava, hilograss, Christmas berry, and yellow foxtail. At the higher elevations ohia lehua, sweet vernal, and pukiawe are common.

Kahanui, Kalae, and Kanepuu soils each make up about 15 percent of the association. Halawa, Alaeloa, Naiwa, and Olelo soils and areas of Rough broken land make up the rest.

Soils in this association have high bulk density in the upper part of the profile because of the concentration of heavy minerals, such as iron and titanium oxides. Kahanui soils have a surface layer of dark-brown gravelly silty clay and a subsoil of dark yellowish-brown and dark-brown silty clay and clay. An ironstone sheet overlies soft weathered rock at a depth of about 22 inches. Kalae soils have a surface layer of dark reddish-brown silty clay and a subsoil of dark reddish-brown to dark-red silty clay to silt loam. Their substratum is soft weathered rock. Kanepuu soils have a surface layer and

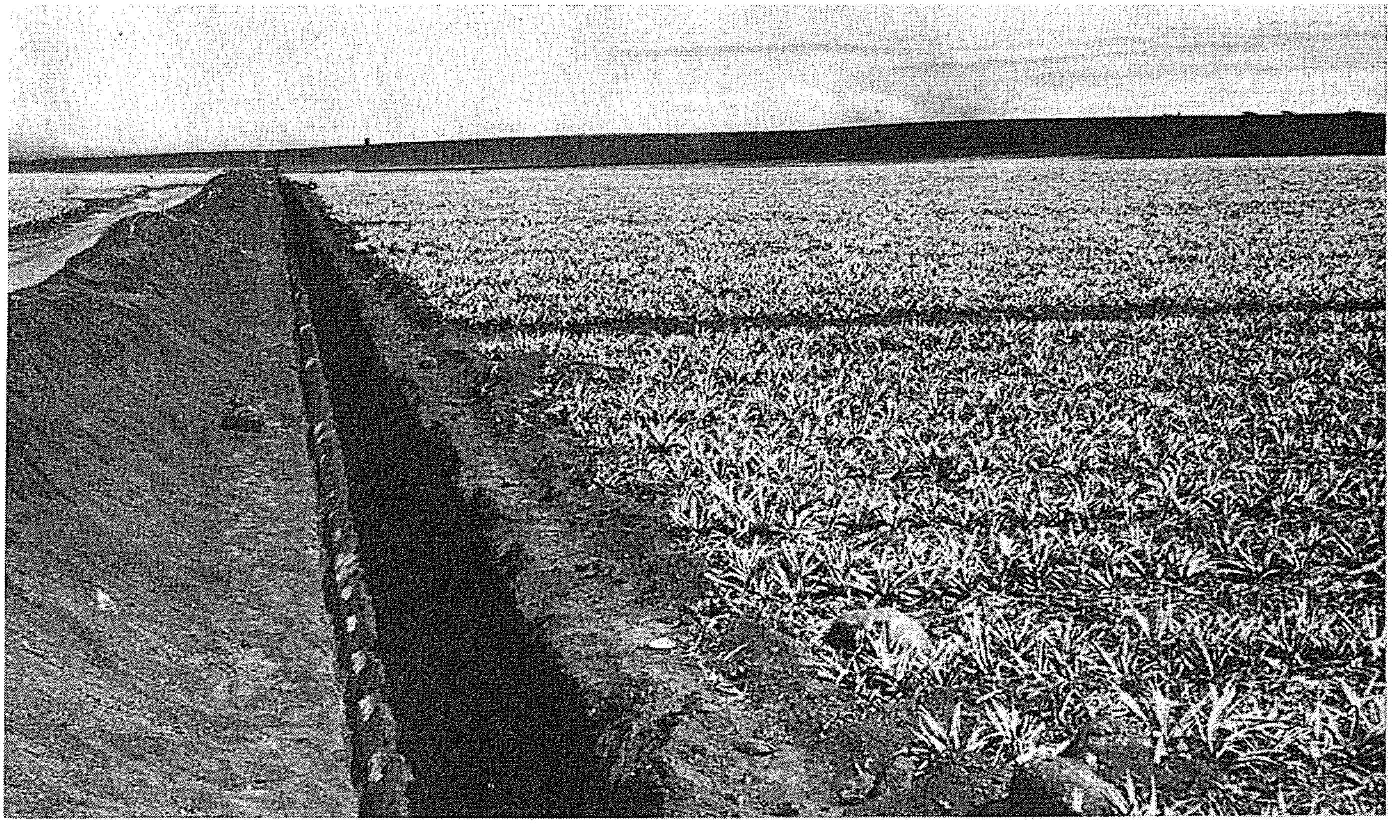

Figure 2.—An area of the Molokai-Lahaina association on Central Molokai showing part of Molakai Irrigation Project. Pipeline is buried at a depth of 6 feet. This association is used extensively for pineapple.

subsoil of dark reddish-brown silty clay. Their substratum is soft weathered rock.

This association is used for pasture, wildlife habitat, woodland, and pineapple. Pastures respond well to fertilizer and lime. Deer and pheasant are the principal kinds of wildlife. Kahanui and Kalae soils are used for woodland. Pine and eucalyptus are the common timber species. Kalae soils are also used for pineapple.

4. Very stony land-Rock land association

Gently sloping to very steep, rocky and stony land types; on uplands and in gulches and valleys

This association consists of gently sloping to very steep, stony and rocky land on uplands and in gulches and valleys on the islands of Molokai and Lanai. The association makes up about 40 percent of the islands.

The elevation ranges from near sea level to 3,000 feet. The annual rainfall is dominantly 10 to 30 inches; most of it falls between November and April. The mean annual soil temperature is between 70° and 75° F. The natural vegetation is mainly kiawe, piligrass, Japanese tea, klu, and Natal redtop.

Very stony land, eroded, makes up about 35 percent of the association, Very stony land 25 percent, and Rock land 15 percent. Rock outcrop and Kalaupapa, Kapuhikani, and Pamoa soils make up the rest.

Very stony land, eroded, is 6 to 30 inches of dark reddish-brown soil material that has many stones and boulders on the surface. Very stony land is made up of many stones and boulders that overlie weathered rock. Rock land is in steep gulches, and 60 to 90 percent of its surface is covered with rock outcrops and stones.

This association is used for pasture and wildlife habitat. Forage from buffelgrass and piligrass is produced mainly during the rainy season. It is difficult to improve pastures because of the stones and rock outcrops. Deer, pheasant, quail, and francolin are the principal kinds of wildlife.

5. Rough broken land-Oli association

Shallow to deep, very steep to precipitous soils in gulches and moderately deep to deep, gently sloping to steep, well-drained soils that have a medium-textured and moderately fine textured subsoil; on uplands

This association consists of well-drained, medium-textured soils on the island of Molokai. It occurs on uplands that are dissected by gulches. The soils are gently sloping to very steep. They formed in volcanic ash and in material weathered from basic igneous rock. The association makes up about 5 percent of the islands.

The elevation ranges from near sea level to 3,500 feet. The annual rainfall is 30 to 50 inches; most of it falls between November and April. The mean annual soil temperature is between 68° and 72° F. The natural vegetation is guava, Natal redtop, lantana, bermudagrass, molassesgrass, aalii, and pukiawe.

Rough broken land makes up 70 percent of the association, and Oli soils 30 percent.

Rough broken land is in gulches. It consists of soft weathered rock covered in places with a thin layer of soil. Oli soils are dark brown throughout the profile. The surface layer and the upper part of the subsoil are very friable silt loam, and the lower part of the subsoil is friable clay loam. Bedrock is at a depth of 2 to 4 feet.

This association is used mainly for pasture and wildlife habitat. A small acreage is used for woodland. Deer, pheasant, and francolin are the principal kinds of wildlife.

6. *Rough mountainous land-Amalu-Olokui association*

Shallow, very steep lands of mountains and gulches and deep to shallow, gently sloping to hilly, poorly drained soils over soft weathered rock; on uplands

This association consists of very steep gulches and valleys and gently sloping to hilly, poorly drained upland soils. It occurs on the islands of Molokai and Lanai. The soils formed in material weathered from basic igneous rock and are high in organic-matter content. This association makes up about 20 percent of the islands.

The elevation ranges from near sea level to 5,000 feet. The annual rainfall ranges from 75 to more than 150 inches and is fairly well distributed throughout the year. The mean annual soil temperature is between 58° and 68° F. The natural vegetation is of the rain forest type. It consists of treefern, ohia lehua, false staghornfern, lapalapa, and sedges.

Rough mountainous land makes up about 80 percent of the association, and Amalu and Olokui soils 10 percent. Tropaquods make up the rest.

Rough mountainous land is on the walls of valleys and gulches. Slopes are steeper than 60 percent. The soil material is shallow, and there are rock outcrops, waterfalls, and occasional scars caused by soil slippage. Amalu soils have 6 to 15 inches of peat and muck over about 10 inches of dark-gray silty clay. An ironstone sheet about an inch thick lies below the silty clay and overlies soft weathered rock. Olokui soils are similar to Amalu soils but have 4 inches or less of peat and muck.

This association is used for watershed and wildlife habitat. The potential for woodland is low because of the very steep slopes and the lack of a timber species suited to the shallow, poorly drained soils. The heavy rainfall is an important factor in recharging the supply of ground water. The kinds of wildlife on Lanai are deer and wild goats, and on Molokai, deer, wild goats, and wild pigs.

Descriptions of the Soils

In this section the soil series and mapping units of the five islands in this survey area are described. The approximate acreage and proportionate extent of the soils are given in table 1.

Three kinds of mapping units are described. A high- and medium-intensity survey was made of all cultivated areas; a low-intensity survey was made of all grazing and forested lands; and a reconnaissance survey was made of inaccessible areas. The composition of the low-intensity mapping units is more variable than that of the high- and medium-intensity units, but it has been controlled well enough to allow interpretations for the expected uses of the soils.

The series descriptions are in alphabetic order. Following each series description is a fairly detailed description of one mapping unit of the series. This detailed description is followed by brief descriptions of the rest of the mapping units.

In the first mapping unit of each series is a short narrative description of a profile representative of the series. Following this is a much more detailed description of the same profile, which can be used by scientists, engineers, and others in making highly technical interpretations. Unless otherwise stated, the color names and color symbols given are for moist soils.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map and indicates whether it is within the high- and medium-intensity, low-intensity, or reconnaissance survey. For a soil within the high- and medium-intensity survey, the symbol consists of a combination of capital and lower-case letters (AeE). It includes a number if the soil is eroded (HfD2). For a soil within the low-intensity survey, the symbol consists of capital letters (ALF). For a soil within the reconnaissance survey, the symbol consists of a lower-case "r" preceding the capital letters (rAAE).

Listed at the end of the description of each mapping unit are the capability classification, sugarcane group, pineapple group, pasture group, and woodland group in which the soil has been placed.

Technical terms used for describing the soils are defined in the Soil Survey Manual (*16*) and in the Glossary. For more general information about the soils, the reader can refer to the section "General Soil Map," in which the broad patterns of soils are described.

Alae Series

This series consists of excessively drained soils on alluvial fans on the island of Maui. These soils developed in volcanic ash and recent alluvium derived from basic igneous rock. They are nearly level to gently sloping. Most areas have cobblestones on the surface. Elevations range from 50 to 600 feet. The annual rainfall amounts to 12 to 20 inches. The mean annual soil temperature is 74° F. Alae soils are geographically associated with Ewa, Pulehu, and Waiakoa soils.

These soils are used for sugarcane and pasture. Small areas are used for truck crops. The natural vegetation is feather fingergrass, kiawe, and uhaloa.

Alae cobbly sandy loam, 0 to 3 percent slopes (AcA).—This soil occurs on smooth alluvial fans. Included in mapping were small areas of Ewa and Pulehu soils.

In a representative profile the surface layer, about 7 inches thick, is very dark grayish-brown, cobbly sandy loam that has granular structure. The substratum, to a depth of 48 inches or more, is very dark grayish-brown, very dark gray, and grayish-brown sandy loam and coarse and very coarse sand. The soil is neutral or mildly alkaline in the surface layer and mildly to moderately alkaline in the substratum.

Permeability is rapid. Runoff is slow, and the erosion hazard is no more than slight. The available water capac-

TABLE 1.—*Approximate acreage and proportionate extent of the soils*

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Alae sandy loam, 3 to 7 percent slopes					972	0.20				
Alae cobbly sandy loam, 0 to 3 percent slopes					783	.16				
Alae cobbly sandy loam, 3 to 7 percent slopes					290	.06				
Alaeloa silty clay, 3 to 7 percent slopes					555	.11				
Alaeloa silty clay, 7 to 15 percent slopes					1, 290	.27				
Alaeloa silty clay, 15 to 35 percent slopes			1, 532	0.39	994	.21	836	0.50		
Ewa silty clay loam, 0 to 3 percent slopes					3, 760	.80				
Ewa silty clay loam, 3 to 6 percent slopes			984	.25						
Ewa silty clay loam, 6 to 12 percent slopes			699	.18						
Ewa cobbly silty clay loam, 0 to 3 percent slopes					506	.10				
Ewa cobbly silty clay loam, 3 to 7 percent slopes					306	.06				
Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes			2, 575	.66						
Ewa silty clay loam, moderately shallow, 2 to 6 percent slopes			262	.06						
Ewa silty clay, 0 to 3 percent slopes					366	.07				
Ewa silty clay, 3 to 7 percent slopes					230	.04				
Ewa cobbly silty clay, 3 to 7 percent slopes					297	.06				
Ewa stony silty clay, 0 to 2 percent slopes			344	.08						
Ewa stony silty clay, 2 to 6 percent slopes			265	.06						
Ewa stony silty clay, 6 to 12 percent slopes			1, 359	.35						
Fill land	1, 458	0.41	1, 546	.39	240	.05				
Haiku silty clay, 3 to 7 percent slopes					836	.17				
Haiku silty clay, 7 to 15 percent slopes					226	.04				
Haiku clay, 3 to 7 percent slopes					1, 169	.25				
Haiku clay, 7 to 15 percent slopes					2, 950	.63				
Haleiwa silty clay loam, 0 to 10 percent slopes							171	.10		
Haleiwa very stony silty clay loam, 0 to 15 percent slopes							351	.21		
Haleiwa silty clay, 0 to 2 percent slopes			1, 902	.49						
Haleiwa silty clay, 2 to 6 percent slopes			474	.12						
Halii gravelly silty clay, 3 to 8 percent slopes	2, 213	.62								
Halii gravelly silty clay, 8 to 15 percent slopes	1, 110	.31								
Halii gravelly silty clay, 15 to 25 percent slopes, eroded	639	.18								
Halii gravelly silty clay, 25 to 40 percent slopes, eroded	897	.25								
Haliimaile silty clay loam, 3 to 7 percent slopes					578	.12				
Haliimaile silty clay loam, 7 to 15 percent slopes					1, 782	.38				
Haliimaile silty clay, 3 to 7 percent slopes					2, 693	.57				
Haliimaile silty clay, 7 to 15 percent slopes					1, 309	.28				
Haliimaile gravelly silty clay, 7 to 15 percent slopes, eroded					218	.04				
Hamakuapoko silty clay, 3 to 7 percent slopes					968	.20				
Hamakuapoko silty clay, 7 to 15 percent slopes					244	.05				
Hamakuapoko silty clay, 7 to 15 percent slopes, eroded					264	.05				
Hanalei silty clay loam, 0 to 2 percent slopes	273	.07								
Hanalei silty clay, 0 to 2 percent slopes	2, 752	.77	2, 034	.52						
Hanalei silty clay, 2 to 6 percent slopes			1, 183	.30						
Hanalei stony silty clay, 2 to 6 percent slopes			707	.18						

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Hanalei peaty silty clay loam, 0 to 2 percent slopes	300	0. 08								
Hanalei silty clay, deep water table, 0 to 6 percent slopes	1, 500	. 42								
Hanamaulu silty clay, 3 to 8 percent slopes	2, 854	. 80								
Hanamaulu silty clay, 8 to 15 percent slopes	1, 077	. 30								
Hanamaulu silty clay, 15 to 25 percent slopes	795	. 22								
Hanamaulu silty clay, 25 to 40 percent slopes	890	. 25								
Hanamaulu stony silty clay, 10 to 35 percent slopes	1, 307	. 36								
Hanamaulu bouldery silty clay, 10 to 35 percent slopes	854	. 24								
Holomua silt loam, 0 to 3 percent slopes							1, 445	. 86		
Holomua silt loam, 3 to 7 percent slopes							2, 425	1. 45		
Holomua silt loam, 3 to 7 percent slopes, severely eroded							1, 424	. 85		
Holomua silt loam, 7 to 15 percent slopes							482	. 28		
Holomua silt loam, 7 to 15 percent slopes, severely eroded							943	. 56		
Honolua silty clay, 7 to 15 percent slopes					1, 659	. 35				
Honolua silty clay, 15 to 25 percent slopes					911	. 19				
Honouliuli clay, 0 to 2 percent slopes			3, 278	. 84						
Honouliuli clay, 2 to 6 percent slopes			235	. 06						
Hoolehua silty clay loam, 3 to 10 percent slopes, severely eroded							1, 700	1. 02		
Hoolehua silty clay, 0 to 3 percent slopes							441	. 26		
Hoolehua silty clay, 3 to 7 percent slopes							1, 936	1. 16		
Hoolehua silty clay, 7 to 15 percent slopes							3, 687	2. 21		
Hoolehua silty clay, 15 to 35 percent slopes							600	. 36		
Iao silty clay, 0 to 3 percent slopes					458	. 09				
Iao silty clay, 3 to 7 percent slopes					397	. 08				
Iao cobbly silty clay, 3 to 7 percent slopes					612	. 13				
Iao cobbly silty clay, 7 to 15 percent slopes					330	. 07				
Iao clay, 3 to 7 percent slopes					1, 210	. 25				
Iao clay, 7 to 15 percent slopes					341	. 07				
Ioleau silty clay loam, 2 to 6 percent slopes	972	. 27								
Ioleau silty clay loam, 6 to 12 percent slopes	1, 334	. 37								
Ioleau silty clay loam, 12 to 20 percent slopes, eroded	1, 008	. 28								
Ioleau silty clay loam, 20 to 35 percent slopes, eroded	979	. 27								
Jaucas sand, 0 to 15 percent slopes			4, 795	1. 24	2, 923	. 62	1, 073	. 64	781	. 86
Jaucas sand, saline, 0 to 12 percent slopes			213	. 05	737	. 15				
Jaucas loamy fine sand, 0 to 8 percent slopes	3, 562	1. 00								
Jaucas loamy fine sand, dark variant, 0 to 8 percent slopes	377	. 10								
Kaena clay, 2 to 6 percent slopes			790	. 20						
Kaena clay, 6 to 12 percent slopes			326	. 08						
Kaena stony clay, 2 to 6 percent slopes			308	. 07						
Kaena stony clay, 6 to 12 percent slopes			251	. 08						
Kaena stony clay, 12 to 20 percent slopes			561	. 14						
Kaena very stony clay, 10 to 35 percent slopes			1, 923	. 49						
Kaena clay, brown variant, 1 to 6 percent slopes	430	. 12								
Kaena clay, brown variant, 6 to 12 percent slopes	376	. 10								
Kahana silty clay, 3 to 7 percent slopes					734	. 15				

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Kahana silty clay, 7 to 15 percent slopes					1,562	0.33				
Kahana silty clay, 15 to 25 percent slopes					390	.08				
Kalae silty clay, 2 to 7 percent slopes							548	.32	766	.85
Kalae silty clay, 7 to 15 percent slopes							103	.06	407	.45
Kalae silty clay, 5 to 15 percent slopes, severely eroded							670	.40		
Kalae silty clay, 15 to 25 percent slopes, severely eroded							100	.06	108	.12
Kalae silty clay, 25 to 40 percent slopes, severely eroded							173	.10		
Kalapa silty clay, 8 to 20 percent slopes	230	.06								
Kalapa silty clay, 20 to 40 percent slopes	869	.24								
Kalapa silty clay, 40 to 70 percent slopes	4,050	1.14								
Kalihi clay	334	.09								
Kaloko clay loam	200	.05								
Kaloko clay	792	.22	314	.08						
Kaloko clay, noncalcareous variant			363	.09						
Kaneohe silty clay, 3 to 8 percent slopes			291	.07						
Kaneohe silty clay, 8 to 15 percent slopes			305	.07						
Kanepuu silty clay, 3 to 7 percent slopes									987	1.09
Kanepuu silty clay, 3 to 7 percent slopes, eroded									661	.73
Kanepuu silty clay, 7 to 15 percent slopes									263	.29
Kanepuu silty clay, 7 to 15 percent slopes, eroded									600	.66
Kapaa silty clay, 3 to 8 percent slopes	5,663	1.59								
Kapaa silty clay, 8 to 15 percent slopes	2,308	.65								
Kapaa silty clay, 15 to 25 percent slopes	1,314	.37								
Kapaa silty clay, 25 to 40 percent slopes	1,307	.36								
Kawaihapai clay loam, 0 to 2 percent slopes			1,443	.37			348	.20		
Kawaihapai clay loam, 2 to 6 percent slopes			1,183	.30						
Kawaihapai clay loam, 6 to 15 percent slopes			248	.06						
Kawaihapai stony clay loam, 0 to 2 percent slopes			365	.09						
Kawaihapai stony clay loam, 2 to 6 percent slopes			1,938	.50			316	.18		
Kawaihapai very stony clay loam, 0 to 15 percent slopes			1,195	.30			226	.14		
Kawaihapai silty clay loam, 2 to 7 percent slopes							317	.19		
Keaau clay, 0 to 2 percent slopes			828	.21						
Keaau stony clay, 2 to 6 percent slopes			248	.06						
Keaau clay, saline, 0 to 2 percent slopes			389	.10						
Keahua silty clay loam, 3 to 7 percent slopes					3,898	.83				
Keahua silty clay loam, 7 to 15 percent slopes					1,866	.40				
Keahua cobbly silty clay loam, 3 to 7 percent slopes					1,619	.34				
Keahua cobbly silty clay loam, 7 to 15 percent slopes					2,115	.45				
Keahua cobbly silty clay loam, 15 to 25 percent slopes					817	.17				
Keahua very stony silty clay loam, 7 to 25 percent slopes					1,097	.23				
Keahua silty clay, 7 to 15 percent slopes					822	.17				
Keahua cobbly silty clay, 7 to 15 percent slopes					678	.14				
Keahua stony silty clay, 7 to 15 percent slopes					340	.07				
Kekaha silty clay, 0 to 2 percent slopes	1,432	.40								
Kekaha silty clay, 2 to 6 percent slopes	251	.07								
Kekaha clay, 0 to 2 percent slopes	1,361	.38								

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Kemoo silty clay, 2 to 6 percent slopes			229	0.05						
Kemoo silty clay, 6 to 12 percent slopes			361	.09						
Kemoo silty clay, 12 to 20 percent slopes			956	.24						
Kemoo silty clay, 20 to 35 percent slopes			938	.24						
Kemoo silty clay, 35 to 70 percent slopes			3,393	.87						
Koele silty clay loam, 3 to 7 percent slopes									408	.45
Koele silty clay loam, 7 to 15 percent slopes									1,091	1.21
Koele silty clay loam, 15 to 25 percent slopes									222	.24
Koko silt loam, 2 to 6 percent slopes			996	.25						
Koko silt loam, 6 to 12 percent slopes			243	.06						
Koko silt loam, 12 to 25 percent slopes			214	.05						
Kokokahi clay, 6 to 12 percent slopes			709	.18						
Kolekole silty clay loam, 1 to 6 percent slopes			1,231	.31						
Kolekole silty clay loam, 6 to 12 percent slopes			794	.20						
Kolekole silty clay loam, 12 to 25 percent slopes			1,053	.27						
Koloa stony silty clay, 3 to 8 percent slopes	1,123	.31								
Koloa stony silty clay, 8 to 15 percent slopes	267	.07								
Koloa stony silty clay, 15 to 25 percent slopes	539	.15								
Kolokolo clay loam	619	.17								
Kula loam, 4 to 12 percent slopes					248	.05				
Kula loam, 12 to 20 percent slopes					2,876	.61				
Kula cobbly loam, 12 to 20 percent slopes					3,956	.84				
Kula very rocky loam, 12 to 40 percent slopes					1,770	.37				
Kunia silty clay, 0 to 3 percent slopes			3,848	.99						
Kunia silty clay, 3 to 8 percent slopes			2,085	.53						
Kunia silty clay, 8 to 15 percent slopes			666	.17						
Lahaina silty clay, 0 to 3 percent slopes			637	.16			560	.33	703	.78
Lahaina silty clay, 3 to 7 percent slopes			3,852	.99	1,373	.29	2,045	1.22	1,376	1.52
Lahaina silty clay, 3 to 7 percent slopes, severely eroded									490	.54
Lahaina silty clay, 7 to 15 percent slopes			2,524	.65	1,512	.32	1,619	.97	769	.85
Lahaina silty clay, 7 to 15 percent slopes, severely eroded			1,239	.32			904	.54	614	.68
Lahaina silty clay, 15 to 25 percent slopes					569	.12				
Lahaina silty clay, 15 to 25 percent slopes, severely eroded							408	.24	376	.41
Lahaina silty clay, 25 to 40 percent slopes, severely eroded							452	.27	79	.08
Lawai silty clay, 0 to 8 percent slopes	781	.22								
Lawai silty clay, 8 to 15 percent slopes	513	.14								
Lawai silty clay, 15 to 25 percent slopes	345	.09								
Leilehua silty clay, 2 to 6 percent slopes			3,687	.95						
Leilehua silty clay, 6 to 12 percent slopes			1,043	.26						
Lihue silty clay, 0 to 8 percent slopes	9,521	2.68								
Lihue silty clay, 8 to 15 percent slopes	2,658	.74								
Lihue silty clay, 15 to 25 percent slopes	1,076	.30								
Lihue silty clay, 25 to 40 percent slopes, eroded	1,024	.28								
Lihue gravelly silty clay, 0 to 8 percent slopes	961	.27								
Lihue gravelly silty clay, 8 to 15 percent slopes	315	.08								
Lolekaa silty clay, 3 to 8 percent slopes			2,569	.66						
Lolekaa silty clay, 8 to 15 percent slopes			923	.23						
Lolekaa silty clay, 15 to 25 percent slopes			1,689	.43						
Lolekaa silty clay, 25 to 40 percent slopes			2,636	.68						
Lolekaa silty clay, 40 to 70 percent slopes			3,199	.82						
Lualualei clay, 0 to 2 percent slopes	431	.12	1,766	.45			278	.16	45	.05
Lualualei clay, 2 to 6 percent slopes	579	.16	805	.20						
Lualualei stony clay, 0 to 2 percent slopes			964	.24						

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Lualualei stony clay, 2 to 6 percent slopes			1, 413	0. 36						
Mahana silt loam, 6 to 12 percent slopes	482	. 13								
Mahana silt loam, 12 to 20 percent slopes	1, 557	. 43								
Mahana silt loam, 12 to 20 percent slopes severely eroded	755	. 21								
Mahana silt loam, 20 to 35 percent slopes	1, 104	. 31								
Mahana silt loam, 20 to 35 percent slopes, severely eroded	1, 864	. 52								
Mahana silty clay loam, 6 to 12 percent slopes, eroded			690	. 17						
Mahana silty clay loam, 12 to 20 percent slopes, eroded			883	. 22						
Mahana silty clay loam, 20 to 35 percent slopes, eroded			1, 142	. 29						
Makalapa clay, 2 to 6 percent slopes			1, 992	. 51						
Makalapa clay, 6 to 12 percent slopes			703	. 18						
Makalapa clay, 12 to 20 percent slopes			248	. 06						
Makapili silty clay, 0 to 8 percent slopes	1, 401	. 39								
Makapili silty clay, 8 to 15 percent slopes	295	. 08								
Makapili silty clay, 15 to 25 percent slopes	339	. 09								
Makapili silty clay, 25 to 40 percent slopes	342	. 09								
Makawao silty clay, 3 to 7 percent slopes					410	. 08				
Makawao silty clay, 7 to 15 percent slopes					1, 488	. 31				
Makaweli silty clay loam, 0 to 6 percent slopes	3, 435	. 96								
Makaweli silty clay loam, 6 to 12 percent slopes	3, 367	. 94								
Makaweli silty clay loam, 12 to 20 percent slopes	2, 004	. 56								
Makaweli silty clay loam, 20 to 35 percent slopes, eroded	732	. 20								
Makaweli stony silty clay loam, 0 to 6 percent slopes	1, 749	. 49								
Makaweli stony silty clay loam, 6 to 12 percent slopes	956	. 26								
Makaweli stony silty clay loam, 12 to 20 percent slopes	707	. 19								
Makaweli stony silty clay loam, 20 to 35 percent slopes	491	. 13								
Makiki clay loam, 0 to 2 percent slopes			875	. 22						
Makiki stony clay loam, 0 to 3 percent slopes			537	. 13						
Mala silty clay, 0 to 3 percent slopes							1, 872	1. 12	191	. 21
Mala silty clay, 3 to 7 percent slopes							200	. 12	118	. 13
Mamala stony silty clay loam, 0 to 12 percent slopes	493	. 13	6, 293	1. 63						
Manana silty clay loam, 2 to 6 percent slopes			802	. 20						
Manana silty clay loam, 6 to 12 percent slopes			786	. 20						
Manana silty clay loam, 12 to 25 percent slopes, eroded			751	. 19						
Manana silty clay, 3 to 8 percent slopes			638	. 16						
Manana silty clay, 8 to 15 percent slopes			1, 001	. 25						
Manana silty clay, 15 to 25 percent slopes			229	. 05						
Manana silty clay, 12 to 25 percent slopes, eroded			354	. 09						
Manana silty clay, 25 to 40 percent slopes			694	. 17						
Mokuleia fine sandy loam	1, 639	. 46								
Mokuleia loam			524	. 13						
Mokuleia clay loam			655	. 16						
Mokuleia clay loam, poorly drained variant	1, 131	. 31								
Mokuleia clay			674	. 17						
Molokai silty clay loam, 0 to 3 percent slopes			280	. 07	1, 652	. 35	1, 955	1. 17	1, 652	1. 83

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Molokai silty clay loam, 3 to 7 percent slopes			3, 715	0. 96	4, 438	0. 95	6, 939	4. 17	4, 439	4. 93
Molokai silty clay loam, 3 to 7 percent slopes, severely eroded							605	. 36		
Molokai silty clay loam, 7 to 15 percent slopes			1, 519	. 39	282	. 06	2, 925	1. 75	522	. 58
Molokai silty clay loam, 7 to 15 percent slopes, severely eroded							1, 865	1. 12	1, 362	1. 51
Molokai silty clay loam, 15 to 25 percent slopes			771	. 19						
Molokai silty clay loam, shallow variant, 15 to 25 percent slopes, severely eroded							1, 055	. 63	372	. 41
Niu silty clay loam, 6 to 12 percent slopes	800	. 22								
Niu silty clay loam, 12 to 20 percent slopes	1, 440	. 40								
Niu silty clay loam, 6 to 20 percent slopes, eroded	234	. 06								
Niu silty clay loam, 20 to 35 percent slopes, eroded	903	. 25								
Nohili clay	1, 150	. 32								
Nonopahu clay, 2 to 10 percent slopes	651	. 18								
Nonopahu stony clay, 2 to 12 percent slopes	247	. 06								
Oli loam, 12 to 20 percent slopes	596	. 16								
Paaloa silty clay, 3 to 12 percent slopes			2, 625	. 67						
Paaloa clay, 2 to 12 percent slopes			690	. 17						
Paia silty clay, 3 to 7 percent slopes					4, 293	. 92				
Paia silty clay, 7 to 15 percent slopes					1, 148	. 24				
Paia silty clay, 7 to 15 percent slopes, eroded					214	. 04				
Pakala clay loam, 0 to 2 percent slopes	937	. 26								
Pakala clay loam, 2 to 10 percent slopes	235	. 06								
Paumalu silty clay, 3 to 8 percent slopes			347	. 08						
Paumalu silty clay, 8 to 15 percent slopes			480	. 12						
Paumalu silty clay, 15 to 25 percent slopes			637	. 16						
Paumalu silty clay, 25 to 40 percent slopes			546	. 14						
Paumalu silty clay, 40 to 70 percent slopes			632	. 16						
Pauwela clay, 3 to 7 percent slopes					782	. 16				
Pauwela clay, 7 to 15 percent slopes					3, 285	. 70				
Pauwela clay, 15 to 25 percent slopes					1, 673	. 35				
Pearl Harbor clay			1, 952	. 50						
Pohakupu silty clay loam, 0 to 8 percent slopes	487	. 13	626	. 16						
Pohakupu silty clay loam, 8 to 15 per- percent slopes			238	. 06						
Pooku silty clay loam, 3 to 8 percent slopes	775	. 21								
Pooku silty clay loam, 8 to 25 percent slopes	321	. 09								
Pooku silty clay, 0 to 8 percent slopes	2, 058	. 57								
Pooku silty clay, 8 to 15 percent slopes	1, 556	. 43								
Pooku silty clay, 15 to 25 percent slopes	1, 053	. 29								
Pooku silty clay, 25 to 40 percent slopes	2, 024	. 57								
Puhi silty clay loam, 0 to 3 percent slopes	442	. 12								
Puhi silty clay loam, 3 to 8 percent slopes	7, 078	1. 99								
Puhi silty clay loam, 8 to 15 percent slopes	2, 095	. 59								
Puhi silty clay loam, 15 to 25 percent slopes	1, 345	. 37								
Puhi silty clay loam, 25 to 40 percent slopes	1, 891	. 53								
Pulehu sandy loam, 2 to 6 percent slopes							94	. 05	199	. 22
Pulehu stony sandy loam, 0 to 7 percent slopes							91	. 05	101	. 11
Pulehu silt loam, 0 to 3 percent slopes					2, 329	. 49				
Pulehu silt loam, 3 to 7 percent slopes					796	. 17				

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Pulehu cobbly silt loam, 0 to 3 percent slopes					816	0.17				
Pulehu cobbly silt loam, 3 to 7 percent slopes					735	.15				
Pulehu clay loam, 0 to 3 percent slopes			1,112	.29	1,925	.41	339	.20	207	.23
Pulehu cobbly clay loam, 0 to 3 percent slopes					1,144	.24				
Pulehu cobbly clay loam, 3 to 7 percnet slopes					966	.20				
Pulehu stony clay loam, 2 to 6 percent slopes			443	.11						
Pulehu very stony clay loam, 0 to 12 percent slopes			914	.23						
Puu Opae silty clay loam, 8 to 15 percent slopes	847	.23								
Puu Opae silty clay loam, 15 to 25 percent slopes	1,355	.38								
Puu Opae silty clay loam, 25 to 40 percent slopes	1,447	.40								
Uwala silty clay loam, 2 to 7 percent slopes									1,632	1.81
Uwala silty clay loam, 7 to 15 percent slopes									1,164	1.29
Uwala silty clay loam, 7 to 15 percent slopes, severely eroded									1,173	1.30
Wahiawa silty clay, 0 to 3 percent slopes			8,981	2.32						
Wahiawa silty clay, 3 to 8 percent slopes			10,188	2.63						
Wahiawa silty clay, 8 to 15 percent slopes			1,740	.45						
Wahiawa silty clay, 15 to 25 percent slopes, eroded			241	.06						
Wahikuli silty clay, 3 to 7 percent slopes					354	.07				
Wahikuli stony silty clay, 3 to 7 percent slopes					441	.09				
Wahikuli stony silty clay, 7 to 15 percent slopes					894	.19				
Wahikuli very stony silty clay, 3 to 7 percent slopes					417	.08				
Waiakoa silty clay loam, 3 to 7 percent slopes					2,103	.45				
Waiakoa silty clay loam, 7 to 15 percent slopes					373	.08				
Waiakoa cobbly silty clay loam, 3 to 7 percent slopes					1,282	.27				
Waiakoa very stony silty clay loam, 3 to 7 percent slopes					2,003	.42				
Waiakoa very stony silty clay loam, 7 to 15 percent slopes					990	.21				
Waiakoa extremely stony silty clay loam, 3 to 7 percent slopes					344	.07				
Waiakoa extremely stony silty clay loam, 7 to 15 percent slopes					375	.08				
Waialua silty clay, 0 to 3 percent slopes			2,644	.68						
Waialua silty clay, 3 to 8 percent slopes			643	.16						
Waialua stony silty clay, 3 to 8 percent slopes			1,040	.26						
Waialua stony silty clay, 12 to 30 percent slopes			238	.06						
Waialua very stony silty clay, 12 to 20 percent slopes			268	.06						
Waialua clay, 2 to 6 percent slopes			512	.13						
Waihuna clay, 0 to 3 percent slopes									1,764	1.96
Waihuna clay, 3 to 7 percent slopes							177	.10	1,206	1.34
Waihuna clay, 7 to 15 percent slopes							476	.28	298	.33
Waihuna clay, 15 to 25 percent slopes							177	.10	96	.10
Waihuna gravelly clay, 3 to 7 percent slopes									228	.25
Waikane silty clay, 3 to 8 percent slopes			602	.15						
Waikane silty clay, 8 to 15 percent slopes			247	.06						

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

HIGH-INTENSITY AND MEDIUM-INTENSITY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Waikane silty clay, 25 to 40 percent slopes			3, 976	1. 02						
Waikane silty clay, 40 to 70 percent slopes			5, 743	1. 48						
Waikane silty clay, 40 to 70 percent slopes, eroded			819	. 21						
Waikane stony silty clay, 15 to 30 percent slopes			310	. 08						
Waikapu silty clay loam, 0 to 3 percent slopes							570	. 34	574	. 63
Waikapu silty clay loam, 3 to 7 percent slopes							1, 406	. 84		
Waikapu silty clay loam, 3 to 7 percent slopes, severely eroded							509	. 30		
Waikapu silty clay loam, 7 to 15 percent slopes, severely eroded							1, 019	. 61	143	. 15
Waikomo stony silty clay	1, 539	. 43								
Waikomo very rocky silty clay	1, 910	. 53								
Waikomo extremely rocky silty clay	283	. 07								
Wailuku silty clay, 3 to 7 percent slopes					514	. 11				
Wailuku silty clay, 7 to 15 percent slopes					1, 613	. 34				
Wailuku cobbly silty clay, 7 to 15 percent slopes					578	. 12				
Wainee very stony silty clay, 3 to 7 percent slopes					388	. 08				
Wainee very stony silty clay, 7 to 15 percent slopes					936	. 20				
Wainee extremely stony silty clay, 3 to 7 percent slopes					370	. 07				
Wainee extremely stony silty clay, 7 to 15 percent slopes					1, 093	. 23				
Waipahu silty clay, 0 to 2 percent slopes			1, 328	. 34						
Waipahu silty clay, 2 to 6 percent slopes			345	. 08						
Waipahu silty clay, 6 to 12 percent slopes			656	. 16						
Total	129, 362	35. 97	162, 837	41. 51	105, 090	21. 50	48, 855	29. 15	28, 187	31. 18
LOW-INTENSITY SURVEY										
Alaeloa silty clay, 15 to 35 percent slopes, severely eroded							201	. 12		
Alaeloa silty clay, 40 to 70 percent slopes			2, 757	. 71						
Alaeloa stony silty clay, 15 to 35 percent slopes, severely eroded							354	. 21		
Alaeloa stony silty clay, overwash, 15 to 35 percent slopes							209	. 12		
Badland	1, 624	. 45								
Badland-Mahana complex	5, 681	1. 60								
Beaches	741	. 20	1, 772	. 45	477	. 10	358	. 21	68	. 07
Blown-out land									2, 732	3. 03
Colluvial land							1, 399	. 84		
Coral outcrop			8, 863	2. 29						
Dune land	638	. 17			1, 168	. 25				
Fill land, mixed			9, 713	2. 51						
Gullied land							2, 181	1. 31		
Halawa silty clay, 3 to 25 percent slopes					786	. 16	1, 383	. 83		
Halawa silty clay, 3 to 25 percent slopes, severely eroded							553	. 33		
Halawa silt loam, 20 to 35 percent slopes			429	. 11						
Halawa silt loam, 35 to 70 percent slopes, eroded			654	. 16						
Hana very stony silty clay loam, 3 to 25 percent slopes					7, 492	1. 60				
Hana extremely stony silty clay loam, 3 to 25 percent slopes					572	. 12				
Hana silty clay loam, moderately deep variant, 3 to 15 percent slopes					1, 360	. 29				

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

LOW-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Hana extremely stony silty clay loam, moderately deep variant, 3 to 15 percent slopes					520	0. 11				
Helemano silty clay, 30 to 90 percent slopes			27, 778	7. 18						
Hihimanu silty clay loam, 40 to 70 percent slopes	8, 431	2. 37								
Hulua gravelly silty clay loam, 3 to 25 percent slopes	2, 472	. 69								
Hulua gravelly silty clay loam, 25 to 70 percent slopes	2, 850	. 80								
Io silt loam, 7 to 25 percent slopes					3, 302	. 70				
Jaucas-Blown-out land complex							1, 174	. 70		
Kahanui silty clay, 3 to 20 percent slopes									351	. 39
Kahanui gravelly silty clay, 3 to 20 percent slopes							1, 972	1. 18		
Kailua silty clay, 3 to 25 percent slopes					6, 630	1. 42				
Kaimu extremely stony peat, 7 to 25 percent slopes					1, 990	. 42				
Kaipoioi loam, 7 to 40 percent slopes					5, 933	1. 27				
Kaipoioi very rocky loam, 7 to 40 percent slopes					4, 522	. 97				
Kalapa very rocky silty clay, 40 to 70 percent slopes	1, 851	. 52								
Kalaupapa very rocky silty clay loam, 3 to 25 percent slopes							1, 359	. 81		
Kamaole very stony silt loam, 3 to 15 percent slopes					7, 714	1. 65				
Kamaole extremely stony silt loam, 3 to 15 percent slopes					1, 018	. 21				
Kaneohe silty clay loam, 5 to 15 percent slopes			348	. 09						
Kaneohe silty clay loam, 15 to 30 percent slopes			210	. 05						
Kaneohe silty clay loam, 30 to 65 percent slopes			400	. 10						
Kaneohe silty clay, 30 to 65 percent slopes			401	. 10						
Kapaa silty clay, 40 to 100 percent slopes			12, 119	3. 13						
Kapuhikani extremely stony clay, 3 to 15 percent slopes							1, 250	. 75		
Kaupo very stony silty clay loam, 3 to 25 percent slopes					1, 914	. 41				
Kaupo extremely stony silty clay, 3 to 25 percent slopes					564	. 12				
Kealia silt loam					1, 110	. 23	1, 430	. 85		
Keawakapu extremely stony silty clay loam, 3 to 25 percent slopes					4, 679	1. 00				
Kekaha extremely stony silty clay loam, 0 to 35 percent slopes	1, 102	. 31								
Kemoo-Badland complex			961	. 24						
Koele-Badland complex							527	. 31	6, 630	7. 36
Koele rocky complex					1, 698	. 36				
Kokee silty clay loam, 0 to 35 percent slopes	2, 435	. 68								
Kokee silty clay loam, 35 to 70 percent slopes	3, 669	1. 03								
Kokokahi very stony clay, 0 to 35 percent slopes			300	. 07						
Kolokolo extremely stony clay loam	1, 982	. 55								
Koolau silty clay, 0 to 8 percent slopes	1, 056	. 29								
Koolau silty clay, 8 to 30 percent slopes	652	. 18								
Kunuweia very gravelly clay loam, 0 to 15 percent slopes	801	. 22								
Laumaia loam, 7 to 40 percent slopes					5, 800	1. 24				
Laumaia loam, 40 to 70 percent slopes					720	. 15				
Laumaia extremely stony loam, 7 to 40 percent slopes					4, 496	. 96				
Lualualei extremely stony clay, 3 to 35 percent slopes	361	. 10	5, 936	1. 53						
Mahana-Badland complex			2, 533	. 65						

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

LOW-INTENSITY SURVEY—Continued

Soil	Kauai		Oahu		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Makaalae silty clay, 7 to 25 percent slopes					4, 374	0. 93				
Makaalae extremely stony silty clay, 7 to 25 percent slopes					2, 054	. 44				
Makaalae clay, 7 to 40 percent slopes					570	. 12				
Makena loam, stony complex, 3 to 15 percent slopes					2, 962	. 63				
Malama extremely stony muck, 3 to 25 percent slopes					2, 960	. 63				
Marsh	652	. 18	960	. 24			599	. 36		
Naiwa silty clay loam, 3 to 20 percent slopes					929	. 19	925	. 55	52	. 05
Naiwa silty clay loam, 7 to 15 percent slopes, severely eroded							623	. 37		
Niulii silty clay loam, 7 to 30 percent slopes							288	. 17		
Niulii silty clay loam, medium textured variant, 7 to 30 percent slopes							535	. 32		
Oanapuka very stony silt loam, 7 to 25 percent slopes					658	. 14				
Oanapuka extremely stony silt loam, 7 to 25 percent slopes					5, 720	1. 22				
Olelo silty clay, 3 to 15 percent slopes					2, 251	. 48	1, 449	. 87		
Oli silt loam, 3 to 10 percent slopes					372	. 07				
Oli silt loam, 10 to 30 percent slopes	1, 122	. 32					2, 554	1. 53		
Oli silt loam, 30 to 70 percent slopes	3, 037	. 86					1, 008	. 60		
Olinda loam, 4 to 12 percent slopes					213	. 04				
Olinda loam, 12 to 20 percent slopes					2, 816	. 60				
Olinda loam, 20 to 40 percent slopes					1, 596	. 34				
Olokui silty clay loam, 3 to 30 percent slopes							841	. 50	22	. 02
Opihikao extremely rocky muck, 3 to 25 percent slopes					412	. 08				
Paaiki loam, 6 to 35 percent slopes	1, 828	. 51								
Paaiki loam, 35 to 70 percent slopes	733	. 20								
Pakala extremely stony sandy clay loam, 0 to 12 percent slopes	914	. 25								
Pamoa silty clay, 5 to 20 percent slopes			409	. 11			774	. 46	283	. 31
Pamoa silty clay, 5 to 20 percent slopes, eroded							1, 054	. 63	271	. 30
Pamoa stony silty clay, 5 to 20 percent slopes, eroded							1, 087	. 65		
Pane silt loam, 7 to 25 percent slopes					3, 246	. 69				
Papaa clay, 6 to 20 percent slopes			259	. 06						
Papaa clay, 20 to 35 percent slopes			233	. 06						
Papaa clay, 35 to 70 percent slopes			631	. 16						
Paumalu-Badland complex			5, 340	1. 38						
Puuone sand, 7 to 30 percent slopes					4, 579	. 98				
Puu Pa very stony silt loam, 7 to 40 percent slopes					15, 282	3. 27				
Tantalus silt loam, 15 to 40 percent slopes			264	. 06						
Tantalus silt loam, 40 to 70 percent slopes			919	. 23						
Tantalus silty clay loam, 8 to 15 percent slopes			576	. 14						
Tantalus silty clay loam, 15 to 40 percent slopes			339	. 08						
Tropaquepts			488	. 12	180	. 03				
Ulupalakua silt loam, 7 to 25 percent slopes					1, 986	. 42				
Uma loamy coarse sand, 15 to 40 percent slopes					1, 724	. 37				
Uma loamy coarse sand, 40 to 70 percent slopes					2, 631	. 56				
Uma rocky loamy coarse sand, 7 to 25 percent slopes					936	. 20				
Waiakoa extremely stony silty clay loam, 3 to 25 percent slopes, eroded					13, 424	2. 88				

TABLE 1.—*Approximate acreage and proportionate extent of the soils*—Continued

LOW-INTENSITY SURVEY—Continued

Soil	Kauai		Ohau		Maui		Molokai		Lanai	
	Acres	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*	*Acres*	*Percent*
Waiawa extremely rocky clay, 30 to 80 percent slopes	8,903	2.50								
Total	53,535	14.98	85,592	22.01	136,340	29.05	26,087	15.58	10,409	11.53

RECONNAISSANCE SURVEY

Soil	Kauai Acres	Kauai Percent	Ohau Acres	Ohau Percent	Maui Acres	Maui Percent	Molokai Acres	Molokai Percent	Lanai Acres	Lanai Percent
Alakai mucky peat, 0 to 30 percent slopes	6,646	1.87	319	.08						
Amalu peaty silty clay, 3 to 20 percent slopes					5,684	1.21	1,034	.62		
Amalu-Olokui association, 3 to 20 percent slopes							1,004	.60		
Cinder land			579	.14	9,978	2.14				
Honomanu silty clay, 5 to 25 percent slopes					1,936	.41				
Honomanu-Amalu association					10,186	2.18				
Hydrandepts-Tropaquods association					41,525	8.91				
Lava flows, Aa					9,030	1.93				
Riverwash	902	.25								
Rock land	1,382	.38	37,537	9.71	13,762	2.95	8,800	5.28	7,007	7.78
Rock outcrop	41,786	11.77	7,749	2.00	16,244	3.48	7,241	4.35	5,890	6.54
Rough broken land	46,368	13.06			14,731	3.16	8,964	5.38	1,045	1.16
Rough broken and stony land					3,035	.65				
Rough mountainous land	69,502	19.57	59,790	15.46	52,122	11.18	32,960	19.80	2,867	3.18
Rubble land	925	.26								
Sandy alluvial land									475	.52
Stony alluvial land					4,683	1.00	811	.48	216	.24
Stony blown-out land									1,415	1.57
Stony colluvial land							753	.45		
Stony land			6,530	1.68						
Stony steep land			8,064	2.08						
Tropaquods							4,611	2.77		
Tropohumults-Dystrandepts association			17,463	4.51						
Very stony land					41,574	8.92	8,921	5.36	15,180	16.86
Very stony land, eroded							16,228	9.75	17,314	19.23
Waialeale mucky silty clay loam, 30 to 70 percent slopes	4,581	1.29								
Total	172,092	48.45	138,031	35.66	224,490	48.12	91,327	54.84	51,409	57.08

ity is about 1.2 inches per foot in the surface layer and 0.9 inch per foot in the substratum. In some places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°50′20″ N. and long. 156°25′53″ W.

A11—0 to 2 inches, very dark brown (10YR 2/2) cobbly sandy loam, very dark grayish brown (10YR 3/2) when dry; weak, fine, granular structure; soft, very friable, nonsticky and nonplastic; plentiful very fine roots; many fine pores; many ash particles, up to 2 millimeters in diameter, that do not break down with continued rubbing; neutral; clear, smooth boundary. 2 to 3 inches thick.

A12—2 to 7 inches, very dark grayish-brown (10YR 3/2) sandy loam, brown (10YR 4/4) when dry; massive; soft, very friable, nonsticky and nonplastic; plentiful fine roots; many fine and very fine pores; many ash particles, up to 2 millimeters in diameter, that do not break down with continued rubbing; a few thin layers of yellowish-red (5YR 4/6), slightly decomposed, volcanic cinders (0.15 to 1 millimeter); mildly alkaline; clear, wavy boundary. 4 to 8 inches thick.

C1—7 to 14 inches, very dark grayish-brown (10YR 3/2) sandy loam, brown (10YR 4/3) when dry; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine pores; many ash particles, up to 2 millimeters in diameter, that do not break down with continued rubbing; slight effervescence with hydrochloric acid; mildly alkaline; abrupt, wavy boundary. 5 to 15 inches thick.

IIC2ca—14 to 29 inches, very dark gray (10YR 3/1) coarse and very coarse sand, gray (10YR 5/1) when dry; single grain; loose; many ash particles up to 2 millimeters in diameter; many pebble-size fragments of basalt; violent effervescence with hydrochloric acid; moderately alkaline; clear, wavy boundary. 10 to 18 inches thick.

IIIC3ca—29 to 55 inches, grayish-brown (10YR 5/2) very coarse sand, gray (10YR 5/1) when dry; single grain; loose; 40 to 50 percent gravel and cobblestones; many volcanic ash particles up to 2 millimeters in diameter; strong effervescence with hydrochloric acid; moderately alkaline.

The content of cobblestones in the A horizon ranges from 5 to 40 percent. In places there are no cobblestones in this horizon. The A horizon ranges from 10YR to 7.5YR in hue, from 2 to 3 in value when moist and from 3 to 5 when dry, and from 1 to 3 in chroma when moist or dry. The C horizon is stratified and has textures of sandy loam, coarse sand, and very coarse sand. In some places a few bands of volcanic ash, ¼ to ¾ inch thick, occur in the C horizon.

This soil is used for sugarcane and pasture. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Alae cobbly sandy loam, 3 to 7 percent slopes (AcB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane and pasture. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Alae sandy loam, 3 to 7 percent slopes (AaB).—This soil is similar to Alae cobbly sandy loam, 0 to 3 percent slopes, except that there are no cobblestones on the surface. Runoff is slow, and the erosion hazard is slight. Included in mapping were small, nearly level areas. In places there are few to many pebble-size rock fragments in the surface layer.

Most of this soil is used for sugarcane and pasture. A small acreage is used for truck crops. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Alaeloa Series

This series consists of well-drained soils on uplands on the islands of Maui, Molokai, and Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to very steep. Elevations range from 100 to 1,500 feet. The annual rainfall amounts to 35 to 60 inches, and it is well distributed throughout the year. The mean annual soil temperature is 72° F. Alaeloa soils are geographically associated with Kaneohe, Lolekaa, Papaa, Waikane, Honolua, and Kahana soils.

These soils are used for pineapple, pasture, wildlife habitat, homesites, and water supply. Small acreages are used for truck crops and orchards. The natural vegetation consists of guava, Java plum, Christmas berry, Japanese tea, and hilograss.

Alaeloa silty clay, 15 to 35 percent slopes (AeE).—This soil occurs on smooth side slopes and toe slopes in the uplands. Included in mapping were small areas of dark-brown soils on uplands and wet soils in the drainageways. Also included were small, eroded areas and gently sloping to moderately sloping areas.

In a representative profile the surface layer is dark reddish-brown silty clay about 10 inches thick. The subsoil, about 48 inches thick, is dark-red and red silty clay that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is medium acid in the surface layer and strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.2 inches per foot in the surface layer and 1.6 inches per foot in the subsoil. Roots penetrate to a depth of 5 feet or more in places. Workability is difficult because of the slope.

Representative profile: Island of Oahu, lat. 21°21′50″ N. and long. 157°44′27″ W.

Ap—0 to 10 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; strong, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic; abundant fine and medium roots; many very fine roots; many, very fine and fine, interstitial and tubular pores; common wormholes and worm casts; some dark-red material from B horizon mixed by cultivation; slight effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 9 to 10 inches thick.

B21t—10 to 18 inches, dark-red (2.5YR 3/6) silty clay, red (2.5YR 4/6) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; common, very fine and fine, tubular pores; few, medium, tubular pores; few wormholes and worm casts; thin, continuous clay films on peds; strongly acid; clear, wavy boundary. 6 to 8 inches thick.

B22t—18 to 29 inches, dark-red (2.5YR 3/6) silty clay, red (2.5YR 4/6) when dry; strong, very fine and medium, subangular blocky structure; hard, friable, sticky and plastic; abundant very fine roots; few, fine, tubular pores; thin, continuous clay films on peds; some films are dark red and some dark brown; strongly acid; gradual, wavy boundary. 9 to 13 inches thick.

B23t—29 to 48 inches, coarse pattern of red (10R 5/6, 2.5YR 4/6 and 4/8) silty clay; red (10R 4/6), dark red (2.5YR 3/6), and dark reddish brown (2.5YR 3/4) when moist; strong, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many, very fine, tubular pores and common, fine, tubular pores; thick, continuous, dark-red clay films in vertical cracks; coated ped faces; some granular (sugarlike) material on peds; few soft rock fragments; strongly acid; clear, wavy boundary. 18 to 26 inches thick.

B24t—48 to 58 inches, red (2.5YR 4/6) silty clay, red (2.5YR 5/6) when dry; strong, very fine and medium, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many, very fine and fine, tubular pores; thick, continuous clay films on peds; weak slickensides; many black specks; many soft, highly weathered rock fragments; strongly acid.

The A horizon ranges from 5YR to 2.5YR in hue, and, when moist, from 2 to 3 in value and chroma. The B horizon ranges from 2.5YR to 10R in hue. It ranges from 2 to 5 in value when moist or dry and from 4 to 6 in chroma when moist and 6 to 8 when dry. The Bt horizon ranges from silty clay to clay loam in texture. Slickensides and organic stains in the Bt horizon range from few to many. In most places depth to the soft, highly weathered parent rock ranges from 3 feet to more than 5 feet. In some places there are stones on the surface or in the profile or areas of rock outcrop.

This soil is used for pineapple, pasture, truck crops, orchards, wildlife habitat, and homesites. Small areas are used for sugarcane. (Capability classification VIe, nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Alaeloa silty clay, 3 to 7 percent slopes (AeB).—On this soil, runoff is slow and the erosion hazard is slight. Workability is easy. Included in mapping were small, nearly level areas.

This soil is used for pineapple. A small acreage is used for pasture and homesites. (Capability classification IIe, irrigated or nonirrigated; pineapple group 5; pasture group 6; woodland group 5)

Alaeloa silty clay, 7 to 15 percent slopes (AeC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult.

This soil is used for pineapple. A small acreage is used for pasture and homesites. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Alaeloa silty clay, 40 to 70 percent slopes (AlF).—In areas of this soil, the most common slope range is 45 to 53 percent. Runoff is rapid to very rapid, and the erosion hazard is severe. Included in mapping were small areas on slopes of less than 35 percent, stony areas, and rock outcrops.

This soil is used for pasture and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 6; woodland group 15)

Alaeloa silty clay, 15 to 35 percent slopes, severely eroded (ALE3).—This soil has a profile like that of Alaeloa silty clay, 15 to 35 percent slopes, except that much of the surface layer and, in places, some of the subsoil has been removed by erosion. Many small included areas have been eroded to soft, highly weathered rock. Most areas are nearly free of stones, but some small areas that are eroded to weathered rock are very stony. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 6; woodland group 5)

Alaeloa stony silty clay, 15 to 35 percent slopes, severely eroded (AME3).—This soil has a profile like that of Alaeloa silty clay, 15 to 35 percent slopes, except that most of the surface layer and, in places, some of the subsoil has been removed by erosion. Highly weathered rock is exposed in many places. There are many stones and some rock outcrop on the surface. In a few places there are boulders as much as 4 feet in diameter. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 6; woodland group 5)

Alaeloa stony silty clay, overwash, 15 to 35 percent slopes (ANE).—This soil has a profile like that of Alaeloa silty clay, 15 to 35 percent slopes, except that it has an overburden of dark-brown stony silty clay, 1 foot to 4 feet thick. Stones and gravel occur throughout the profile. The soil is on toe slopes and in depressions where fine-textured alluvium has accumulated. The erosion hazard is severe, and gullies are common. About 10 percent of this soil is nonstony.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Alakai Series

This series consists of very poorly drained soils on uplands on the islands of Kauai and Oahu. These soils formed by the deposition and decomposition of organic matter over basalt, under wet conditions. They are level to moderately steep. Elevations range from 3,000 to 5,000 feet. The annual rainfall amounts to 100 to 450 inches. There is cloud and fog cover almost daily. The mean annual soil temperature is 56° F. Alakai soils are geographically associated with Waialeale soils.

These soils are not cultivated, because they are always wet. They are used for water supply and wildlife habitat. The natural vegetation consists of ohia lehua, Hawaiian lobelia, mokihana, puakeawe, treefern, and other rainforest vegetation.

Alakai mucky peat, 0 to 30 percent slopes (rAAE).—This soil occurs on mountaintops and high ridges. Included in mapping were small areas of hypnum moss peat. In these areas the water table is at or near the surface, and the vegetation consists of mosses, scrub ohia, and puakeawe. Also included was a small area of Alakai soil mapped at an elevation below 2,000 feet.

In a representative profile the surface layer is very dusky red mucky peat about 8 inches thick. Below this is dark reddish-brown, reddish-black, and very dusky red muck about 24 inches thick. The texture of the substratum is clay. Some layers are gray, and some are greenish gray.

Permeability is slow below the muck. Runoff is slow, and the erosion hazard is slight. Reaction is extremely acid.

Representative profile: Island of Kauai, lat. 22°09′25″ N. and long. 159°35′48″ W.

1—0 to 8 inches, very dusky red (10R 2/2) mucky peat, reddish black (10R 2/1) when dry; massive; extremely hard, friable, smeary and nonsticky and nonplastic; abundant roots; extremely acid; clear, smooth boundary. 7 to 12 inches thick.

2—8 to 14 inches, reddish-black (10R 2/1) muck, reddish black (10R 2/1) when dry; massive; extremely hard, firm, smeary and slightly sticky and slightly plastic; abundant roots; extremely acid; clear, smooth boundary. 5 to 9 inches thick.

3—14 to 22 inches, dark reddish-brown (2.5YR 2/4) muck, reddish black (10R 2/1) when dry; massive; extremely hard, friable, smeary and slightly sticky and slightly plastic; abundant roots; extremely acid; clear, smooth boundary. 6 to 10 inches thick.

4—22 to 32 inches, very dusky red (2.5YR 2/2) muck, black (N 2/0) when dry; massive; extremely hard, friable, smeary and slightly sticky and slightly plastic; abundant roots; extremely acid; abrupt, smooth boundary. 6 to 10 inches thick.

IIC1—32 to 38 inches, gray (N 6/0 and 5Y 5/1), brown (7.5YR 5/4), and reddish-yellow (7.5YR 6/8) clay; rubbed (mixed) color is grayish brown (2.5Y 5/2), gray (2.5Y 6/1) when dry; massive; very hard, firm, very sticky and very plastic; few very fine and micro roots; common micro pores; this layer is capped by 1 to 2 inches of gravelly clay; extremely acid; clear, smooth boundary. 4 to 8 inches thick.

IIC2—38 to 51 inches, gray (N 6/0) and grayish-brown (2.5Y 5/2) clay, gray (N 6/0 and 5Y 6/1) and light gray (5Y 7/1) when dry; massive; very hard, firm, very sticky and very plastic; few very fine roots; common micro pores; some irregularly shaped pebbles, ½ inch to 2 inches across; extremely acid.

The depth to clay ranges from 18 to 36 inches. In places the clay rests on an ironstone sheet ⅛ inch to 4 inches thick. The organic layers range from 10R to 5YR in hue. The values are 2 to 3 when moist and 2 when dry. The clay layers are brown, gray, and greenish gray. They range from 5 to 7 in value and from 0 to 1 in chroma when moist or dry.

This soil is used for water supply and wildlife habitat. (Capability classification VIIw, nonirrigated; woodland group 16)

Amalu Series

This series consists of poorly drained soils on dissected uplands on the islands of Maui and Molokai. These soils developed in organic material and material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 2,000 to 5,500 feet. The annual rainfall amounts to 75 to 400 inches. Fog and cloud cover are present most days throughout the year. The mean annual soil temperature is 58° F. Amalu soils are geographically associated with Honomanu, Kahanui, and Olokui soils.

These soils are used for water supply and wildlife habitat. The natural vegetation consists of clubmoss, lapalapa, ohelo, ohia, sedges, false staghornfern, and treefern.

Amalu peaty silty clay, 3 to 20 percent slopes (rAMD).—This soil is on high ridges and mountaintops. Included in mapping were small areas of Honomanu and Olokui soils and of steep gulches.

In a representative profile an organic layer of black peat, about 8 inches thick, overlies a layer of gray massive clay about 8 inches thick. The substratum is soft, weathered basic igneous rock capped by a horizontal ironstone sheet 1/8 to 1 inch thick. The soil is extremely acid above the ironstone layer.

Permeability is restricted by the ironstone sheet, which is impermeable except for cracks. Runoff is very slow, and the erosion hazard is no more than slight. Roots penetrate to a depth of 8 to 15 inches in places.

Representative profile: Island of Maui, lat. 20°48′46″ N. and long. 156°13′44″ W.

O1—8 inches to 0, black (5YR 2/1) peat; massive; soft, nonsticky and nonplastic; abundant medium and coarse roots; extremely acid; abrupt, wavy boundary. 5 to 15 inches thick.

A2g—0 to 8 inches, gray (10YR 5/1) clay; massive; firm, sticky, plastic and weakly smeary; abundant roots; many, fine and medium, tubular pores; common dark-gray (10YR 4/1) organic stains; extremely acid; abrupt, smooth boundary. 4 to 15 inches thick.

B2irm—8 to 8¼ inches, dark reddish-brown (5YR 2/2) horizontal, laminar ironstone sheet that has a surface that appears to be troweled; thin coating of yellowish-red (5YR 4/6) soft material on upper surface. 1/8 to 1 inch thick.

C—8¼ to 60 inches +, very dark gray (10YR 3/1) saprolite that has light-gray (10YR 7/1) and yellowish-red (5YR 5/6) colors in and adjacent to cracks; breaks down to smeary silt loam; saprolite has some original rock structure; soft plinthite in cracks or coatings around rock cores; few, hard, discontinuous ironstone sheets, up to 1 inch thick, oriented horizontally and vertically. Many feet thick.

The depth to the ironstone sheet ranges from 8 to 15 inches below the base of the O1 horizon. The A2g horizon ranges from 10YR to 5Y in hue, from 2 to 5 in value, and from 1 to 2 in chroma. In places a black mucky layer, 1 to 2 inches thick, occurs between the A2g and B2irm horizons.

This soil is used for water supply and wildlife habitat. (Capability classification VIIw, nonirrigated; woodland group 16)

Amalu-Olokui association, 3 to 20 percent slopes (rAOD).—This association consists of Amalu peaty silty clay, 3 to 20 percent slopes, and Olokui silty clay loam, 3 to 30 percent slopes. It is on intermediate uplands in the eastern part of the island of Molokai. Amalu soils make up about 60 percent of the association, and Olokui soils about 40 percent. Amalu soils occupy the depressions and the wetter sites. Included in mapping were small areas of Kahanui soils and many small, very steep gulches.

This association is used for water supply and wildlife habitat. (Amalu part is in capability classification VIIw, nonirrigated; woodland group 16. Olokui part is in capability classification VIIIw, nonirrigated; woodland group 16)

Badland

Badland consists of steep or very steep, nearly barren land, ordinarily not stony. The soil-forming material is generally soft or hard saprolite. The annual rainfall amounts to 22 to 60 inches. Elevations range from nearly sea level to about 3,000 feet. This land type is mapped on the island of Kauai and, in addition, as part of soil complexes on Lanai, Molokai, and Oahu.

Badland (BL).—This land type occurs on the island of Kauai. It is steep to very steep and nearly barren. Runoff is very rapid, and geological erosion is active. Included in mapping were areas of Kalapa, Lihue, and Makaweli soils.

This land type is used for water supply and wildlife habitat. Ironwood trees have been planted in small areas. (Capability classification VIIIe, nonirrigated)

Badland-Mahana complex (BM).—This complex occurs on the western side of the island of Kauai. Badland makes up about 60 percent of the acreage; Mahana silt loam, 20 to 35 percent slopes, makes up about 40 percent. Elevations range from 1,500 to 3,000 feet. The annual rainfall amounts to 30 to 45 inches. Slopes are steep to very steep.

Most of the Badland part of this complex is barren, but some areas have been planted to ironwood, silk-oak, and eucalyptus. The Mahana part is used for pasture and woodland. (Badland part is in capability classification VIIIe, nonirrigated. Mahana part is in capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Beaches

Beaches (BS) occur as sandy, gravelly, or cobbly areas on all the islands in the survey area. They are washed and rewashed by ocean waves. The beaches consist mainly of light-colored sands derived from coral and seashells. A few of the beaches, however, are dark colored because their sands are from basalt and andesite.

Beaches have no value for farming. Where accessible and free of cobblestones and stones, they are highly suitable for recreational uses and resort development. (Capability classification VIIIw, nonirrigated)

Blown-out Land

Blown-out land (BW) occurs mainly on the windswept northern plateau of the island of Lanai. The slope ranges from 0 to 15 percent, but included in mapping were areas adjacent to gulches and hummocks, where the slope is as much as 40 percent. Elevations range from 1,500 to 1,700 feet. The annual rainfall amounts to 15 to 25 inches. Strong trade winds are common. Most areas are barren and are eroded to the compact subsoil or to soft, weathered rock. The subsoil material is similar to that of Kanepuu and Lahaina soils. As much as 10 percent of the area has hummocks or small dunes that are partly stabilized by dallisgrass, molassesgrass, bermudagrass, and ilima. Runoff is rapid, and the erosion hazard is severe.

The main management requirement on this land type is the provision of vegetative cover to check further loss of soil material. Test plantings of pineapple have indicated that Blown-out land is very deficient in zinc, as well as in major nutrient elements. (Capability classification VIIe, nonirrigated)

Cinder Land

Cinder land (rCl) consists of areas of bedded magmatic ejecta associated with cinder cones. It is a mixture of cinders, pumice, and ash. These materials are black, red, yellow, brown, or variegated in color. They have jagged edges and a glassy appearance and show little or no evidence of soil development.

Cinder land occurs on the islands of Maui and Oahu. On Maui, it is mainly at elevations between 8,000 and 10,000 feet, in the Haleakala National Park. On Oahu, it is mainly at elevations between 200 and 2,000 feet, near Mount Tantalus. The annual rainfall amounts to 20 to 30 inches on Maui and 60 to 100 inches on Oahu.

Although Cinder land commonly supports some vegetation, it has no value for grazing, because of its loose nature and poor trafficability. It is used for wildlife habitat and recreational areas. (Capability classification VIIIs, nonirrigated)

Colluvial Land

Colluvial land (CO) consists of steep and very steep talus slopes in windward valleys on the island of Molokai. It occurs in isolated valleys that are accessible only by long mountain trails or by boat during the summer months. It is characterized by a mixture of soil material, gravel, stones, and boulders moved by gravity and water. The soil material is very dark brown silty clay loam and silty clay. The slope generally ranges from 25 to 60 percent, but it is more gentle along valley bottoms. There are many intermittent streams throughout this area. Elevations range from sea level to 1,000 feet. The annual rainfall amounts to 70 to 100 inches.

This land type is used for watershed and for wildlife habitat. The vegetation consists of dense stands of guava, kukui, ginger, honohono, hilograss, and associated plants. (Capability classification VIIe, nonirrigated; woodland group 15)

Coral Outcrop

Coral outcrop (CR) consists of coral or cemented calcareous sand on the island of Oahu. The coral reefs formed in shallow ocean water during the time the ocean stand was at a higher level. Small areas of coral outcrop are exposed on the ocean shore, on the coastal plains, and at the foot of the uplands. Elevations range from sea level to approximately 100 feet. The annual rainfall amounts to 18 to 40 inches. Coral outcrop is geographically associated with Jaucas, Keaau, and Mokuleia soils.

Coral outcrop makes up about 80 to 90 percent of the acreage. The remaining 10 to 20 percent consists of a thin layer of friable, red soil material in cracks, crevices, and depressions within the coral outcrop. This soil material is similar to that of the Mamala series.

This land type is used for military installations, quarries, and urban development. Vegetation is sparse. It consists of kiawe, koa haole, and fingergrass. (Capability classification VIIIs, nonirrigated)

Dune Land

Dune land (DL) consists of hills and ridges of sand-size particles drifted and piled by wind. The hills and ridges are actively shifting or are so recently fixed or stabilized that no soil horizons have developed. The sand is dominantly from coral and seashells. This miscellaneous land type occurs in coastal areas on the islands of Maui and Kauai. Elevations range from nearly sea level to 150 feet. The annual rainfall amounts to 15 to 90 inches.

This land type is used for wildlife habitat and recreational areas and as a source of liming material. Vegetation is sparse, but ironwood trees, koa haole, tropical almond, kiawe, and mixed grasses have gained a foothold in places. (Capability classification VIIIe, nonirrigated)

Ewa Series

This series consists of well-drained soils in basins and on alluvial fans on the islands of Maui and Oahu. These soils developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. Elevations range from near sea level to 150 feet. The annual rainfall amounts to 10 to 30 inches. Most of it occurs between November and April. The mean annual soil temperature is 73° F. Ewa soils are geographically associated with Honouliuli, Mamala, Molokai, Pulehu, and Waiakoa soils.

These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of fingergrass, kiawe, koa haole, klu, and uhaloa.

Ewa silty clay loam, 3 to 6 percent slopes (EaB).—This soil occurs on alluvial fans and terraces. Included in mapping were small areas of Honouliuli and Mamala soils. Also included were small areas of soils that have a silt loam surface layer and subsoil.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 18 inches thick. The subsoil, about 42 inches thick, is dark reddish-brown and dark-red silty clay loam that has subangular blocky structure. The substratum is coral limestone, sand, or gravelly alluvium. The soil is neutral in the surface layer and subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot in the surface layer and 1.4 inches per foot in the subsoil. This soil is more than 60 inches deep. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°22′20″ N. and long. 158°03′33″ W.

Ap1—0 to 13 inches, dark reddish-brown (5YR 2/3) silty clay loam, dark reddish brown (5YR 3/3) when dry; cloddy, breaking to weak, fine, and very fine, granular structure; hard, friable, sticky and plastic; abundant fine and very fine roots; many, fine and very fine, interstitial pores; common wormholes and worm casts; many, very fine, black concretions that effervesce strongly with hydrogen peroxide; neutral; clear, wavy boundary. 11 to 13 inches thick.

Ap2—13 to 18 inches, dark reddish-brown (2.5YR 3/3) silty clay loam, dark reddish brown (2.5YR 3/4) when dry; weak, fine and very fine, granular structure; hard, friable, sticky and plastic; abundant fine and very fine roots; common, very fine, tubular and interstitial pores; many, very fine, black concretions that effervesce strongly with hydrogen peroxide; clear, wavy boundary. 3 to 6 inches thick.

B21—18 to 45 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; weak, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; plentiful very fine and fine roots; many, fine and very fine, tubular pores; common, medium, tubular pores, and few, coarse, tubular pores; weak, patchy pressure cutans on ped faces; few reddish-yellow and yellow sand grains; common, very fine, black concretions that effervesce strongly with hydrogen peroxide; neutral; diffuse, wavy boundary. 25 to 28 inches thick.

B22—45 to 60 inches, dark-red (2.5YR 2/5) silty clay loam, dark red (2.5YR 3/6) when dry; moderate, medium and fine, subangular blocky structure; hard, friable, slightly sticky and plastic; plentiful fine and very fine roots; many, fine and very fine, tubular pores and few, medium, tubular pores; many, thin, patchy coatings that are nearly continuous with depth; many sand grains; many, very fine, black concretions that effervesce strongly with hydrogen peroxide; neutral.

The depth to coral limestone or gravelly alluvium ranges from 50 to more than 60 inches. In some areas cobblestones and stones occur on the surface and in the surface layer. The A and B horizons range from 5YR to 2.5YR in hue and, when moist, from 2 to 3 in value and from 3 to 5 in chroma. The texture of the A horizon is silty clay loam or silty clay. The structure in the B horizon ranges from weak to moderate.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Ewa silty clay loam, 0 to 3 percent slopes (EaA).—On this soil, runoff is very slow and the erosion hazard is no more than slight. In a few places small, gently sloping areas were included in mapping.

This soil is used for sugarcane and homesites. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 2)

Ewa silty clay loam, 6 to 12 percent slopes (EaC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were a few small areas that are strongly sloping.

This soil is used for sugarcane and pasture. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 3; pasture group 2)

Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes (EmA).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except that the depth to coral limestone is 20 to 50 inches. Runoff is very slow, and the erosion hazard is no more than slight. Included in mapping were a few small areas less than 20 inches deep.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIs if irrigated, IVs if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 2)

Ewa silty clay loam, moderately shallow, 2 to 6 percent slopes (EmB).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except that the depth to coral limestone is 20 to 50 inches. Included in mapping were small areas less than 20 inches deep.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Ewa cobbly silty clay loam, 0 to 3 percent slopes (EcA).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except that it is cobbly on the surface. Runoff is very slow, and the erosion hazard is no more than slight.

Most of this soil is used for sugarcane. A small acreage is used for pasture. (Capability classification IIs if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Ewa cobbly silty clay loam, 3 to 7 percent slopes (EcB).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except that it is cobbly on the surface. Included in mapping were a few small, stony areas.

Most of this soil is used for sugarcane. A small acreage is used for pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Ewa silty clay, 0 to 3 percent slopes (EsA).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer. Runoff is very slow, and the erosion hazard is no more than slight.

This soil is used for sugarcane. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 2)

Ewa silty clay, 3 to 7 percent slopes (EsB).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer.

Most of this soil is used for sugarcane. A small acreage is used for pasture. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Ewa cobbly silty clay, 3 to 7 percent slopes (EtB).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer. Cobblestones in the surface layer interfere with tillage but do not make intertilled crops impracticable.

This soil is used for sugarcane. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Ewa stony silty clay, 0 to 2 percent slopes (EwA).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer. Surface stones interfere with tillage but do not make intertilled crops impracticable. Runoff is very slow, and the erosion hazard is no more than slight. Included in mapping were a few small areas where the texture of the surface layer is silty clay loam.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIs if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Ewa stony silty clay, 2 to 6 percent slopes (EwB).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer. Stones in the surface layer interfere with tillage, but not enough to make intertilled crops impracticable. Included in mapping were a few small, nonstony areas where the texture of the surface layer is silty clay loam.

This soil is used for sugarcane and pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Ewa stony silty clay, 6 to 12 percent slopes (EwC).—This soil has a profile like that of Ewa silty clay loam, 3 to 6 percent slopes, except for the texture of the surface layer. Surface stones interfere with tillage but do not make intertilled crops impracticable. Runoff is slow to medium, and the erosion hazard is slight to moderate. Included in mapping were small, gently sloping areas.

This soil is used for pasture. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Fill Land

This land type consists of areas filled with material from dredging, excavation from adjacent uplands, garbage, and bagasse and slurry from sugar mills. The areas are on the islands of Kauai, Maui, and Oahu.

Fill land (Fd).—This land type consists mostly of areas filled with bagasse and slurry from sugar mills. A few areas are filled with material from dredging and from soil excavations. Generally, these materials are dumped and spread over marshes, low-lying areas along the coastal flats, coral sand, coral limestone, or areas shallow to bedrock.

This land type is used mostly for the production of sugarcane. (Not in a capability classification)

Fill land, mixed (Fl).—This land type occurs mostly near Pearl Harbor and in Honolulu, adjacent to the ocean. It consists of areas filled with material dredged from the ocean or hauled from nearby areas, garbage, and general material from other sources. Included in mapping were a few areas that have been excavated.

This land type is used for urban development including airports, housing areas, and industrial facilities. (Not in a capability classification)

Gullied Land

Gullied land (Gl) occurs on the island of Molokai. It is so cut by recent gullies that it is nonarable and the soil profile has been largely destroyed. Erosion is very active, and the soil is bare in many places. Kiawe, ilima, uhaloa, and piligrass provide some protection. Elevations range from nearly sea level to 1,200 feet. The annual rainfall amounts to 20 to 25 inches. This land type is geographically associated with Pamoa, Waikapu, Hoolehua, and Waihuna soils.

Gullied land occurs in the heads of drainageways and on alluvial terraces along the streams. Near the upper margins of the drainageways, almost vertical-sided gullies have cut back into the undisturbed soil areas, leaving remnants of deep soil between gullies. Farther down the slopes, these little spurs are also eroded to varying degrees; at still lower elevations, stones and bedrock are left in the gullies. Slopes on these gulches range from 25 to 70 percent. Where this land type occurs on alluvial terraces, as in the Mahana area of Molokai (fig. 3), there are small tillable areas between gullies. The slope is 3 to 15 percent, and some stones are scattered on the surface. The areas are small and unimportant for cultivation.

This land type is used for pasture. (Capability classification VIIe, nonirrigated)

Haiku Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently to moderately sloping. Elevations range from nearly sea level to 1,200 feet. The annual rainfall amounts to 50

Figure 3.—Gullied land on alluvial terraces. This land type is in the Mahana area on the island of Molokai.

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to 80 inches. The mean annual soil temperature is 70° F. Haiku soils are geographically associated with Makawao, Paia, and Pauwela soils.

These soils are used for pineapple, pasture, and homesites. The natural vegetation consists of californiagrass, guava, hilograss, lantana, and ricegrass.

Haiku clay, 7 to 15 percent slopes (HbC).—This soil occurs on uplands. Included in mapping were small areas of Paia and Pauwela soils. Also included were small eroded spots and small areas where the slope is as much as 25 percent.

In a representative profile the surface layer is dark-brown clay about 14 inches thick. The subsoil, about 31 inches thick, is yellowish-red, dark reddish-brown, and dark-red clay or silty clay that has subangular and angular blocky structure. The substratum is soft, weathered, basic igneous rock. The soil is very strongly acid in the surface layer and extremely acid and very strongly acid in the subsoil and substratum.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.4 inches per foot in the surface layer and 1.3 inches per foot in the subsoil. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°54′04″ N. and long. 156°17′36″ W.

Ap1—0 to 7 inches, dark-brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) when dry; strong, fine and very fine, angular blocky structure and strong, medium and fine, granular; slightly hard, firm, sticky and plastic; abundant fine roots; many fine and few coarse pores; many very fine glistening specks; common sand-size aggregates that are resistant to crushing; common worm casts; high bulk density; very strongly acid; gradual, wavy boundary. 6 to 9 inches thick.

Ap2—7 to 14 inches, dark-brown (7.5YR 4/4) clay, light brown (7.5YR 6/4) when dry; strong, fine and very fine, angular blocky structure and strong, medium and fine, granular; slightly hard, firm, sticky and plastic; plentiful roots; common fine and medium pores; many very fine glistening specks; common sand-size aggregates that are resistant to crushing; more firm in place than the Ap1 horizon; common worm casts; high bulk density; thin, massive layer near contact of Ap2 and B21t horizons; very strongly acid; abrupt, wavy boundary. 6 to 10 inches thick.

B21t—14 to 22 inches, yellowish-red (5YR 4/6) clay, yellowish red (5YR 4/8) when dry; weak and moderate, fine and very fine, angular blocky structure; soft, friable, sticky and plastic; few roots; many fine and medium pores; thin, patchy clay films on peds; few sand-size aggregates that are resistant to crushing; extremely acid; gradual, wavy boundary. 5 to 9 inches thick.

B22t—22 to 31 inches, dark reddish-brown (2.5YR 3/4) clay, dark reddish brown (2.5YR 3/4) when dry; moderate, fine and very fine, angular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; many fine pores; thin, patchy clay films on peds; common sand-size aggregates that are resistant to crushing; few pebble-size nodules; very strongly acid; gradual, wavy boundary. 8 to 10 inches thick.

B23t—31 to 39 inches, dark-red (2.5YR 3/6), moist and dry, clay; moderate and strong, medium and fine, angular and subangular blocky structure; slightly hard, firm, sticky and plastic; few fine roots; many fine and medium pores; thin, patchy clay films on peds; many pebble-size gibbsite nodules; very strongly acid; gradual, wavy boundary. 7 to 11 inches thick.

B3—39 to 45 inches, dark-red (2.5YR 3/6) and reddish-brown (5YR 4/4) silty clay, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular and angular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many fine pores; thin, patchy clay films on peds; 60 to 80 percent of horizon is very dark brown (10YR 2/2), highly weathered, basic igneous rock that can be easily cut with a knife; very strongly acid; gradual, wavy boundary. 4 to 12 inches thick.

C—45 to 66 inches, very dark brown (10YR 2/2) and dark brown (10YR 3/3) highly weathered basalt with dark-red, continuous, thick coatings that look like oxide coatings on rock surfaces; very little soil material in the rock voids; very strongly acid.

The solum is more than 40 inches thick. The A horizon ranges from 5YR to 7.5YR in hue and, in value, from 3 to 4 when moist and from 3 to 6 when dry. It ranges from 3 to 4 in chroma when moist and from 4 to 6 when dry. The texture of the A horizon is silty clay or clay. The B horizon ranges from 5YR to 2.5YR in hue and from 3 to 4 in value when moist or dry. It ranges from 3 to 6 in chroma when moist and from 3 to 8 when dry.

This soil is used for pineapple, pasture, and homesites. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 8; woodland group 7)

Haiku clay, 3 to 7 percent slopes (HbB).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small, nearly level areas.

This soil is used for pineapple, pasture, and homesites. (Capability classification IIe, irrigated or nonirrigated; pineapple group 5; pasture group 8; woodland group 7)

Haiku silty clay, 3 to 7 percent slopes (HaB).—This soil has a profile like that of Haiku clay, 7 to 15 percent slopes, except for the texture of the surface layer. Runoff is slow, and the erosion hazard is slight. Included in mapping were small, nearly level areas.

This soil is used for pineapple and homesites. (Capability classification IIe, irrigated or nonirrigated; pineapple group 5; pasture group 8; woodland group 7)

Haiku silty clay, 7 to 15 percent slopes (HaC).—This soil has a profile like that of Haiku clay, 7 to 15 percent slopes, except for the texture of the surface layer.

This soil is used for pineapple. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 8; woodland group 7)

Halawa Series

This series consists of well-drained soils on uplands on the islands of Maui, Molokai, and Oahu. These soils developed in volcanic ash and in material weathered from basic igneous rock. They are gently sloping to very steep. Elevations range from 500 to 2,000 feet. The annual rainfall amounts to 30 to 60 inches. The mean annual soil temperature is 69° F. Halawa soils are geographically associated with Honolua and Olelo soils.

These soils are used almost entirely for pasture. Small areas are used for pineapple and woodland. The natural vegetation consists of guava, hilograss, kikuyugrass, yellow foxtail, lantana, and brackenfern.

Halawa silty clay, 3 to 25 percent slopes (HlD).—This soil occurs as narrow tracts bounded by gulches. Included in mapping was a tract, about 160 acres in size, of dark-brown soil that is slightly acid throughout the profile. The included area is near Cape Halawa, Molokai, where the rainfall amounts to 25 to 35 inches annually and the elevation is less than 500 feet.

In a representative profile the surface layer is dark reddish-brown silty clay about 11 inches thick. The upper part of the subsoil is reddish-brown silt loam about 5 inches thick. The lower part is dark reddish-brown silty clay, about 28 inches thick, that has subangular blocky structure. The underlying material is silty clay loam over soft, weathered rock. The soil is strongly acid in the surface layer and very strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 inches per foot in the surface layer and 1.6 inches per foot in the subsoil. Roots penetrate to a depth of 5 feet or more. Tillage is somewhat difficult because of the slope.

Representative profile: Island of Molokai, lat. 21°7′4″ N. and long. 156°45′47″ W.

Ap—0 to 11 inches, dark reddish-brown (5YR 3/2) silty clay, dark brown (7.5YR 4/2) when dry; strong, very fine and fine, subangular blocky structure; very hard, firm, sticky and plastic; many roots; common, very fine, tubular pores; few wormholes; many glistening specks; high bulk density; strongly acid; abrupt, smooth boundary. 9 to 12 inches thick.

B21—11 to 16 inches, reddish-brown (5YR 4/4) heavy silt loam, dark brown (7.5YR 4/4) when dry; weak, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; many roots; many very fine and fine tubular pores; bulk density is significantly lower than that of Ap horizon; very strongly acid; abrupt, smooth boundary. 4 to 6 inches thick.

IIB22—16 to 26 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay; moderate, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; many roots; many very fine pores; few pockets of friable silty clay loam; very strongly acid; clear, wavy boundary. 9 to 15 inches thick.

IIB23t—26 to 44 inches, dark reddish-brown (2.5YR 3/4 moist, 5 YR 3/3 dry) silty clay; strong, medium, subangular blocky structure breaking to strong, fine and very fine, subangular blocky; very hard, firm, sticky and plastic; many roots; many very fine pores; thin, nearly continuous clay films on ped surfaces; many gritty lumps; very strongly acid; clear, wavy boundary. 11 to 18 inches thick.

IIC1—44 to 58 inches, dark reddish-brown (5YR 3/4) silty clay loam, mottled with red (2.5YR 4/6), strong brown (7.5YR 4/6), and black (10YR 2/1); massive; hard, firm, sticky and plastic; few roots; many pores; very strongly acid. 12 to 16 inches thick.

IIC2—58 inches, very porous saprolite.

The solum ranges from 33 inches to more than 51 inches in thickness. In the A horizon the concentration of heavy minerals is variable. In some areas the bulk density of the A horizon is high, but in others it is negligible. The A horizon ranges from 5YR to 7.5YR in hue, and, when moist, from 2 to 3 in value and chroma. The B horizon ranges from 5YR to 2.5YR in hue. It ranges from 2 to 4 in value and from 3 to 6 in chroma when moist.

This soil is used mainly for pasture. A small acreage is wooded. (Capability classification IVe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Halawa silty clay, 3 to 25 percent slopes, severely eroded (HlD3).—This soil occurs near Kalae, Molokai. Its profile is like that of Halawa silty clay, 3 to 25 percent slopes, except that most of the surface layer and part of the subsoil have been removed by erosion. In many places cultivation has brought weathered rock fragments to the surface. Runoff is medium, and the erosion hazard is moderate to severe.

This soil is used mainly for pasture. Nearly all the acreage was once used for pineapple, but the crop was poorly suited. Only a few small areas are now used for pineapple. (Capability classification VIe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Halawa silt loam, 20 to 35 percent slopes (HJE).—This soil occurs on side slopes of the Waianae Range, between Waialua and Kolekole Pass. It has a profile like that of Halawa silty clay, 3 to 25 percent slopes, except for the texture of the surface layer. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Tillage is difficult because of the slope.

Included in mapping were small areas that have been eroded down to the bedrock. In places there are remnants of a nearly massive subsoil. Also included, at the higher elevations, were very steep to precipitous areas of Rock land and Stony land.

This soil is used for pasture. Pineapple was formerly grown but was poorly suited. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Halawa silt loam, 35 to 70 percent slopes, eroded (HJF2).—This soil has a profile like that of Halawa silty clay, 3 to 25 percent slopes, except that most of the surface layer and part of the subsoil have been removed by erosion. Runoff is rapid, and the erosion hazard is severe. Included in mapping were a few stony areas.

This soil is used for pasture. Cultivation is impractical, because the soil is too steep. (Capability classification VIIe, nonirrigated; pasture group 6; woodland group 15)

Haleiwa Series

This series consists of well-drained soils on fans and in drainageways along the coastal plains. These soils are on the islands of Oahu and Molokai. They developed in alluvium derived from basic igneous material. They are nearly level to strongly sloping. Elevations range from sea level to 250 feet. The annual rainfall amounts to 30 to 60 inches, most of which occurs between November and April. The mean annual soil temperature is 73° F. Haleiwa soils are geographically associated with Waialua and Kawaihapai soils on Oahu and Kalaupapa soils on Molokai.

These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of koa haole, lantana, guava, Christmas berry, bermudagrass, and fingergrass.

Haleiwa silty clay, 0 to 2 percent slopes (HeA).—This soil occurs as large areas on alluvial fans or as long, narrow areas in drainageways. Included in mapping were small areas of poorly drained clayey soils in depressions, as well as small areas of moderately well drained clayey soils.

In a representative profile the surface layer is dark-brown silty clay about 17 inches thick. The subsoil and substratum, to a depth of more than 5 feet, are dark-brown and dark yellowish-brown silty clay that has subangular blocky structure. The soil is neutral to slightly acid.

Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.9 inches per foot. In places roots penetrate to a depth of 5 feet or more. The soil is subject to occasional nondamaging overflow in some places.

Representative profile: Island of Oahu, lat. 21°34′18″ N. and long. 158°03′33″ W.

Ap1—0 to 9 inches, dark-brown (10YR 3/3) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine and medium, granular structure; hard, firm, sticky and plastic; abundant fine, medium, and coarse roots; many, very fine and fine, interstitial pores; moderate effervescence with hydrogen peroxide; slightly acid; gradual, smooth boundary. 4 to 9 inches thick.

Ap2—9 to 17 inches, dark-brown (10YR 3/3) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine and fine, and few coarse roots; common, fine, tubular pores and few, medium, tubular pores; slight effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 6 to 9 inches thick.

B2—17 to 26 inches, dark-brown (10YR 3/3), moist and dry, silty clay; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine and fine roots; common, fine, tubular pores and few, medium, tubular pores; patchy, red material that looks like clay films in pores and on some peds; slight effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 8 to 10 inches thick.

C1—26 to 36 inches, dark-brown (10YR 3/3), moist and dry, silty clay; weak, fine, subangular blocky structure; hard, firm, sticky and plastic; plentiful very fine and fine roots; many, very fine, tubular pores; common, medium, tubular pores; few, coarse, tubular pores; moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 8 to 12 inches thick.

C2—36 to 48 inches, dark yellowish-brown (10YR 3/4) silty clay, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and medium roots; many, very fine, tubular pores; common, fine, tubular pores; few, medium, tubular pores; slight effervescence on soil mass with hydrogen peroxide; neutral; clear, wavy boundary. 10 to 12 inches thick.

C3—48 to 65 inches, dark yellowish-brown (10YR 3/4) silty clay, dark brown (10YR 3/3) when moist; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; many, very fine, tubular pores and few tubular pores; slight effervescence with hydrogen peroxide on stains within pores.

In places the A horizon is silty clay loam or very stony silty clay loam. The solum ranges from 10YR to 7.5YR in hue. A few rounded pebbles occur throughout the profile. In places stones or stratified sand and gravel occur at a depth below 40 inches.

This soil is used for sugarcane, pasture, and truck crops. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Haleiwa silty clay, 2 to 6 percent slopes (HeB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, and truck crops. (Capability classification IIe if irrigated. IIIc if nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Haleiwa silty clay loam, 0 to 10 percent slopes (HcB).—This soil occurs on the Kalaupapa peninsula on Molokai. It has a profile like that of Haleiwa silty clay, 0 to 2 percent slopes, except for the texture of the surface layer and the slope. Runoff is slow to medium, and the erosion hazard is slight. In most places the slope is 3 to 10 percent. In most areas there are a few scattered stones in the surface layer.

This soil is used for pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Haleiwa very stony silty clay loam, 0 to 15 percent slopes (HdC).—This soil occurs on the Kalaupapa peninsula on Molokai. Runoff is slow to medium, and the erosion hazard is slight to moderate. There are many stones on the surface and in the profile. The stones make cultivation difficult.

This soil is used for pasture. (Capability classification VIs, irrigated or nonirrigated; pasture group 3; woodland group 1)

Halii Series

This series consists of well drained and moderately well drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock, probably mixed with volcanic ash and ejecta. They are gently sloping to steep. Elevations range from 300 to 1,000 feet. The annual rainfall amounts to 100 to 200 inches. The mean annual soil temperature is 71° F. Halii soils are geographically associated with Kapaa and Koolau soils.

These soils are used for water supply, wildlife habitat, sugarcane, and pasture. The natural vegetation consists of melastoma, rhodomyrtus, guava, ricegrass, and associated shrubs and grasses.

Halii gravelly silty clay, 3 to 8 percent slopes (HfB).—This soil occurs on ridgetops and side slopes on uplands.

In a representative profile the surface layer is very dark grayish-brown gravelly silty clay about 6 inches thick. The upper part of the subsoil is dark reddish-brown and strong-brown silty clay and clay loam that has subangular blocky structure. Red bands up to 2 inches thick are common. The lower part of the subsoil consists of bands of red clay loam that continue to a depth of more than 60 inches. The substratum is soft, weathered rock. The soil is very strongly acid in the surface layer and very strongly acid to extremely acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°00′32.3″ N. and long. 159°25′54.3″ W.

A11—0 to 3 inches, very dark grayish-brown (10YR 3/2) gravelly silty clay, very dark brown (10YR 2/2) when dry; moderate, fine and very fine, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; abundant roots; the pebbles and sand grains are of the kind usually called ironstone; soil aggregates tend to harden irreversibly; very strongly acid; clear, smooth boundary. 2 to 5 inches thick.

A12—3 to 6 inches, very dark grayish-brown (10YR 3/2) ironstone gravel and very coarse sand that contains a little clay; single grain; loose; abundant roots; very strongly acid; abrupt, smooth boundary. 2 to 8 inches thick.

B21—6 to 15 inches, strong-brown (7.5YR 4/5) heavy silty clay loam, reddish brown (5YR 4/4) when dry; moderate, medium, subangular blocky structure; soft, friable, sticky and plastic; plentiful roots; common very fine pores; contains numerous hard and soft pebbles and sand ranging from 1 millimeter to several centimeters in diameter; peds have nearly continuous coatings that look like clay films; extremely acid; abrupt, wavy boundary. 8 to 12 inches thick.

B22—15 to 18 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/4) and dark reddish brown (5YR 3/3) when dry; moderate, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; common fine and very fine pores; 10 to 15 percent weathered rock fragments that are cemented and cannot be broken in the hand; numerous patchy coatings that look like clay films, nearly continuous in places; extremely acid; abrupt, wavy boundary. 3 to 8 inches thick.

B23—18 to 24 inches, dark reddish-brown (5YR 3/2) clay loam; common, fine, distinct mottles of strong brown (7.5YR 5/6), dark brown (7.5YR 4/4) when dry; weak, coarse and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; very few very fine roots; common patchy coatings that look like clay films on all ped surfaces and in pores; very strongly acid; abrupt, wavy boundary. 6 to 10 inches thick.

B24—24 to 31 inches, bands of red (2.5YR 4/6) clay loam, reddish brown (5YR 4/3) and dark brown (7.5YR 3/2 and 7.5YR 3/4) when dry; common, fine, distinct mottles of strong brown (7.5YR 5/6); weak, coarse, subangular blocky structure; slightly hard, friable, sticky and plastic; very few very fine roots; common very fine, fine, and medium pores; common, thin, patchy coatings that look like clay films on all ped surfaces; very strongly acid; abrupt, wavy boundary. 4 to 10 inches thick.

B25—31 to 60 inches, three red layers with interlayered dark-brown horizons of material like that of the B24 horizon; very few very fine roots; common very fine, fine, and medium pores; few to common patchy coatings that look like clay films; very strongly acid. 20 to 30 inches thick.

The A horizon ranges from gravelly silty clay loam to gravelly silty clay in texture. It ranges from 7.5YR to 2.5Y in hue. The B horizon ranges from 2.5YR to 7.5YR in hue, from 3 to 5 in value, and from 2 to 6 in chroma.

This soil is used for sugarcane, wildlife habitat, and water supply. (Capability classification IVs, nonirrigated; sugarcane group 2; pineapple group 7; pasture group 10; woodland group 9)

Halii gravelly silty clay, 8 to 15 percent slopes (HfC).—On this soil, runoff is slow and the erosion hazard is slight to moderate.

This soil is used for sugarcane, wildlife habitat, and water supply. (Capability classification IVe, nonirrigated; sugarcane group 2; pineapple group 8; pasture group 10; woodland group 9)

Halii gravelly silty clay, 15 to 25 percent slopes, eroded (HfD2).—This soil is similar to Halii gravelly silty clay, 3 to 8 percent slopes, except that most of the surface layer has been removed by erosion. Runoff is medium, and the erosion hazard is moderate.

This soil is used for water supply, wildlife habitat, pasture, and sugarcane. (Capability classification IVe, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Halii gravelly silty clay, 25 to 40 percent slopes, eroded (HfE2).—The surface layer and the upper part of the subsoil have been removed by erosion. Runoff is rapid, and the erosion hazard is severe. Included in mapping were small areas where the slope is less than 25 percent or more than 40 percent.

This soil is used for water supply and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 10; woodland group 9)

Haliimaile Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently to strongly sloping. Elevations range from 500 to 2,000 feet. The annual rainfall amounts to 30 to 50 inches. The mean annual soil temperature is 71° F. Haliimaile soils are geographically associated with Hamakuapoko, Keahua, Paia, and Pane soils.

These soils are used for sugarcane, pineapple, pasture, and homesites. The natural vegetation consists of guava, indigo, koa haole, lantana, Natal redtop, and yellow foxtail.

Haliimaile silty clay, 3 to 7 percent slopes (HhB).—This soil is on smooth uplands. Included in mapping were small areas of Keahua and Paia soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 15 inches thick. The subsoil, to a depth of more than 60 inches, is dark reddish-brown silty clay and very dark grayish-brown clay. It has subangular blocky and angular blocky structure. The substratum is solt, weathered basic igneous rock. The soil is strongly acid in the surface layer and strongly acid to medium acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.6 inches per foot in the surface layer and about 1.2 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°51′08″ N. and long. 156°21′24″ W.

Ap—0 to 15 inches, dark reddish-brown (5YR 3/3 moist, 5YR 3/4 dry) silty clay; moderate, fine and very fine, granular structure; hard, friable, sticky and plastic; abundant roots; many fine pores; common, small, black concretions; few weathered rock fragments; strong effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 12 to 18 inches thick.

B21—15 to 27 inches, dark reddish-brown (5YR 3/3 moist, 5YR 3/4 dry) silty clay; moderate, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many fine and very fine pores; patchy pressure cutans; common, small, black concretions; strong effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary, 12 to 18 inches thick.

B22—27 to 41 inches, dark reddish-brown (5YR 3/3 moist, 5YR 3/4 dry) silty clay; moderate, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many fine and very fine pores; patchy pressure cutans; few very fine rock fragments; common, small, black concretions; strong effervescence with hydrogen peroxide; strongly acid; abrupt, wavy boundary. 12 to 16 inches thick.

IIB3—41 to 65 inches, very dark grayish-brown (10YR 3/2) clay, dark gray (10YR 4/1) when dry; strong, fine and very fine, angular blocky structure; hard, firm, very sticky and very plastic; few roots; many fine and very fine pores; patchy pressure cutans; many highly weathered rock fragments; slight effervescence with hydrogen peroxide; medium acid.

The thickness of the solum is more than 60 inches. A little gravel and a few cobblestones occur in some places. The A horizon ranges from 5YR to 7.5YR in hue, from 2 to 3 in value when moist or dry, and from 2 to 3 in chroma when moist and 2 to 4 when dry. The texture of the A horizon is generally silty clay, but in places it is silty clay loam or gravelly silty clay. The B2 horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when dry, and from 2 to 3 in chroma when moist and 2 to 4 when dry. The texture of the B2 horizon is silty clay or clay.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 3; woodland group 1)

Haliimaile silty clay, 7 to 15 percent slopes (HhC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small, cobbly areas and small, moderately steep areas.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 3; woodland group 1)

Haliimaile gravelly silty clay, 7 to 15 percent slopes, eroded (HkC2).—This soil has a profile like that of Haliimaile silty clay, 3 to 7 percent slopes, except that in most places about 50 percent of the original surface layer has been lost through erosion. In a few places all the surface layer and part of the subsoil have been removed. Runoff is medium to rapid, and the erosion hazard is severe.

This soil is used for pineapple and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 3; woodland group 1)

Haliimaile silty clay loam, 3 to 7 percent slopes (HgB).—This soil has a profile like that of Haliimaile silty clay, 3 to 7 percent slopes, except for the texture of the surface layer. Included in mapping were small eroded areas on knolls. The surface layer of the included areas contains few to many pebble-size rock fragments.

This soil is used for pineapple, pasture, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 3; woodland group 1)

Haliimaile silty clay loam, 7 to 15 percent slopes (HgC).—This soil has a profile like that of Haliimaile silty clay, 3 to 7 percent slopes, except for the texture of the surface layer. Runoff is medium, and the erosion hazard is moderate. Included in mapping were small eroded areas on knolls. The surface layer of the included areas contains few to many pebble-size rock fragments.

This soil is used for pineapple, pasture, and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 3; woodland group 1)

Hamakuapoko Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently to strongly sloping. Elevations range from 500 to 1,200 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 71° F. Hamakuapoko soils are geographically associated with Haiku, Haliimaile, and Paia soils.

These soils are used for pineapple, pasture, and homesites. The natural vegetation consists of Christmas berry, guava, hilograss, and yellow foxtail.

Hamakuapoko silty clay, 3 to 7 percent slopes (HIB).—This soil is on smooth slopes in the uplands. Included in mapping were small areas of Haiku and Haliimaile soils. Also included were small, moderately steep areas.

In a representative profile the surface layer is dark-brown silty clay about 16 inches thick. The subsoil, about 35 inches thick, is dark-brown and very dark grayish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is extremely acid in the surface layer and strongly acid or very strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.2 inches per foot in the surface layer and 1.5 inches per foot in the subsoil. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°52′52″ N. and long. 156°14′52″ W.

Ap1—0 to 10 inches, dark-brown (10YR 3/3) silty clay, dark grayish brown (10YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; hard, firm, very sticky and very plastic; plentiful roots; many fine pores; common sand-size aggregates that are resistant to crushing; high bulk density; extremely acid; gradual, wavy boundary. 8 to 12 inches thick.

Ap2—10 to 16 inches, dark-brown (10YR 3/3) silty clay, brown (10YR 4/3) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, very sticky and very plastic; plentiful roots; common fine and medium pores; common sand-size aggregates that are resistant to crushing; high bulk density; very strongly acid; clear, wavy boundary. 4 to 8 inches thick.

B21—16 to 21 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 4/2) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many fine and very fine pores; strongly acid; clear, wavy boundary. 3 to 7 inches thick.

B22t—21 to 38 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 4/2) when dry; strong, fine and very fine, subangular blocky structure; hard, firm, very sticky and plastic; few roots; many fine and very fine pores; nearly continuous, moderately thick clay films; common sand-size aggregates that are resistant to crushing; very strongly acid; gradual, wavy boundary. 16 to 20 inches thick.

B3—38 to 51 inches, very dark grayish-brown (10YR 3/2) silty clay, brown (10YR 4/3) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; common fine and very fine pores; thin, patchy clay films; 15 to 20 percent highly weathered gravel and cobblestones; very strongly acid.

The solum is more than 40 inches thick. The A horizon ranges from 2 to 3 in value when moist, and from 2 to 3 in chroma when moist or dry. The Bt horizon ranges from 2 to 3 in value when moist and from 2 to 3 in chroma when moist or dry. The texture of the Bt horizon ranges from silty clay to clay.

Most of this soil is used for pineapple. A small acreage is used for pasture. (Capability classification IIe, irrigated or nonirrigated; pineapple group 5; pasture group 6; woodland group 5)

Hamakuapoko silty clay, 7 to 15 percent slopes (HIC).—On this soil, runoff is medium and the erosion hazard is moderate.

Most of this soil is used for pineapple. A small acreage is used for pasture and homesites. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Hamakuapoko silty clay, 7 to 15 percent slopes, eroded (HIC2).—This soil has a profile like that of Hamakuapoko silty clay, 3 to 7 percent slopes, except that it is eroded. In most places about 50 percent of the original surface layer has been removed by erosion. In a few places all of the surface layer and part of the subsoil have been lost. Runoff is medium to rapid, and the erosion hazard is severe.

This soil is used for pineapple. (Capability classification IVe, irrigated or nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Hana Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to moderately steep. Elevations range from nearly sea level to 1,200 feet. The annual rainfall amounts to 80 to 150 inches. It is well distributed throughout the year. The mean annual soil temperature is 73° F. Hana soils are geographically associated with Honomanu and Malama soils.

In this survey area moderately deep variants of the Hana series were mapped. These soils, Hana silty clay loam, moderately deep variant, 3 to 15 percent slopes, and Hana extremely stony silty clay loam, moderately deep variant, 3 to 15 percent slopes, are described in alphabetical order, along with other units of this series.

These soils are used for pasture and homesites. The natural vegetation consists of californiagrass, guava, kaimiclover, koa, and sedges.

Hana very stony silty clay loam, 3 to 25 percent slopes (HKLD).—This soil is on smooth, low mountain slopes. Included in mapping were small areas of Honomanu soils. Also included were small, steep areas near cinder cones.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silty clay loam about 12 inches thick. The subsoil, about 22 inches thick, is dark-brown silty clay loam that has subangular blocky structure. The substratum is moderately weathered, pebble-size cinders overlying Aa lava. The soil is strongly acid to medium acid in the surface layer and slightly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. In places roots penetrate to a depth of 3 to 4 feet. The available water capacity is about 1.2 inches per foot in the surface layer and 1.4 inches per foot in the subsoil.

Representative profile: Island of Maui, lat. 20°47′14″ N. and long. 156°02′04″ W.

Ap—0 to 7 inches, very dark brown (10YR 2/2, moist) very stony silty clay loam; strong, very fine and fine, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic, and moderately smeary; abundant very fine and fine roots; many fine pores; common worm casts; stones cover 1 to 3 percent of the surface; strongly acid; gradual, smooth boundary. 6 to 9 inches thick.

A1—7 to 12 inches, very dark grayish-brown (10YR 3/2, moist) silty clay loam; strong, very fine and fine, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic, and moderately smeary; abundant very fine and fine roots; many fine pores; few worm casts; common, moderately weathered, fine cinders; medium acid; clear, wavy boundary. 4 to 6 inches thick.

B21—12 to 20 inches, dark-brown (7.5YR 3/2, moist) silty clay loam; moderate, medium and fine, subangular blocky structure; very hard, friable, sticky and plastic, and moderately smeary; abundant very fine and fine roots; many fine pores; common, fine, red, weathered cinders; slightly acid; gradual, wavy boundary. 7 to 12 inches thick.

B22—20 to 34 inches, dark-brown (7.5YR 3/2, moist) silty clay loam; moderate, fine and medium, subangular blocky structure; hard, very friable, slightly sticky and slightly plastic, and moderately smeary; abundant very fine and fine roots; many fine and medium pores; 5 percent hard rock fragments; slightly acid; abrupt, wavy boundary. 10 to 20 inches thick.

IIC—34 inches, red and grayish-brown moderately weathered, pebble-size cinders over Aa lava.

The depth to cinders and Aa lava ranges from 34 to 48 inches. In places stones cover as much as 3 percent of the surface. The A horizon ranges from 7.5YR to 10YR in hue and from 2 to 3 in value and chroma. The B horizon ranges from 5YR to 10YR in hue and from 2 to 4 in value and chroma. The B horizon hardens irreversibly into black and brown, sharp, angular, very hard, fine, pebble-size aggregates.

This soil is used for pasture. (Capability classification VIs, nonirrigated; pasture group 11; woodland group 8)

Hana extremely stony silty clay loam, 3 to 25 percent slopes (HKMD).—This soil has a profile like that of Hana very stony silty clay loam, 3 to 25 percent slopes, except that stones cover 3 to 15 percent of the surface. Workability is very difficult. Included in mapping were small, steep areas near cinder cones.

This soil is used for pasture. (Capability classification VIs, nonirrigated; pasture group 11; woodland group 8)

Hana silty clay loam, moderately deep variant, 3 to 15 percent slopes (HKNC).—This soil is nonstony and moderately deep. Its surface layer is dark-brown silty clay loam that contains 10 to 15 percent gravel and cobblestones. The subsoil, 6 to 14 inches thick, is reddish-brown, very friable silty clay loam that has weak, subangular blocky structure. It contains 20 to 30 percent gravel and cobblestones. The substratum is fragmental Aa lava at a depth of 20 to 30 inches.

Runoff is slow to medium, and the erosion hazard is slight to moderate. In places roots penetrate to a depth of 2 to 3 feet. Included in mapping were small, moderately steep and steep areas near cinder cones. Also included were a few rock outcrops.

This soil is used for pasture and homesites. (Capability classification IIIe, nonirrigated; pasture group 11; woodland group 8)

Hana extremely stony silty clay loam, moderately deep variant, 3 to 15 percent slopes (HKOC).—This soil has a profile like that of Hana silty clay loam, moderately deep variant, 3 to 15 percent slopes, except that stones cover 3 to 15 percent of the surface. Workability is very difficult. Included in mapping were small, moderately steep and steep areas near cinder cones.

This soil is used for pasture. (Capability classification VIs, nonirrigated; pasture group 9; woodland group 8)

Hanalei Series

This series consists of somewhat poorly drained to poorly drained soils on bottom lands on the islands of Kauai and Oahu. These soils developed in alluvium derived from basic igneous rock. They are level to gently sloping. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 20 to 120 inches. The mean annual soil temperature is 74° F. Hanalei soils are geographically associated with Haleiwa, Hihimanu, Mokuleia, and Pearl Harbor soils.

These soils are used for taro, pasture, sugarcane, and vegetables. The natural vegetation consists of paragrass, sensitiveplant, honohono, Java plum, and guava.

Hanalei silty clay, 0 to 2 percent slopes (HnA).—This soil is on stream bottoms and flood plains. Included in the areas mapped on Kauai along the Waimea River and in Waipaoiki Valley are small areas where the surface layer is 8 to 10 inches of reddish-brown silty clay. Included in the areas mapped on Oahu were small areas of very deep, well-drained alluvial soils and small areas of very poorly drained to poorly drained clay soils that are strongly mottled and are underlain by peat, muck, or massive marine clay.

In a representative profile the surface layer, about 10 inches thick, is dark-gray and very dark gray silty clay that has dark-brown and reddish mottles. The subsurface layer is very dark gray and dark-gray silty clay about 3 inches thick. The subsoil, about 13 inches thick, is mottled, dark-gray and dark grayish-brown silty clay loam that has angular blocky structure. The substratum is stratified alluvium. The soil is strongly acid to very strongly acid in the surface layer and neutral in the subsoil.

Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available moisture capacity is about 2.1 inches per foot of soil. Roots penetrate to the water table. Flooding is a hazard.

Representative profile: Island of Kauai, lat. 22°12′37.8″ N. and long. 159°28′47″ W.

Ap—0 to 6 inches, dark-gray (10YR 4/1) silty clay; common distinct mottles of dark brown (7.5YR 4/4), red (2.5YR 5/6), and dark reddish brown (5YR 3/4); weak, coarse and medium, granular structure; very hard, friable, sticky and plastic; abundant fine and medium roots; many fine and medium pores; very strongly acid; abrupt, wavy boundary. 4 to 6 inches thick.

A1g—6 to 10 inches, very dark gray (10YR 3/1) silty clay; many distinct mottles of dark reddish brown (5YR 3/4), yellowish red (5YR 4/6), dark brown (7.5YR 4/4), and dark grayish brown (10YR 4/2); weak, coarse, prismatic structure; very hard, firm, sticky and plastic; abundant fine and medium roots; common fine and medium pores; strongly acid; gradual, smooth boundary. 3 to 5 inches thick.

A3g—10 to 13 inches, mixed, very dark gray (10YR 3/1) and dark gray (10YR 4/1) silty clay; many distinct mottles of yellowish red (5YR 4/6) and dark reddish brown (2.5YR 3/4); weak, coarse, prismatic structure; very hard, firm, sticky and plastic; common medium and fine roots; many fine and medium pores; slightly acid; gradual, smooth boundary. 2 to 4 inches thick.

B21g—13 to 18 inches, mixed, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) silty clay loam; many distinct mottles of strong brown and dark red (2.5YR 3/6); massive, but a few pockets have weak, medium, angular blocky structure; hard, firm, sticky and plastic; few medium and fine roots; many fine and medium pores; neutral; gradual, smooth boundary. 4 to 7 inches thick.

B22g—18 to 26 inches, dark grayish-brown (10YR 4/2) silty clay loam; many distinct mottles of dark red (2.5YR 3/6) and strong brown (7.5YR 5/6); weak, coarse, prismatic structure breaking to weak, fine and medium, angular blocky; slightly hard, firm, sticky and plastic; few medium and fine roots; many fine and medium pores; neutral; gradual, smooth boundary. 7 to 9 inches thick.

C—26 to 36 inches, dark grayish-brown (10YR 4/2) silty clay loam; common distinct mottles of strong brown (7.5YR 5/6), dark red (2.5YR 3/6), and red (2.5YR 4/6); massive; slightly hard, friable, sticky and plastic; few medium roots; many, fine and medium, tubular pores; slightly acid; water stands above this layer.

The A horizon ranges from 10YR to 2.5Y in hue, from 3 to 4 in value, and from 1 to 2 in chroma. Mottles range from a few faint ones to many distinct ones. The B horizon ranges from 10YR to 2.5Y in hue, from 2 to 4 in value, and from 1 to 2 in chroma. Mottles in the B and C horizons range from few to many. The depth to the seasonal high water table ranges from 2 to 5 feet. The C horizon is stratified. It ranges from silty clay to sand in texture.

This soil is used for taro, pasture, and sugarcane. (Capability classification IIw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanalei silty clay, 2 to 6 percent slopes (HnB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, taro, and pasture. (Capability classification IIw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanalei stony silty clay, 2 to 6 percent slopes (HoB).—This soil has a profile like that of Hanalei silty clay, 0 to 2 percent slopes, except that it is stony. Runoff is slow, and the erosion hazard is slight. Stones hinder machine cultivation.

This soil is used for sugarcane and pasture. (Capability classification IIw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanalei silty clay, deep water table, 0 to 6 percent slopes (HrB).—This soil has a profile like that of Hanalei silty clay, 0 to 2 percent slopes, except that it has fewer mottles and the water table is at a depth of more than 3 feet. Included in mapping were small areas of stony soils.

This soil is used for sugarcane, taro, pasture, and vegetables. (Capability classification IIw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanalei silty clay loam, 0 to 2 percent slopes (HmA).—This soil has a profile like that of Hanalei silty clay, 0 to 2 percent slopes, except for the texture of the surface layer. Also, this soil is underlain by sand at a depth of 30 to 50 inches. Included in mapping was an area on the Hanalei River bottom that is less than 30 inches deep over sand.

This soil is used for taro, pasture, and sugarcane. (Capability classification IIw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanalei peaty silty clay loam, 0 to 2 percent slopes (HpA).—This soil has a profile like that of Hanalei silty clay, 0 to 2 percent slopes, except for the texture of the surface layer. Also, the water table is at the surface.

This soil is used for pasture. (Capability classification IVw, irrigated or nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Hanamaulu Series

This series consists of well-drained soils on stream terraces and steep terrace breaks on the island of Kauai. These soils developed in alluvium washed from upland soils. They are nearly level to strongly sloping. Elevations range from 200 to 700 feet. The annual rainfall amounts to 60 to 100 inches. The mean annual soil temperature is 73° F. Hanamaulu soils are geographically associated with Kapaa and Hihimanu soils.

These soils are used for sugarcane, pasture, wildlife habitat, and water supply. The natural vegetation consists of guava, pandanus, glenwoodgrass, ricegrass, hau, and mango.

Hanamaulu silty clay, 3 to 8 percent slopes (HsB).—This soil is on terraces. Included in mapping were two areas of stony soil adjacent to streams.

In a representative profile the surface layer is brown and very dark grayish-brown silty clay about 11 inches thick. The subsoil, about 60 inches thick, is dark-brown and dark reddish-brown subangular blocky silty clay over silty clay loam. The substratum consists of slightly to strongly weathered pebbles, stones, and boulders. The soil is extremely acid in the surface layer and very strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. The available moisture capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°02′26.5″ N. and long. 159°23′59.3″ W.

Ap1—0 to 5 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark grayish brown (2.5Y 3/2) when dry; moderate, medium and fine, granular structure; hard, firm, sticky and plastic; many roots; slight effervescence with hydrogen peroxide; some material from Ap2 horizon mixed by plowing; extremely acid; abrupt, smooth boundary. 5 to 7 inches thick.

Ap2—5 to 11 inches, dark-brown (7.5YR 3/4) silty clay, brown (7.5YR 4/3) when dry; weak, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; plentiful fine and very fine roots; many fine and very fine pores; slight effervescence with hydrogen peroxide; some material from B21 horizon mixed by plowing; very strongly acid; clear, smooth boundary. 6 to 7 inches thick.

B21—11 to 20 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; strong, very fine, subangular blocky structure; hard, firm, sticky and plastic; plentiful fine and very fine roots; common fine and many very fine pores; many moderately thick coatings on ped faces and in pores; coatings look like clay films; strongly acid; gradual, smooth boundary. 7 to 10 inches thick.

B22—20 to 36 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay; strong, very fine, subangular blocky structure; very hard, firm, sticky and plastic; plentiful fine and few very fine roots; few fine and many very fine pores; continuous, moderately thick coatings on ped faces and in pores; coatings look like clay films; very strongly acid; gradual, smooth boundary. 12 to 21 inches thick.

B23—36 to 54 inches, dark-brown (7.5YR 3/4), moist and dry, silty clay loam; strong, very fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine and very fine roots; few fine and many very fine pores; continuous, moderately thick coatings on ped faces and in pores; coatings look like clay films; pore coatings are strong brown (7.5YR 4/6); very strongly acid; gradual, smooth boundary. 12 to 22 inches thick.

B24—54 to 61 inches, dark-brown (7.5YR 3/4), moist and dry, silty clay loam; moderate, very fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few fine and very fine roots; few fine and many very fine pores; continuous, moderately thick coatings on ped faces and in pores; coatings look like clay films; some pores coated with strong brown (7.5YR 4/6); very strongly acid; gradual, smooth boundary. 12 to 21 inches thick.

B3—61 to 72 inches, dark-brown (7.5YR 3/4) clay loam; 1/10-inch bands and pockets of yellowish red (5YR 3/6) and coatings and segregations of strong brown (7.5YR 5/6); weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few fine and very fine pores; few thin coatings that look like clay films; under a 10-power hand lens, the soil material has a sugary appearance; strongly acid.

The A horizon ranges from 7.5YR to 2.5Y in hue, and the B horizon from 5YR to 7.5YR. The depth to the underlying pebbles, stones, and boulders ranges from 3 feet to more than 6 feet.

This soil is used for sugarcane, pasture, water supply, and wildlife habitat. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Hanamaulu silty clay, 8 to 15 percent slopes (HsC).—On this soil, runoff is slow to medium and the erosion hazard is slight. Included in mapping were some areas that have a dark reddish-brown surface layer.

This soil is used for sugarcane, pasture, water supply, and wildlife habitat. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Hanamaulu silty clay, 15 to 25 percent slopes (HsD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were some areas that have a dark reddish-brown surface layer.

This soil is used for sugarcane, pasture, water supply, and wildlife habitat. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Hanamaulu silty clay, 25 to 40 percent slopes (HsE).—On this soil, runoff is rapid and the erosion hazard is moderate to severe. Included in mapping were some areas that have a dark reddish-brown surface layer.

This soil is used for pasture, woodland, water supply, and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Hanamaulu stony silty clay, 10 to 35 percent slopes (HtE).—This soil has a profile like that of Hanamaulu silty clay, 3 to 8 percent slopes, except that it is stony and the slope is as much as 35 percent. The stones interfere with the operation of farm machinery. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Included in mapping were some areas that have a dark reddish-brown surface layer.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Hanamaulu bouldery silty clay, 10 to 35 percent slopes (HuE).—This soil has a profile like that of Hanamaulu silty clay, 3 to 8 percent slopes, except for the boulders, which make the use of farm machinery for land preparation and planting impractical. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Included in mapping were some areas that have a dark reddish-brown surface layer.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Helemano Series

This series consists of well-drained soils on alluvial fans and colluvial slopes on the sides of gulches. These soils are on the island of Oahu. They developed in alluvium and colluvium derived from basic igneous rock. They are steep to extremely steep. Elevations range from 500 to 1,200 feet. The annual rainfall dominantly amounts to 30 to 60 inches but ranges to 75 inches at the highest elevations. The mean annual soil temperature is 72° F. Helemano soils are geographically associated with Lahaina, Leilehua, Manana, Molokai, and Wahiawa soils.

These soils are used for pasture, woodland, and wildlife habitat. The natural vegetation consists of bermudagrass, Christmas berry, eucalyptus, Formosa koa, guava, Japanese tea, Java plum, and koa haole.

Helemano silty clay, 30 to 90 percent slopes (HLMG).—This soil is on the sides of V-shaped gulches. Included in mapping were small areas of Lahaina and Molokai soils. Also included were small areas of rock outcrop, steep stony land, and eroded spots.

In a representative profile the surface layer is dark reddish-brown silty clay about 10 inches thick. The subsoil, about 50 inches thick, is dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, highly weathered basic igneous rock. The soil is neutral in the surface layer and neutral to slightly acid in the subsoil.

Permeability is moderately rapid. Runoff is medium to very rapid, and the erosion hazard is severe to very severe.

Representative profile: Island of Oahu, lat. 21°27′47″ N. and long. 157°59′59″ W.

Ap—0 to 10 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; moderate, very fine and fine, granular structure; hard, firm, sticky and plastic; abundant roots; many, very fine, interstitial pores; neutral in reaction; abrupt, smooth boundary. 6 to 10 inches thick.

B21—10 to 30 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; plentiful roots; common, fine, tubular pores; 5 to 10 percent gravel and stones; neutral; clear, smooth boundary. 12 to 20 inches thick.

B22—30 to 41 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; common, fine, tubular pores; 15 to 25 percent soft, strongly weathered gravel and stones; neutral; gradual, smooth boundary. 8 to 12 inches thick.

B3—41 to 60 inches, dark-red (10YR 3/6) silty clay, red (10YR 4/6) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; common, fine and medium, tubular pores; 25 to 50 percent soft, strongly weathered gravel and stones; slightly acid. 10 to 20 inches thick.

The depth to highly weathered rock is variable but ranges from 25 to more than 60 inches. Near the toe of slopes, the soil is commonly more than 60 inches thick and commonly stony throughout. The A horizon ranges from 2.5YR to 5YR in hue. The B horizon ranges from 2.5YR to 10R in hue; from 2 to 4 in value; and, when moist, from 2 to 6 in chroma.

This soil is used for pasture, woodland, and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 3; woodland group 15)

Hihimanu Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock and colluvium at the base of slopes. They are very steep. Elevations range from 100 to 2,000 feet. The annual rainfall amounts to 70 to 120 inches. The mean annual soil temperature is 69° F. Hihimanu soils are geographically associated with Hanalei and Hanamaulu soils.

These soils are used for water supply, pasture, wildlife habitat, and woodland. The natural vegetation consists of koa, melastoma, yellow foxtail, lantana, false staghornfern, paspalum, hala, guava, ohia, and associated shrubs and grasses.

Hihimanu silty clay loam, 40 to 70 percent slopes (HMMF).—This soil is very steep and occupies uplands. Included in mapping were small areas that are less steep and small areas of stony soils.

In a representative profile the surface layer is dark-brown silty clay loam and silty clay about 15 inches thick. The subsoil, 24 to more than 57 inches thick, is brown, dark-brown, and reddish-brown silty clay and clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is very strongly acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°56′55.4″ N. and long. 159°27′28.4″ W.

A1—0 to 7 inches, dark-brown (7.5YR 3/3) silty clay loam, dark brown (7.5YR 3/2) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant, coarse, medium and fine roots; a few weathered pebbles; slight effervescence with hydrogen peroxide; very strongly acid; clear, smooth boundary. 7 to 10 inches thick.

A3—7 to 15 inches, dark-brown (7.5YR 3/4), moist and dry, silty clay; weak, fine and very fine, subangular blocky structure; very hard, friable, sticky and plastic; abundant medium, fine, and very fine roots; few coarse roots; many fine pores; few weathered pebbles; upper part mixed with A1 material by worm activity; very strongly acid; gradual, smooth boundary. 6 to 10 inches thick.

B21—15 to 27 inches, reddish-brown (5YR 4/4) silty clay, brown (7.5YR 4/3) when dry; moderate, fine and very fine, subangular blocky structure; very hard, firm, very sticky and plastic; abundant very fine and fine roots, common medium roots, and few large roots; many fine pores; few weathered pebbles; very strongly acid; gradual, smooth boundary. 9 to 15 inches thick.

B22—27 to 45 inches, reddish-brown (5YR 4/4 moist, 5YR 4/3 dry) clay; moderate, fine and very fine, subangular blocky structure; very hard, firm, very sticky and plastic; common very fine and fine roots and few medium roots; many fine pores; few weathered pebbles; very strongly acid; gradual, smooth boundary. 14 to 20 inches thick.

B23—45 to 72 inches, brown (7.5YR 4/4 moist, 7.5YR 4/3 dry) silty clay; moderate, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; few very fine and fine roots; many fine pores; many weathered pebbles; intermittent thin bands of dark brown (7.5YR 3/3) and pockets of reddish brown (5YR 4/4); very strongly acid.

The A horizon ranges from 7.5YR to 10YR in hue, and the B horizon from 5YR to 7.5YR. The depth to soft, weathered rock ranges from 24 to more than 60 inches.

This soil is used for water supply, pasture, wildlife habitat, and woodland. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Holomua Series

This series consists of well-drained soils on uplands on the island of Molokai. These soils developed in volcanic ash and material weathered from andesite rock. They are nearly level to strongly sloping. The elevation ranges from 100 to 1,000 feet, but in most places it is less than 500 feet. The annual rainfall amounts to 15 to 20 inches. Most of the rain comes in the form of storms, from November to April. The summers are hot and dry, and there is little or no rain. The mean annual soil temperature is 74° F. Holomua soils are geographically associated with Molokai soils, generally downslope from those soils.

These soils are used for pineapple, pasture, truck crops, and wildlife habitat. The natural vegetation consists of kiawe, uhaloa, ilima, piligrass, and feather fingergrass.

Holomua silt loam, 0 to 3 percent slopes (HvA).—This soil occurs as large, smooth areas. Included in mapping were a few small, slightly eroded and stony areas.

In a representative profile the surface layer is dark reddish-brown silt loam about 9 inches thick. The upper part of the subsoil is dark reddish-brown silt loam, and the lower part is dark reddish-brown and dark-brown silty clay loam that has prismatic structure. The subsoil is 40 to more than 60 inches thick. The substratum is soft, weathered rock. Reaction in the surface layer is neutral in uncultivated areas and very strongly acid in areas used for pineapple. The subsoil is neutral.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Molokai, lat. 21°08′03″ N. and long. 157°03′01″ W.

Ap1—0 to 2 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silt loam; weak, very fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many roots; violent effervescence with hydrogen peroxide; medium acid; gradual, smooth boundary. 2 to 3 inches thick.

Ap2—2 to 9 inches, dark reddish-brown (2.5YR 3/4) silt loam, dark red (2.5YR 3/6) when dry; weak, medium and coarse, subangular blocky structure breaking to weak, very fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many interstitial pores; common, black stains; violent effervescence with hydrogen peroxide; medium acid; clear, wavy boundary. 5 to 8 inches thick.

B21—9 to 20 inches, dark reddish-brown (2.5YR 3/4) silt loam, dark red (2.5YR 3/6) when dry; weak, coarse, prismatic structure breaking to weak, medium and coarse, subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores and few, fine, tubular pores; violent effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 6 to 14 inches thick.

B22—20 to 26 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay loam; weak, coarse, prismatic structure breaking to moderate, fine and medium, subangular blocky; hard, friable, sticky and plastic; common roots; many, very fine and fine, tubular pores; violent effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 5 to 6 inches thick.

B23—26 to 38 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay loam; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots, most of which are along vertical cleavage planes; many very fine pores; many, very fine, black concretions, initially gritty when rubbed; firm in place; slight effervescence with hydrogen peroxide; few, thin, glazed patches; neutral; gradual, wavy boundary. 11 to 15 inches thick.

IIB24b—38 to 44 inches, dark reddish-brown (5YR 3/4) silty clay loam, yellowish red (5YR 4/6) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine, tubular pores; few glazed patches; gritty feeling because of the many hard earthy lumps that break down on rubbing; firm in place; slight effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 5 to 7 inches thick.

IIB25b—44 to 54 inches, dark-brown (10YR 3/3 and 7.5YR 3/2) silty clay loam, dark brown (7.5YR 4/4) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine, tubular pores; few glazed patches; compact in place; initially gritty when rubbed; no effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 5 to 10 inches thick.

IIB26b—54 to 66 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; moderate and strong, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; few roots, most of which are along cleavage planes; many, very fine and fine, tubular pores; common patchy glaze; firm in place; initially gritty when rubbed; neutral.

The depth to bedrock ranges from 4 to more than 7 feet. In most years the soil is dry in some horizons for more than 90 cumulative days. The A horizon ranges from 2.5YR to 5YR in hue; from 3 to 4 in value when moist; and, in chroma, from 3 to 4 when moist and 4 to 6 when dry. The B horizon ranges from 2.5YR to 5YR in hue, but the buried horizons range from 5YR to 10YR. It ranges from 3 to 4 in value when dry and from 2 to 6 in chroma when moist or dry. The structure ranges from weak to strong in this horizon.

This soil is used for pineapple and truck crops where irrigation water is available and for pasture and wildlife habitat where water is not available. Insufficient water is the principal limiting factor. If irrigated, this soil can be used for a wide variety of climatically suited crops. Wind erosion is a major problem in this area, and adequate windbreaks are needed for crops susceptible to wind damage. (Capability classification I if irrigated, VIc if nonirrigated; pineapple group 1; pasture group 1)

Holomua silt loam, 3 to 7 percent slopes (HvB).—On this soil, runoff is slow and the erosion hazard is slight to moderate.

This soil is used for pineapple, pasture, truck crops, and wildlife habitat. (Capability classification IIe if irrigated, VIc if nonirrigated; pineapple group 2; pasture group 1)

Holomua silt loam, 3 to 7 percent slopes, severely eroded (HvB3).—On this soil, runoff is slow to medium and the erosion hazard is moderate. Most of the surface layer and, in places, part of the subsoil have been removed by wind and water erosion. Vegetation is sparse, especially in summer.

This soil is used for pineapple, pasture, and wildlife habitat. (Capability classification IIIe if irrigated, VIe if nonirrigated; pineapple group 2; pasture group 1)

Holomua silt loam, 7 to 15 percent slopes (HvC).—On this soil, runoff is slow to medium and the erosion hazard is moderate. Slight erosion has occurred in many places. The depth to soft, weathered rock ranges from 2 to 4 feet.

This soil is used for pasture, pineapple, and wildlife habitat. (Capability classification IIIe if irrigated, VIe if nonirrigated; pineapple group 3; pasture group 1)

Holomua silt loam, 7 to 15 percent slopes, severely eroded (HvC3).—This soil occurs along gulches and on slope breaks. It has a profile like that of Holomua silt loam, 0 to 3 percent slopes, except that wind and water erosion have removed most of the surface layer and, in places, part of the subsoil. Runoff is medium, and the erosion hazard is severe. Weathered rock fragments are on the surface in many places. There are a few shallow gullies and many erosion scars. Included in mapping were small, stony areas.

This soil is used for pasture. Vegetation is sparse in most places. (Capability classification IVe if irrigated, VIe if nonirrigated; pineapple group 3; pasture group 1)

Honolua Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are moderately sloping to moderately steep. Elevations range from 500 to 1,500 feet. The annual rainfall amounts to 50 to 80 inches. The mean annual soil temperature is 69° F. Honolua soils are geographically associated with Olelo soils.

These soils are used for pineapple, pasture, woodland, wildlife habitat, and water supply. The natural vegetation consists of guava, hilograss, lantana, and ohia.

Honolua silty clay, 7 to 15 percent slopes (HwC).—This soil is on smooth interfluves on uplands. Included in mapping were small areas of Alaeloa and Olelo soils. Also included were small, gently sloping areas and small, eroded spots.

In a representative profile the surface layer is dark-brown silty clay about 12 inches thick. The subsoil, about 58 inches thick, is dark reddish-brown and reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is strongly acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 inches per foot in the surface layer and about 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°58′58″ N. and long. 156°37′16″ W.

Ap—0 to 12 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 4/4) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many fine pores; strongly acid; abrupt, wavy boundary. 9 to 14 inches thick.

B21t—12 to 18 inches, dark reddish-brown (5YR 3/4) silty clay, brown (7.5YR 4/4) when dry; strong, very fine, subangular blocky structure; slightly hard, friable, sticky and plastic, and weakly smeary; abundant roots; many fine and medium pores; thick, patchy clay films on peds; many sand-size aggregates that are resistant to crushing; very strongly acid; clear wavy boundary. 4 to 8 inches thick.

B22t—18 to 36 inches, reddish-brown (5YR 4/3) silty clay, reddish brown (5YR 4/4) when dry; strong, very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine and medium pores; thick, patchy clay films on peds; many sand-size aggregates that are resistant to crushing; few grayish, highly weathered, pebble-size rock fragments; strongly acid; gradual, wavy boundary. 15 to 20 inches thick.

B31—36 to 58 inches, dark reddish-brown (5YR 3/4) silty clay, brown (7.5YR 5/4) when dry; moderate, very fine and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; many fine pores; thin, patchy clay films on peds; many sand-size aggregates that are resistant to crushing; 20 to 30 percent highly weathered pebble-size rock fragments; strongly acid; clear, wavy boundary. 20 to 26 inches thick.

B32—58 to 70 inches, dark reddish-brown (5YR 3/4) silty clay, brown (7.5YR 5/4) when dry; moderate, very fine and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; many fine pores; thin, patchy clay films on peds; many sand-size aggregates that are resistant to crushing; 50 to 70 percent highly weathered basic igneous rock; strongly acid.

The solum is more than 40 inches thick. The A horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when dry, and from 2 to 3 in chroma when moist. The structure is moderate to strong. The Bt horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value and chroma when moist, and from 3 to 5 in value and from 4 to 8 in chroma when dry. The upper part of the Bt horizon is weakly to moderately smeary.

This soil is used for pineapple, pasture, and woodland. (Capability classification IIIe, nonirrigated; pineapple group 3; pasture group 8; woodland group 7)

Honolua silty clay, 15 to 25 percent slopes (HwD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were eroded areas on knolls. In these areas, common pebble-size rock fragments are in the surface layer and subsoil.

This soil is used for pineapple, pasture, and water supply. (Capability classification IVe, nonirrigated; pineapple group 3; pasture group 8; woodland group 7)

Honomanu Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to moderately steep. Elevations range from 1,000 to 4,500 feet. The annual rainfall amounts to 100 to 250 inches. It is well distributed throughout the year. The mean annual soil temperature is 62° F. Honomanu soils are geographically associated with Amalu, Hana, and Kailua soils.

These soils are used for water supply and wildlife habitat. The natural vegetation consists of koa, kukui, ohia, ricegrass, sedge, and treefern.

Honomanu silty clay, 5 to 25 percent slopes (rHOD).—This soil is on the wettest parts of the northeastern slopes of Haleakala. Included in mapping were small areas of Amalu and Kailua soils and rock outcrops.

In a representative profile the surface layer is very dark brown silt loam and dark yellowish-brown silty clay about 11 inches thick, capped with an organic layer about 3 inches thick. The subsoil, about 26 inches thick, is dark yellowish-brown and brown silty clay that has subangular blocky structure. The substratum is dark yellowish-brown loam and fragmental basic igneous rock. The soil is extremely acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°48′50″ N. and long. 156°15′14″ W.

O1—3 inches to 0, very dark grayish-brown (10YR 3/2) decaying vegetable matter and some soil material. The soil material is very dark grayish-brown (10YR 3/2) loam; massive; loose, slightly sticky and nonplastic; abundant roots; very porous; extremely acid; clear, wavy boundary. 2 to 5 inches thick.

A11—0 to 3 inches, very dark brown (10YR 2/2) silt loam; massive; very friable, slightly sticky, nonplastic, and strongly smeary; abundant roots; many fine and very fine pores; extremely acid; clear, wavy boundary. 2 to 5 inches thick.

A12—3 to 11 inches, dark yellowish-brown (10YR 3/4) silty clay; moderate, medium, subangular blocky structure; friable, sticky, plastic, and strongly smeary; abundant fine roots; many fine and very fine pores; many dark-brown and black organic stains on ped surfaces; few weathered pebbles; extremely acid; gradual, wavy boundary. 8 to 13 inches thick.

B21—11 to 25 inches, dark yellowish-brown (10YR 4/4) silty clay; moderate, medium, subangular blocky structure; firm, sticky, plastic, and strongly smeary; plentiful fine roots; many fine and medium pores; few black stains on ped surfaces; few weathered pebbles; extremely acid; gradual, smooth boundary. 11 to 16 inches thick.

B22—25 to 37 inches, brown (10YR 4/3) silty clay; moderate, medium, subangular blocky structure; friable, sticky, plastic, and strongly smeary; plentiful fine roots; many fine and medium pores coated with yellowish material that looks like gibbsite; 10 percent weathered cobblestones that have hard cores; extremely acid; clear, smooth boundary. 10 to 13 inches thick.

C—37 to 60 inches, dark yellowish-brown (10YR 3/4) loam; massive; very friable, slightly sticky, nonplastic, and strongly smeary; few fine roots; many fine and medium pores; many fine and very fine (less than 2 millimeters) particles that feel like sand; common small, hard, white fragments that look like gibbsite; 60 to 70 percent slightly weathered rock; extremely acid.

The solum ranges from 31 to 47 inches in thickness. In places a few pebbles, cobblestones, and stones occur on the surface. The organic horizon is lacking in some areas where the vegetation has been removed. The A horizon ranges from 7.5YR to 10YR in hue and from 2 to 3 in value. The B horizon ranges from 5YR to 10YR in hue and from 3 to 4 in value and chroma. The A and B horizons dehydrate irreversibly into black, sharp, angular, very hard, fine, pebble-size aggregates.

This soil is used for water supply and wildlife habitat. (Capability classification IVe, nonirrigated; pasture group 11; woodland group 8)

Honomanu-Amalu association (rHR).—The soils in this association have the profiles described as typical of their respective series. The areas are almost inaccessible by vehicle or on foot. They are on gently sloping to moderately steep, intermediate uplands on East Maui. The Honomanu soils occupy the more sloping, better drained side slopes. The Amalu soils occur on the less sloping tops of ridges and interfluves. The Honomanu soils are well drained; the Amalu soils are poorly drained. Runoff is slow to very slow, and the erosion hazard is slight.

Honomanu soils make up about 60 percent of the association, and Amalu soils about 40 percent. Included in mapping were small areas of Kailua soils and many small, very steep gulches.

This association is used for water supply and wildlife habitat. It is covered with dense rain forest vegetation. (Honomanu part is in capability classification IVe, nonirrigated; woodland group 8. Amalu part is in capability classification VIIw, nonirrigated)

Honouliuli Series

This series consists of well-drained soils on coastal plains on the island of Oahu in the Ewa area. These soils developed in alluvium derived from basic igneous material. They are nearly level and gently sloping. Elevations range from 15 to 125 feet. The annual rainfall amounts to 18 to 30 inches and occurs mainly between November and April. The mean annual soil temperature is 74° F. Honouliuli soils are geographically associated with Ewa, Lualualei, Mamala, and Waialua soils.

These soils are used for sugarcane, truck crops, orchards, and pasture. The natural vegetation consists of kiawe, koa haole, fingergrass, bristly foxtail, and bermudagrass.

Honouliuli clay, 0 to 2 percent slopes (HxA).—This soil occurs in the lowlands along the coastal plains. Included in mapping were small areas of fine-textured alluvial soils that have a stony subsoil. Also included were small areas of shallow, red, friable soils that are underlain by reef limestone.

In a representative profile the soil is dark reddish-brown, very sticky and very plastic clay throughout. The surface layer is about 15 inches thick. The subsoil and substratum have subangular blocky structure, and they have common to many slickensides. The soil is neutral to mildly alkaline.

Permeability is moderately slow. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because of the very sticky and very plastic clay. The shrink-swell potential is high.

Representative profile: Island of Oahu, lat. 21°20′56″ N. and long. 158°12′23″ W.

Ap—0 to 15 inches, dark reddish-brown (5YR 3/2), moist and dry, clay; moderate, medium and fine, granular structure; hard, firm, very sticky and very plastic; plentiful fine roots; common, fine, interstitial pores; few black specks and few shiny specks; few light-colored sand grains; few black concretions that exhibit moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 6 to 16 inches thick.

B2—15 to 26 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; moderate, coarse, subangular blocky structure; hard, friable, very sticky and very plastic; plentiful fine roots;

many, fine and medium, tubular pores; common slickensides; few light-colored sand grains; few shiny specks; common black concretions and few black stains that exhibit moderate effervescence with hydrogen peroxide in pores and between peds; neutral; clear, smooth boundary.

C1—26 to 36 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; weak, medium and coarse, subangular blocky structure: hard, friable, very sticky and very plastic; plentiful roots; common, fine and medium, tubular pores; few light-colored sand grains; few shiny specks; common black concretions and few black stains in pores and between peds that effervesce with hydrogen peroxide; many moderate slickensides; strong effervescence with hydrogen peroxide; neutral; abrupt, smooth boundary. 8 to 12 inches thick.

C2—36 to 48 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; moderate, fine and medium, subangular blocky structure; hard, friable, very sticky and very plastic; abundant fine roots; common, fine and medium, tubular pores; many strong slickensides; few light-colored sand grains; few shiny specks; common black concretions that effervesce with hydrogen peroxide; neutral; gradual, smooth boundary. 10 to 14 inches thick.

C3—48 to 68 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; moderate, medium and fine, subangular blocky structure; hard, friable, very sticky and very plastic; few fine roots matted between peds; few, fine, tubular pores; many, strong, deeply grooved slickensides; few light-colored sand grains; few shiny specks; common black concretions that exhibit strong effervescence with hydrogen peroxide; mildly alkaline.

The A horizon ranges from 3 to 4 in value and, in chroma, from 1 to 3 when dry and 2 to 4 when moist. The B horizon ranges from 2 to 3 in chroma when moist. In places gravel occurs in the solum at depths below 3 feet. In some places where these soils adjoin the shallow Mamala soils, coral fragments are mixed in the upper part of the solum by cultivation.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 4; pasture group 2)

Honouliuli clay, 2 to 6 percent slopes (HxB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 4; pasture group 2)

Hoolehua Series

This series consists of well-drained soils in depressions and in drainageways on the island of Molokai. These soils developed in old alluvium. The slope is generally 15 percent or less; locally, however, the slope may be as much as 35 percent. Elevations range from 400 to 1,300 feet. The annual rainfall amounts to 20 to 35 inches. Most of the rainfall occurs from November to April; the summers are hot and dry. The mean annual soil temperature is 72° F. Hoolehua soils are geographically associated with Molokai and Lahaina soils.

These soils are used for pineapple, pasture, and wildlife habitat. The natural vegetation consists of lantana, guineagrass, ilima, kiawe, and feather fingergrass.

Hoolehua silty clay, 0 to 3 percent slopes (HzA).—This soil occurs in depressions.

In a representative profile the surface layer is dark reddish-brown silty clay about 15 inches thick. The subsoil is dark reddish-brown silty clay and silty clay loam that has subangular blocky structure. The subsoil is 45 to more than 57 inches thick. The substratum is old alluvium. The reaction ranges from medium acid in areas used for pasture to extremely acid in areas used for pineapple. The subsoil is medium acid to neutral.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.8 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Molokai, lat. 21°09′34″ N. and long. 157°03′08″ W.

Ap1—0 to 9 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish gray (5YR 4/2) when dry; cloddy, because of tillage; compacted by farm machinery; hard, firm, sticky and plastic; common roots; few, medium and coarse, tubular pores; violent effervescence with hydrogen peroxide; extremely acid; clear, smooth boundary. 8 to 9 inches thick.

Ap2—9 to 15 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; cloddy; hard, friable, sticky and plastic; few roots; few, very fine, tubular pores; violent effervescence with hydrogen peroxide; extremely acid; clear, wavy boundary. 4 to 7 inches thick.

B11—15 to 21 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay loam; weak, fine and medium, subangular blocky structure; slightly hard, very friable, sticky and plastic; few roots; many, very fine and fine, tubular pores and common, medium, tubular pores; many, very fine, black concretions; violent effervescence with hydrogen peroxide; medium acid; clear, wavy boundary. 5 to 9 inches thick.

B12—21 to 27 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; weak, fine and medium, subangular blocky structure (slightly stronger than in the B11 horizon); hard, friable, sticky and plastic; no roots; many, very fine and fine, tubular pores and common, medium, tubular pores; many, very fine, black concretions; common black stains in pores; violent effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 6 to 7 inches thick.

B21—27 to 49 inches, dark reddish-brown (5YR 3/3 and 5YR 3/4), moist and dry, silty clay; strong, very fine, subangular blocky structure and a few pockets of weak and medium, very fine, subangular blocky structure; very hard, firm, sticky and plastic; no roots; common, very fine, tubular pores; many, very fine, black concretions; common black stains on ped faces; almost continuous coatings on peds; compact in place; common hard earthy lumps, because of aggregate stability, that break down after prolonged rubbing; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 19 to 26 inches thick.

B22—49 to 64 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay; moderate and strong, fine, subangular blocky structure; very hard, firm, sticky and plastic; no roots; common, very fine, tubular pores; common, very fine, black concretions; few black stains on ped faces; common thin illuviation cutans on ped faces; slightly firm in place; many hard earthy lumps, because of aggregate stability, that break down after prolonged rubbing; moderate effervescence with hydrogen peroxide; slightly acid.

Stratification of the profile ranges from moderate to none. In places there are a few weathered pebbles throughout. There is a significant amount of mica throughout. The A and B horizons range from 5YR to 7.5YR in hue and from 2 to 4 in chroma.

This soil is used principally for pineapple. Small areas are used for truck crops and pasture. (Capability classification I if irrigated, IIIc if nonirrigated; pineapple group 1; pasture group 3).

Hoolehua silty clay, 3 to 7 percent slopes (HzB).—This soil occurs as large areas on uplands. Runoff is slow, and the erosion hazard is slight to moderate.

Included in mapping, along the northern coast of the Hoolehua plains, were about 100 acres of dark-brown windblown material overlying Hoolehua and Lahaina soils. The windblown material is derived from weathered andesite particles that were blown inland from the edge of the northern cliffs. The water intake rate on this included soil is relatively slow and contributes to rapid runoff and a moderate to severe erosion hazard.

This soil is used principally for pineapple; small areas are used for truck crops and pasture. (Capability classification IIe if irrigated, IIIc if nonirrigated; pineapple group 2; pasture group 3)

Hoolehua silty clay, 7 to 15 percent slopes (HzC).—This soil occurs mainly on West Molokai. Runoff is slow to medium, and the erosion hazard is moderate.

This soil is used for pineapple and pasture. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 3; pasture group 3)

Hoolehua silty clay, 15 to 35 percent slopes (HzE).—This soil occurs near Ualapue, Molokai. It is similar to Hoolehua silty clay, 0 to 3 percent slopes, except that the slopes are steep, dominantly 25 to 35 percent. The soil is very sticky and very plastic. Soft, weathered rock occurs at a depth of about 36 inches. The depth to bedrock is 5 feet or more. Runoff is rapid, and the erosion hazard is severe. Workability is difficult. There are few to common stones and boulders.

Included in mapping at the lower elevations were small areas of stony and severely eroded soils. There are a few gullies in these areas.

This soil is used for pasture. (Capability classification VIe, irrigated or nonirrigated; pasture group 3)

Hoolehua silty clay loam, 3 to 10 percent slopes, severely eroded (HyB3).—This soil occurs in the dry, windswept northwestern part of Molokai. The annual rainfall amounts to about 20 inches. Wind has caused much of the erosion, as evidenced by blown-out areas and areas of deposition. Most of the topsoil and, in places, part of the subsoil have been removed; some lag gravel and stones remain on the surface. There are small dunes or hummocks in the most severely eroded areas. Runoff is rapid, and the erosion hazard is severe. Many of the blown-out areas are barren, but other areas are protected by uhaloa, ilima, and fingergrass. Revegetation of bare areas is difficult because of the drying winds and low rainfall. Included in mapping were small areas of severely eroded Molokai soils.

This soil is used for pasture. (Capability classification VIe, irrigated or nonirrigated; pasture group 3)

Hulua Series

This series consists of poorly drained soils on uplands on the island of Kauai. These soils have a layer of indurated ironstone at depths of 10 to 20 inches. They developed in material weathered from basic igneous rock. They are gently sloping to very steep. Elevations range from 400 to 2,400 feet. The annual rainfall amounts to 100 to 200 inches. The mean annual soil temperature is 66° F. Hulua soils are geographically associated with Koolau and Halii soils.

These soils are used for water supply and wildlife habitat. The natural vegetation consists of false staghornfern (uluhe), scrub ohia, clubmoss, uki uki, hilograss, and associated plants.

Hulua gravelly silty clay loam, 25 to 70 percent slopes (HNUF).—This soil is on uplands.

In a representative profile the upper part of the surface layer is black gravelly silty clay loam about 10 inches thick. The subsurface layer, about 6 inches thick, is mottled, dark grayish-brown, massive silty clay. This horizon overlies indurated ironstone, ½ inch to 3 inches thick. The ironstone sheet caps yellowish-red and very dusky red clay loam and soft, weathered rock that extends to a depth of more than 70 inches.

Permeability is moderately rapid, except in the ironstone layer, which is nearly impermeable. Runoff is very rapid, and the erosion hazard is severe to very severe. Roots penetrate to the ironstone.

Representative profile: Island of Kauai, lat. 21°58′16.6″ N. and long. 159°30′21.3″ W.

O1—1 inch to 0, uluhe litter. Undecomposed layer of stems and leaves of uluhe.

A1g—0 to 10 inches, black (5Y 2/1) gravelly silty clay loam, dark gray (2.5Y 4/1) when dry; massive; very hard, firm, slightly sticky and plastic, and weakly smeary; abundant roots; irregularly shaped ironstone pebbles 0.3 to 0.5 inch across; many, small, glistening particles; strongly acid; clear, wavy boundary. 7 to 12 inches thick.

A2—10 to 16 inches, dark grayish-brown (2.5Y 4/2) silty clay, reddish yellow (7.5YR 6/6) with coatings of brown (10YR 4/3) and mottles of white (10YR 8/2) and strong brown (7.5YR 5/8) when dry; massive; hard, firm, sticky and plastic, and weakly smeary; plentiful roots; few very fine pores; strongly acid; abrupt, smooth boundary. 3 to 8 inches thick.

B2ir—16 to 18 inches, very dark brown (7.5R 2/2 and 2/4) and brown (7.5YR 4/4) indurated ironstone sheet; some fine pores contain a whitish, soft material; ironstone sheet is laminated and has a troweled upper surface; clear, wavy boundary. ½ inch to 3 inches thick.

C1—18 to 30 inches, yellowish-red (5YR 5/6) clay loam, reddish yellow (7.5YR 6/6) when dry; has appearance of original rock structure but has pores coated with material of strong brown (7.5YR 5/6), red (2.5YR 4/8), and yellowish red (5YR 5/8); fracture faces have coatings of reddish black (10R 2/1), dark red (10R 3/6), and black (N 2/0) when moist; hard, firm, sticky and plastic, and smeary; no roots; many fine pores; this layer consists of hard and soft material; hard material can be broken down with difficulty when moist; very strongly acid; gradual, smooth boundary. 11 to 14 inches thick.

C2—30 to 60 inches, very dusky red (2.5YR 2/2) clay loam; many fine mottles of reddish yellow (7.5YR 7/6), dark red (2.5YR 3/6), and yellowish red (5YR 5/6); weak red (2.5YR 4/2) with mottles of red (2.5YR 5/6) and reddish yellow (7.5YR 7/6) when dry; hard, firm, sticky and plastic; no roots; common medium and fine pores; has appearance of the original rock structure, but pores are filled with illuvial material; very strongly acid.

The A1g horizon ranges from 2.5Y to 5Y in hue and from 2 to 3 in value. The ironstone sheet ranges from ½ inch to 3 inches in thickness. The C horizon ranges from 10R to 7.5YR in hue, from 2 to 5 in value, and from 2 to 8 in chroma. The depth to ironstone ranges from 10 to 20 inches.

This soil is used for water supply and wildlife habitat. (Capability classification VIIe, nonirrigated; woodland group 16)

Hulua gravelly silty clay loam, 3 to 25 percent slopes (HNUD).—This soil is similar to Hulua gravelly silty clay loam, 25 to 70 percent slopes, except that it is gently sloping to moderately steep. Runoff is rapid, and the erosion hazard is severe.

This soil is used for water supply and wildlife habitat. (Capability classification VIe, nonirrigated; woodland group 16)

Hydrandepts-Tropaquods Association

Areas mapped as Hydrandepts-Tropaquods association (rHT) consist of well-drained to poorly drained soils on uplands. These soils are on the northern slopes of West Maui and the northern and eastern slopes of East Maui. They developed in volcanic ash and in material weathered from cinders and basic igneous rock. They are moderately sloping to steep. Elevations range from 1,000 to 6,000 feet. The annual rainfall amounts to 100 to 350 inches. The mean annual soil temperature is 60° F. This association is geographically associated with soils of the Amalu, Honomanu, and Olelo series.

Hydrandepts make up about 60 percent of the association, and Tropaquods 40 percent. Included in mapping were small areas of Rough mountainous land. Also included were small peat bogs.

Hydrandepts are the steeper areas of the association. These are well drained to moderately well drained soils that are similar to those of the Honomanu series. The surface layer is high in organic-matter content. The subsoil is dark-brown or dark yellowish-brown, smeary silty clay loam or silty clay. The substratum consists of volcanic ash and cinders or weathered basic igneous rock. These soils dehydrate irreversibly into fine pebble-size aggregates.

Tropaquods are poorly drained soils that are similar to those of the Amalu and Olokui series. They have a peaty or mucky surface layer that overlies a dark gray to very dark gray, mottled layer. The mottled layer rests on an ironstone sheet 1/4 to 1 inch thick. The ironstone is at a depth of 10 to 20 inches. It normally caps highly weathered basic igneous rock.

The soils in this association have low bearing capacity and low shear strength. They are slippery and difficult to traverse. Because of their ability to absorb water and to transmit it rapidly, these soils are important for maintenance of ground water for domestic use and irrigation.

This association is used for water supply and wildlife habitat. The natural vegetation consists of ohia, puakeawe, sedges, false staghornfern, treefern, and other rain forest vegetation. (Hydrandepts soils are in capability classification VIIe, nonirrigated. Tropaquods soils are in capability classification VIIw, nonirrigated)

Iao Series

This series consists of well-drained soils on valley fill and alluvial fans. These soils developed in alluvium derived from basic igneous rock. They are nearly level to moderately sloping. Elevations range from 100 to 500 feet. The annual rainfall amounts to 25 to 40 inches. The mean annual soil temperature is 74° F. Iao soils are geographically associated with Paia, Pulehu, and Wailuku soils.

These soils are used for sugarcane. Small acreages are used for pasture and homesites. The natural vegetation consists of bermudagrass, feather fingergrass, koa haole, lantana, and Natal redtop.

Iao clay, 3 to 7 percent slopes (IcB).—This soil is on smooth alluvial fans and valley fill. Included in mapping were small areas of Paia and Wailuku soils. Also included were small, nearly level areas.

In a representative profile the surface layer is dark-brown clay about 15 inches thick. The subsoil, about 45 inches thick, is very dark brown, dark-brown, and very dark grayish-brown clay and silty clay. The substratum is clayey alluvium. The soil is neutral in the surface layer and subsoil.

Permeability is moderately slow. Runoff is medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.7 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°54′14″ N. and long. 156°30′22″ W.

Ap—0 to 15 inches, dark-brown (10YR 3/3) clay, dark gray (10YR 4/1) when dry; massive; very hard, firm, very sticky and very plastic; abundant roots; many fine pores; few cracks up to 1/4 inch wide; many weathered basalt sand grains; strong effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 12 to 18 inches thick.

B21—15 to 25 inches, very dark brown (10YR 2/2) clay, very dark grayish brown (10YR 3/2) when rubbed, dark brown (10YR 3/3) when dry; weak, medium and coarse, subangular blocky structure; very hard, firm, very sticky and very plastic; abundant roots; many very fine pores; firm in place; many weathered basalt sand grains; few basalt pebbles; strong effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 8 to 14 inches thick.

B22—25 to 48 inches, dark-brown (10YR 3/3), moist and dry, clay; moderate, medium and coarse, subangular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; many fine pores; continuous pressure cutans on peds; compact in place; many weathered basalt sand grains and pebbles; strong effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 20 to 27 inches thick.

B3—48 to 60 inches, very dark grayish-brown (10YR 3/2) silty clay, dark brown (10YR 3/3) when dry; massive; hard, firm, sticky and plastic; few roots; many fine and medium pores; many weathered basalt sand grains and pebbles; strong effervescence with hydrogen peroxide; neutral.

The solum is more than 40 inches thick. A few cobblestones occur on the surface in some places. The A horizon ranges from 2 to 3 in value when moist and 3 to 4 when dry, and, in chroma, from 1 to 3 when moist and 1 to 2 when dry. The B horizon ranges from 3 to 4 in value when dry, and, in chroma, from 2 to 3 when moist or dry. The texture ranges from silty clay to clay.

This soil is used for sugarcane and homesites. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3)

Iao clay, 7 to 15 percent slopes (IcC).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for sugarcane and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3)

Iao silty clay, 0 to 3 percent slopes (IaA).—On this soil, runoff is slow and the erosion hazard is no more than slight.

This soil is used for sugarcane. (Capability classification I if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3)

Iao silty clay, 3 to 7 percent slopes (IaB).—This soil has a profile like that of Iao clay, 3 to 7 percent slopes, except for the texture of the surface layer.

This soil is used for sugarcane. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3)

Iao cobbly silty clay, 3 to 7 percent slopes (IbB).—This soil has a profile like that of Iao clay, 3 to 7 percent slopes, except for the texture of the surface layer and the content of cobblestones.

This soil is used for sugarcane and homesites. (Capability classification IIe if irrigated, IIIs if nonirrigated; sugarcane group 1; pasture group 3)

Iao cobbly silty clay, 7 to 15 percent slopes (IbC).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for sugarcane and pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3)

Io Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash and material weathered from cinders. They are moderately sloping to moderately steep. Elevations range from 1,000 to 2,500 feet. The annual rainfall amounts to 25 to 35 inches. The mean annual soil temperature is 69° F. Io soils are geographically associated with Kula, Oanapuka, and Ulupalakua soils.

These soils are used for pasture and wildlife habitat. Small areas are used for truck crops. The natural vegetation consists of bermudagrass, buffelgrass, burclover, guineagrass, lantana, and Natal redtop.

Io silt loam, 7 to 25 percent slopes (ISD).—This soil is on smooth, low mountain slopes. Included in mapping were small areas of Kula and Oanapuka soils. Also included were small, cobbly areas and small, steep areas near cinder cones.

In a representative profile the surface layer is very dark brown silt loam about 10 inches thick. The subsurface layer is dark-brown silty clay loam about 7 inches thick. The subsoil, 10 to 30 inches thick, is dark-brown and dark reddish-brown clay loam that has subangular blocky structure. The substratum is black, unweathered, fine cinders and dark reddish-brown loam. The soil is neutral in the surface layer and mildly alkaline in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.8 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of more than 25 inches.

Representative profile: Island of Maui, lat. 20°39′20″ N. and long. 156°24′40″ W.

Ap—0 to 10 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; weak and moderate, fine and very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant fine roots; many fine and very fine pores; slight effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 9 to 12 inches thick.

A1—10 to 17 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; weak and moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; many fine and very fine pores; mildly alkaline; gradual, wavy boundary. 4 to 9 inches thick.

B21—17 to 25 inches, dark-brown (10YR 3/3) clay loam, brown (10YR 4/3) when dry; weak, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; many fine pores; thin, dark coatings that look like organic stains on peds; compact in place; mildly alkaline; clear, smooth boundary. 7 to 11 inches thick.

B22—25 to 30 inches, dark reddish-brown (5YR 3/3) and yellowish-red (5YR 4/6) clay loam, reddish brown (5YR 4/4) and yellowish red (5YR 5/6) when dry; weak and moderate, fine, subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; many medium and fine pores; 20 percent fine cinders; mildly alkaline; abrupt, smooth boundary. 4 to 6 inches thick.

IIC1—30 to 39 inches, black cinders 1 to 10 millimeters in size; single grain; extremely hard and loose; few fine roots; moderately alkaline; abrupt, smooth boundary. 8 to 10 inches thick.

IIIC2—39 to 45 inches, dark reddish-brown (5YR 3/4) loam, reddish yellow (7.5YR 6/6) when dry; massive; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; few fine roots; many fine pores; moderately alkaline.

The depth to black, unweathered cinders ranges from 24 to 38 inches. A few cobblestones and stones occur on the surface in some areas. The A horizon ranges from 7.5YR to 10YR in hue and, in value, from 2 to 3 when moist and 3 to 4 when dry. The texture is silt loam and silty clay loam. The B horizon ranges from 5YR to 10YR in hue. It ranges in value from 2 to 3 when moist and 3 to 4 when dry and, in chroma, from 2 to 3 when moist and 3 to 6 when dry. The texture is clay loam or silty clay loam.

This soil is used for pasture, truck crops, and wildlife habitat. (Capability classification IVe, nonirrigated; pasture group 4; woodland group 2)

Ioleau Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock, probably mixed with volcanic ash. They are gently sloping to steep. Elevations range from 100 to 750 feet. The annual rainfall amounts to 40 to 70 inches. The mean annual soil temperature is 72° F. Ioleau soils are geographically associated with Lihue and Puhi soils.

These soils are used for irrigated sugarcane, pasture, pineapple, irrigated orchards, irrigated truck crops, wildlife habitat, and woodland. The natural vegetation consists of lantana, koa haole, guava, and associated shrubs and grasses.

Ioleau silty clay loam, 6 to 12 percent slopes (IoC).—This soil is on ridgetops in the uplands.

In a representative profile the surface layer is dark-brown and yellowish-red silty clay loam 15 inches thick. The subsoil, 40 to 60 inches thick, is dark-brown and dark reddish-brown silty clay that has subangular blocky structure and is very compact in place. The substratum is soft, weathered rock. The soil is very strongly acid to extremely acid throughout.

Permeability is slow to moderately slow. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.4 inches per foot of soil. Roots penetrate to a depth of 15 to 25 inches or to the plow depth.

Representative profile: Island of Kauai, lat. 22°07′32.9″ N. and long. 157°13′03″ W.

Ap1—0 to 6 inches, dark-brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) when dry; cloddy, breaking to moderate, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; abundant medium and fine roots and plentiful very fine roots; very strongly acid; abrupt, wavy boundary. 6 to 8 inches thick.

Ap2—6 to 15 inches, mixture of yellowish-red (5YR 4/6) silty clay loam, strong brown (7.5YR 5/6) when dry; massive; slightly hard, friable, sticky and plastic; and yellowish-red (5YR 4/6) silty clay, reddish brown (5YR 4/4) when dry; strong, very fine, subangular blocky structure; hard, firm, sticky and plastic; few medium roots and plentiful fine and very fine roots; common fine pores; very strongly acid; abrupt, wavy boundary. 7 to 10 inches thick.

B21t—15 to 27 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; very few fine and very fine roots; common very fine pores; very compact in place; many moderately thick clay films on ped faces; very strongly acid; clear, wavy boundary. 5 to 12 inches thick.

B22t—27 to 38 inches, dark-brown (7.5YR 3/2) silty clay, yellowish red (5YR 3/6) in pores, dark brown (7.5YR 4/4) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; very few fine and very fine roots; few medium pores and many very fine pores; compact in place; many moderately thick clay films on ped faces and in pores; few pebbles; very strongly acid; clear, wavy boundary. 9 to 11 inches thick.

B23t—38 to 57 inches, dark-brown (7.5YR 3/3) light silty clay, dark brown (7.5YR 4/4) in pores, dark brown (7.5YR 4/4) when dry; strong, fine and very fine, subangular blocky structure; slightly hard, firm, slightly sticky and slightly plastic; few medium, fine, and very fine roots; many very fine pores; patchy, moderately thick clay films on ped faces; continuous in pores; few pebbles; extremely acid; clear, wavy boundary. 15 to 22 inches thick.

B24t—57 to 61 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; no roots; many very fine pores; patchy, moderately thick clay films on ped faces; continuous in pores; extremely acid.

The A horizon ranges from 5YR to 10YR in hue. In places the texture of the A horizon is clay loam. The B horizon ranges from 2.5YR to 7.5YR in hue, from 3 to 4 in value, and from 2 to 6 in chroma. The depth to the very compact B21t ranges from 15 to 25 inches.

This soil is used for sugarcane, pasture, pineapple, orchards, and truck crops. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Ioleau silty clay loam, 2 to 6 percent slopes (IoB).—This soil has a profile like that of Ioleau silty clay loam, 6 to 12 percent slopes, except that it is 10 to 20 inches deeper to the compact layer. Runoff is slow, and the erosion hazard is slight. Roots penetrate to a depth of 25 to 40 inches.

This soil is used for sugarcane, pasture, pineapple, orchards, and truck crops. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 6; woodland group 6)

Ioleau silty clay loam, 12 to 20 percent slopes, eroded (IoD2).—This soil is similar to Ioleau silty clay loam, 6 to 12 percent slopes, except that it is moderately steep and part of the surface layer has been removed by erosion. Runoff is rapid, and the erosion hazard is moderate to severe.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Ioleau silty clay loam, 20 to 35 percent slopes, eroded (IoE2).—This soil is similar to Ioleau silty clay loam, 6 to 12 percent slopes, except that it is steep and most of the surface layer has been removed by erosion. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture, woodland, sugarcane, pineapple, and water supply. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 6)

Jaucas Series

This series consists of excessively drained, calcareous soils that occur as narrow strips on coastal plains, adjacent to the ocean. These soils occur on all the islands of this survey area. They developed in wind- and water-deposited sand from coral and seashells. They are nearly level to strongly sloping. Elevations range from sea level to 100 feet; but locally on West Molokai, the elevation is as high as 650 feet. The annual rainfall amounts to 10 to 40 inches. The mean annual soil temperature is 75° F. Jaucas soils are geographically associated with Pulehu, Mokuleia, Kaloko, and Lualualei soils.

In this survey area a dark variant of the Jaucas series was mapped. This soil, Jaucas loamy fine sand, dark variant, 0 to 8 percent slopes, is described in alphabetical order, along with other mapping units of this series.

These soils are used for pasture, sugarcane, truck crops, alfalfa, recreational areas, wildlife habitat, and urban development. The natural vegetation consists of kiawe, koa haole, bristly foxtail, bermudagrass, fingergrass, and Australian saltbush.

Jaucas sand, 0 to 15 percent slopes (JaC).—The slope range of this soil is 0 to 15 percent, but in most places the slope does not exceed 7 percent. Included in mapping were narrow strips of Beaches and areas of Pulehu, Mokuleia, and Keaau soils.

In a representative profile the soil is single grain, pale brown to very pale brown, sandy, and more than 60 inches deep. In many places the surface layer is dark brown as a result of accumulation of organic matter and alluvium. The soil is neutral to moderately alkaline throughout the profile.

Permeability is rapid, and runoff is very slow to slow. The hazard of water erosion is slight, but wind erosion is a severe hazard where vegetation has been removed. The available water capacity is 0.5 to 1.0 inch per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because the soil is loose and lacks stability for use of equipment.

Representative profile: Island of Molokai, lat. 21°05′38″ N. and long. 157°13′03″ W.

C1—0 to 13 inches, pale-brown (10YR 6/3) sand, light yellowish brown (10YR 6/4) when dry; single grain; loose, nonsticky and nonplastic; plentiful roots; violent effervescence with dilute hydrochloric acid; neutral; gradual, wavy boundary. 3 to 15 inches thick.

C2—13 to 22 inches, light yellowish-brown (10YR 6/4) sand, very pale brown (10YR 7/4) when dry; single grain; loose, nonsticky and nonplastic; few roots; violent effervescence with dilute hydrochloric acid; mildly alkaline; gradual, wavy boundary. 6 to 30 inches thick.

C3—22 to 60 inches, very pale brown (10YR 7/4) sand; single grain; loose, nonsticky and nonplastic; violent effervescence with dilute hydrochloric acid; neutral.

The texture of the surface layer is dominantly sand, but in a few places it is fine sand or loamy sand. In some places there is an A horizon, a few inches thick, that is darkened by organic matter and alluvium. The profile is 10YR in hue. It ranges from 6 to 7 in value, and, in chroma, from 2 to 4 when moist. Pebble-size fragments of coral and seashell are common in the profile.

This soil is used for pasture, sugarcane, truck crops, and urban development. (Capability classification IVs if irrigated, VIe if nonirrigated; sugarcane group 1; pasture group 1)

Jaucas sand, saline, 0 to 12 percent slopes (JcC).—This soil occurs near the ocean in areas where the water table is near the surface and salts have accumulated. It is somewhat poorly drained in depressions but excessively drained on knolls. In the depressions there is normally a layer of silty alluvial material flocculated by the high concentration of soluble salts. The water table is normally within a depth of 30 inches.

This soil is used for pasture, wildlife habitat, and urban development. Vegetation on the salty soil in the depressions consists of salt-tolerant plants. Kiawe grows profusely on the better drained soils on knolls. (Capability classification VIIs, nonirrigated; pasture group 1)

Jaucas loamy fine sand, 0 to 8 percent slopes (JfB).—This soil occurs on old beaches and on windblown sand deposits in the western and southern parts of Kauai. It has a profile like that of Jaucas sand, 0 to 15 percent slopes, except for the texture of the surface layer.

This soil is used for pasture, recreational areas, wildlife habitat, sugarcane, and alfalfa. (Capability classification IVs if irrigated, VIe if nonirrigated; sugarcane group 1; pasture group 1)

Jaucas loamy fine sand, dark variant, 0 to 8 percent slopes (JkB).—This soil occurs on Kauai near the town of Waimea. Unlike other soils of the Jaucas series, sand and coral sand are mixed throughout the profile. The basaltic sand gives this soil a dark-brown to black color.

This soil is used for sugarcane, pasture, and homesites. (Capability classification IVs if irrigated, VIe if nonirrigated; sugarcane group 1; pasture group 1)

Jaucas-Blown-out land complex (JL).—This complex occurs as a long, nearly level to moderately sloping strip in the northwestern part of the island of Molokai. It is inland where strong prevailing winds have lifted and carried coral sand from sea level to elevations of about 650 feet. The Jaucas soil, which makes up 25 to 70 percent of the acreage, occurs as small dunes. In many places it is mixed with fine material from Blown-out land, and the texture is loamy sand. Blown-out land consists of an exposed compact subsoil and substratum similar to those of Molokai soils. Included in mapping were a few limestone outcrops.

This complex is used for pasture. Kiawe trees are scrubby and scattered because they cannot obtain moisture from the water table. Most of the forage consists of grasses that grow mainly during the rainy season. Much of the area is barren. Strong winds are prevalent, and wind and water erosion is active. (Capability classification VIe, nonirrigated; pasture group 1)

Kaena Series

This series consists of very deep, poorly drained soils on alluvial fans and talus slopes on the islands of Oahu and Kauai. These soils developed in alluvium and colluvium from basic igneous material. They are gently sloping to steep and are commonly stony. Elevations range from 50 to 150 feet. The annual rainfall amounts to 30 to 45 inches, most of which occurs between November and April. The mean annual soil temperature is 74° F. Kaena soils are geographically associated with Honouliuli, Lualualei, and Waialua soils.

In this survey area brown variants of the Kaena series were mapped. These soils, Kaena clay, brown variant, 1 to 6 percent slopes, and Kaena clay, brown variant, 6 to 12 percent slopes, are described in alphabetical order, along with other mapping units of the series.

These soils are used for sugarcane, truck crops, pasture, and homesites. The natural vegetation consists of kiawe, klu, lantana, koa haole, and fingergrass.

Kaena stony clay, 6 to 12 percent slopes (KaeC).—This soil occurs on alluvial fans. Included in mapping were small areas of clayey, dark reddish-brown soils that are moderately well drained to well drained.

In a representative profile the surface layer is very dark gray clay about 10 inches thick. The next layer, 36 to more than 48 inches thick, is dark-gray and dark grayish-brown clay that has prismatic structure. It is underlain by highly weathered gravel. The soil is very sticky and very plastic, and it is mottled. It is slightly acid to neutral.

Permeability is slow. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.4 inches per foot in the surface layer and about 1.7 inches per foot in the subsoil. Workability is difficult because of the narrow range of moisture content within which the soils can be cultivated. There are sufficient stones to hinder, but not prevent, cultivation. The shrink-swell potential is very high. In places the soil is affected by seepage.

Representative profile: Island of Oahu, lat. 21°41′50″ N. and long. 157°59′08″ W.

Ap—0 to 10 inches, very dark gray (10YR 3/1), moist and dry, stony clay; strong, fine and medium, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; abundant fine and medium roots; common, very fine, tubular and interstitial pores; few coral fragments; angular stones; few highly weathered pebble-size basalt fragments; common, black, organic stains; common, fine, distinct, dark yellowish-brown mottles; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; neutral; abrupt, smooth boundary. 8 to 12 inches thick.

ACg—10 to 37 inches, dark-gray (10YR 4/1), moist and dry, stony clay; weak, coarse, prismatic structure; extremely hard, very firm, very sticky and very plastic; plentiful very fine and fine and few medium roots; many, very fine, tubular pores; many prominent slickensides; many, fine, distinct, dark reddish-brown mottles; few highly weathered, pebble-size rock fragments; few black stains; slight effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 20 to 30 inches thick.

C1g—37 to 45 inches, dark grayish-brown (10YR 4/2), moist and dry, stony clay; weak, coarse, prismatic structure; extremely hard, very firm, very sticky and very plastic; few very fine roots; common, very fine, tubular pores; many distinct slickensides; common, fine, distinct, strong-brown mottles; few highly weathered, pebble-size rock fragments; few black stains; common, strong-brown, very fine specks; few fine and medium gypsum crystals; slight effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 7 to 9 inches thick.

C2—45 to 54 inches, dark grayish-brown (10YR 4/2), moist and dry, stony clay; common, fine, distinct, strong-brown mottles; massive; extremely hard; very fine roots; common, very fine, tubular pores; common moderately strong slickensides; many highly weathered pebbles and basaltic stones; neutral.

The amount of stones in the profile ranges from less than 10 percent in the upper part to about 40 percent in the lower part. The number increases with depth. The A horizon ranges from 10YR to 7.5YR in hue and from 2 to 3 in value when moist and 3 to 4 when dry. The C horizon ranges from 10YR to 7.5YR in hue, from 3 to 4 in value, and from 1 to 2 in chroma when moist or dry. Mottles in the C horizon range from distinct to prominent.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 4; pasture group 7; woodland group 4)

Kaena stony clay, 2 to 6 percent slopes (KaeB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pasture, and homesites. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 4; pasture group 7; woodland group 4)

Kaena stony clay, 12 to 20 percent slopes (KaeD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for sugarcane, pasture, and homesites. (Capability classification IVw if irrigated, VIw if nonirrigated; sugarcane group 4; pasture group 7; woodland group 4)

Kaena very stony clay, 10 to 35 percent slopes (KanE).—This soil occurs on talus slopes and alluvial fans. It has a profile like that of Kaena stony clay, 6 to 12 percent slopes, except that there are many stones on the surface and in the profile. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because the soil is stony, steep, and very sticky and very plastic. Included in mapping were small areas of Rock outcrop, Stony steep land, and small areas where the slope is less than 10 percent.

This soil is used for pasture and urban development. (Capability classification VIs, nonirrigated; pasture group 7; woodland group 4)

Kaena clay, 2 to 6 percent slopes (KaB).—This soil has a profile like that of Kaena stony clay, 6 to 12 percent slopes, except that there are few or no stones in the surface layer. Runoff is slow, and the erosion hazard is slight.

This soil is used for sugarcane, truck crops, pasture, and urban development. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 4; pasture group 7; woodland group 4)

Kaena clay, 6 to 12 percent slopes (KaC).—This soil has a profile like that of Kaena stony clay, 6 to 12 percent slopes, except that there are few or no stones in the surface layer. Included in mapping were small stony areas at the higher elevations.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 4; pasture group 7; woodland group 4)

Kaena clay, brown variant, 1 to 6 percent slopes (KavB).—This soil occurs on alluvial fans on Kauai. It is geographically associated with Kalapa soils.

This variant is somewhat poorly drained, and the surface layer is browner than is typical of the Kaena series. Also, it occurs at elevations up to 500 feet, and the rainfall amounts to 50 to 75 inches per year.

Permeability is slow to moderately slow. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Kaena clay, brown variant, 6 to 12 percent slopes (KavC).—This soil occurs on Kauai. It is geographically associated with Kalapa soils. It is similar to Kaena clay, brown variant, 1 to 6 percent slopes, except for the slope. Runoff is medium, and the erosion hazard is slight to moderate.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Kahana Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 100 to 1,200 feet. The annual rainfall amounts to 30 to 45 inches. The mean annual soil temperature is 70° F. Kahana soils are geographically associated with Alaeloa, Honolua, and Lahaina soils.

These soils are used for sugarcane, pineapple, and homesites. The natural vegetation consists of guava, klu, koa haole, lantana, Natal redtop, and yellow foxtail.

Kahana silty clay, 7 to 15 percent slopes (KbC).—This soil is on smooth uplands. Included in mapping were small areas of Alaeloa and Lahaina soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 14 inches thick. The subsoil is dark reddish-brown silty clay, about 50 inches thick, that has subangular blocky structure. The substratum is soft, weathered, basic igneous rock. These soils are strongly acid and very strongly acid in the surface layer, strongly acid in the upper part of the subsoil, and neutral in the lower part.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.3 inches per foot in the surface layer and 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°57′44″ N. and long. 156°39′00″ W.

Ap1—0 to 7 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, very sticky and very plastic; abundant fine roots; many fine and very fine pores; many, very fine, black concretions; violent effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 6 to 9 inches thick.

Ap2—7 to 14 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate, medium and fine, subangular blocky structure; hard, firm, very sticky and very plastic; abundant fine roots; many fine and very fine pores; many, fine and very fine, black concretions; violent effervescence with hydrogen peroxide; very strongly acid; abrupt, wavy boundary. 6 to 9 inches thick.

B1—14 to 22 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; strong, fine and very fine, subangular blocky structure; hard, firm, sticky and very plastic; plentiful fine roots; many, fine and very fine, tubular pores; many, fine and very fine, black concretions; few black coatings on ped surfaces; violent effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 6 to 10 inches thick.

B21—22 to 34 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; strong, fine and very fine, subangular blocky structure; hard, firm, sticky and very plastic; few fine roots; many, fine and very fine, tubular pores; many sand-size aggregates that are resistant to crushing; continuous pressure cutans; common fine and very fine, black concretions; strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 8 to 15 inches thick.

B22—34 to 47 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; strong, fine and very fine, subangular blocky structure; hard, firm, sticky and very plastic; few fine roots; many, fine and very fine, tubular pores; continuous pressure cutans that look like slickensides; common sand-size aggregates that are resistant to crushing; many, fine and very fine, black concretions; common black coatings on ped surfaces; slight effervescence with hydrogen peroxide in matrix and violent effervescence on black coatings; neutral; clear, wavy boundary. 10 to 18 inches thick.

B3—47 to 61 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; strong, very fine, subangular blocky structure; slightly hard, friable, sticky and very plastic; many coarse, medium, and fine tubular pores; continuous pressure cutans; common highly weathered pebbles that can be broken with the fingers; neutral.

The solum is more than 40 inches thick. The A horizon ranges from 2 to 3 in value when moist and, in chroma, from 2 to 4 when moist and 3 to 4 when dry. The B horizon ranges from 2.5YR to 10R in hue and from 3 to 4 in chroma when moist. The texture ranges from silty clay to clay.

This soil is used for sugarcane, pineaple, and homesites. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 3; woodland group 1)

Kahana silty clay, 3 to 7 percent slopes (KbB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIe, irrigated or nonirrigated; pineapple group 5; pasture group 3; woodland group 1)

Kahana silty clay, 15 to 25 percent slopes (KbD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas of eroded soils where weathered rock fragments commonly occur in the surface layer.

This soil is used for sugarcane. Small acreages are used for pineapple. (Capability classification IVe, irrigated or nonirrigated; pineapple group 6; pasture group 3; woodland group 1)

Kahanui Series

This series consists of well drained and moderately well drained soils on uplands on the islands of Molokai and Lanai. These soils developed in material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 1,250 to 3,750 feet. The annual rainfall amounts to 60 to 80 inches, except on Lanai. Although actual precipitation amounts to only 35 inches on Lanai, effective rainfall amounts to 60 to 80 inches because fog and cloud cover are common. The rainfall is distributed fairly well throughout the year. The mean annual soil temperature is 62° F. Kahanui soils are geographically associated with Olelo and Olokui soils.

These soils are used for woodland, pasture, wildlife habitat, and water supply. The natural vegetation consists of hilograss, sweet vernalgrass, Boston fern, ohia, false staghornfern, and amaumau fern.

Kahanui gravelly silty clay, 3 to 20 percent slopes (KATD).—This soil occurs on ridgetops on the upper slopes of East Molokai. The surface layer is gravelly because of ironstone fragments.

In a representative profile the surface layer, about 15 inches thick, is dark-brown silty clay that has granular and subangular blocky structure. It has many ironstone concretions and fragments. The subsoil, 9 to 13 inches thick, is dark yellowish-brown and dark-brown silty clay and clay that has subangular blocky structure. The substratum is soft, weathered rock. A discontinuous ironstone sheet is at a depth of 12 to 24 inches. The soil is very strongly acid throughout the profile.

Permeability is moderately rapid above the ironstone sheet. Except for cracks, the ironstone sheet is impermeable. Runoff is slow to medium, and the erosion hazard is slight. At a depth of 12 to 24 inches, roots grow horizontally over the ironstone sheet. Trees growing on this soil tend to form a flat rooting system (fig. 4).

Representative profile: Island of Molokai, lat. 21°08′40″ N. and long. 156°57′21″ W.

A1—0 to 3 inches, dark-brown (10YR 3/3) gravelly silty clay, gray (10YR 5/1) when dry; strong, very fine to coarse, granular structure; hard, firm, sticky and plastic; many roots; many interstitial pores; many ironstone concretions as much as ½ inch long; many glistening specks; common worm casts; slight effervescence with hydrogen peroxide after a delay; moderately high bulk density; very strongly acid; abrupt, smooth boundary. 3 to 5 inches thick.

A3—3 to 15 inches, dark-brown (7.5YR 3/2) gravelly silty clay, grayish brown (10YR 5/2) when dry; dense slaglike layer breaking to weak, fine and medium, subangular blocky structure; hard, firm, very sticky and very plastic; few roots; many, very fine, tubular pores; many ironstone concretions as much as ¼ inch long; very high bulk density; slight efferves-

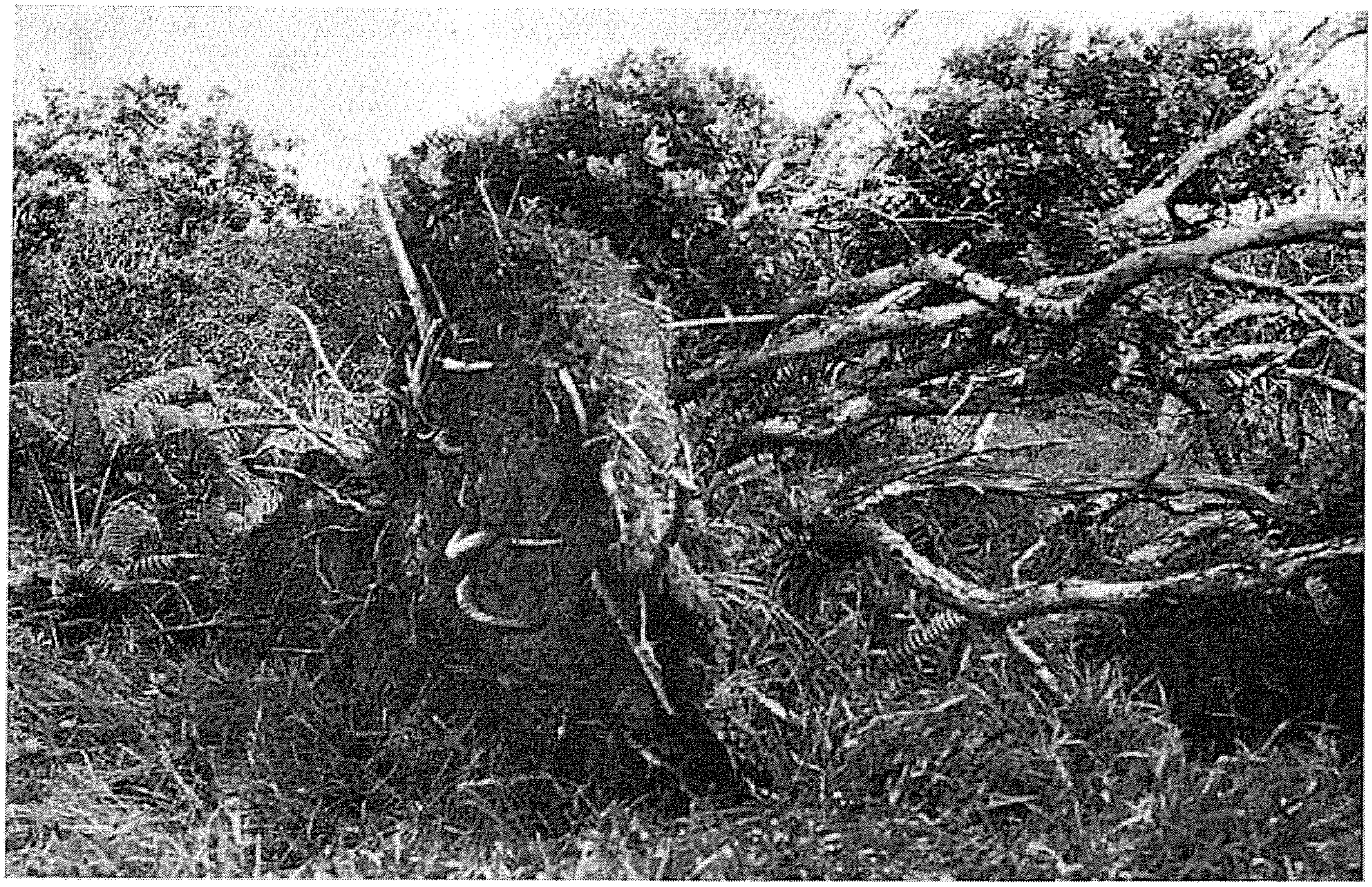

Figure 4.—Windblown tree on Kahanui gravelly silty clay. The soil has an ironstone sheet at a depth of 12 to 24 inches, and the tree roots developed laterally to form a flat rooting system.

cence with hydrogen peroxide; very strongly acid; abrupt, wavy boundary. 11 to 12 inches thick.

B21—15 to 21 inches, dark yellowish-brown (10YR 4/4), moist and dry, silty clay; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine, tubular pores; common elongated ironstone concretions, as much as 1 inch long, embedded horizontally throughout the horizon; very strongly acid; gradual, wavy boundary. 5 to 6 inches thick.

B22ir—21 to 25 inches, dark-brown (7.5YR 4/4), moist and dry, clay; moderate, very fine and fine, subangular blocky structure; hard, friable, very sticky and very plastic; few roots; many, very fine, tubular pores and common, fine and medium, tubular pores; few roots; at a depth of 22 inches there is a weakly developed ironstone sheet that is permeable to roots and water; very strongly acid; clear, wavy boundary. 4 to 7 inches thick.

C1—25 to 30 inches, soft saprolite, dark brown (10YR 3/3), brown (7.5YR 5/2), and gray (N 6/0) when moist; dark-brown mottles; this horizon has some original rock structure but breaks down to clay; hard, firm, sticky and plastic, and smeary; very strongly acid; abrupt, wavy boundary. 2 to 5 inches thick.

C2—30 to 60 inches, soft saprolite, yellowish red (5YR 4/6), reddish yellow (7.5YR 8/6), reddish brown (5YR 4/3), and dark gray (5YR 4/1) when moist; breaks down to gritty silt loam; hard, firm, slightly sticky and slightly plastic, and smeary; very strongly acid.

The amount of ironstone concretions and fragments in the A horizon ranges from 5 to 30 percent. In places the ironstone concretions and fragments form a slaglike mass to a depth of as much as 3 feet. The discontinuous ironstone sheet is slightly hard to very hard and ranges from ⅛ inch to 1 inch or more in thickness. In depressions it is hard or very hard, continuous, and impermeable to roots and water. Hard rock is at a depth of more than 5 feet. On concave slopes there are few, distinct, dark reddish-brown mottles in the upper part of the solum. The A horizon ranges from 7.5YR to 2.5Y in hue and, in value, from 3 to 4 when moist and 1 to 2 when dry. The B horizon ranges from 7.5YR to 10YR in hue, from 4 to 5 in value when moist, and from 4 to 6 in chroma when moist.

This soil is used mainly for woodland, wildlife habitat, and water supply. Small areas are used for pasture. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 12)

Kahanui silty clay, 3 to 20 percent slopes (KASD).—This soil occurs on narrow ridgetops near the higher elevations on the island of Lanai. This soil has a profile like that of Kahanui gravelly silty clay on the island of Molokai, except that there are only a few ironstone concretions and fragments in the surface layer. There is considerable cloud cover during most of the afternoons and nights, and the soil receives much of its moisture in the form of fog drip. Because of this, the soil under large trees is poorly drained. Gibbsite nodules are exposed in cuts and eroded areas.

This soil is used for water supply and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 12)

Kailua Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to moderately steep. Elevations range from 200 to 2,000 feet. The annual rainfall amounts to 90 to 160 inches. It is well distributed throughout the year. The mean annual soil temperature is 70° F. Kailua soils are geographically associated with Pauwela soils.

These soils are used for pasture, woodland, and wildlife habitat. The natural vegetation consists of guava, hilograss, kaimiclover, kukui, and rattailgrass.

Kailua silty clay, 3 to 25 percent slopes (KBID).—This soil is on low uplands. Included in mapping were areas of Honomanu and Makawao soils. Also included were small, steep areas near cinder cones.

In a representative profile the surface layer is dark-brown silty clay about 9 inches thick. The upper part of the subsoil, about 18 inches thick, is dark-brown and dark reddish-brown silty clay that has subangular blocky structure. The lower part of the subsoil is very dark gray silty clay loam. The substratum is soft, weathered basic igneous rock. The soil is very strongly acid in the surface layer and strongly acid or medium acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°53′42″ N. and long. 156°14′58″ W.

Ap1—0 to 5 inches, dark-brown (10YR 3/3) silty clay, brown (10YR 4/3) when dry; strong, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic, and weakly smeary; abundant fine and medium roots; many medium pores; few, fine, glistening specks; very strongly acid; clear, smooth boundary. 3 to 6 inches thick.

Ap2—5 to 9 inches, dark-brown (10YR 3/3) silty clay, brown (10YR 4/3) when dry; strong, fine and medium, subangular blocky structure; hard, friable, sticky and plastic, and weakly smeary; plentiful fine roots; many medium pores; few, fine, pale-yellow, pebble-size fragments; few glistening specks; few, fine, highly weathered, red rock fragments; very strongly acid; clear, smooth boundary. 4 to 6 inches thick.

B21—9 to 14 inches, dark-brown (7.5YR 3/2) silty clay, brown (7.5YR 4/3) when dry; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic, and weakly smeary; few fine roots; many medium and coarse pores; continuous, gelatinlike coatings on ped faces; few glistening specks; few, fine, hard, pale-yellow, pebble-size fragments; common hard rock fragments (1 millimeter to 3 millimeters); strongly acid; clear, wavy boundary. 4 to 8 inches thick.

B22—14 to 27 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic, and moderately smeary; few fine roots; common medium pores; continuous, thick, gelatinlike coatings on ped faces; few, pale-yellow, pebble-size fragments; medium acid; clear, wavy boundary. 8 to 16 inches thick.

IIB23—27 to 40 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) when dry; moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; few fine roots; common, hard, pale-yellow, pebble-size fragments; many dark-brown and reddish-brown highly weathered basalt fragments; medium acid.

The depth to weathered rock is more than 40 inches. In places a few stones occur on the surface. The A horizon ranges from 5YR to 10YR in hue, from 3 to 4 in value when dry, and from 2 to 3 in chroma when moist and 3 to 4 when dry. The B horizon ranges from 5YR to 10YR in hue, from 3 to 4 in value, and from 1 to 4 in chroma when moist. The B horizon dehydrates irreversibly into black and brown, sharp, angular, very hard, and fine, pebble-size aggregates.

This soil is used for pasture, woodland, and wildlife habitat. (Capability classification IVe, nonirrigated; pasture group 11; woodland group 8)

Kaimu Series

This series consists of well-drained, very shallow soils on uplands on the island of Maui. These soils developed in organic material. They are moderately sloping to moderately steep. Elevations range from 1,000 to 3,500 feet. The annual rainfall amounts to 30 to 50 inches. There is some afternoon cloud cover most of the year. The mean annual soil temperature is 68° F. Kaimu soils are geographically associated with Io and Kula soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of black wattle, ilima, kikuyugrass, lantana, and molassesgrass.

Kaimu extremely stony peat, 7 to 25 percent slopes (KCXD).—This soil is on rough, undulating, relatively young Aa lava flows. Included in mapping were small areas of Io and Kula soils. Outcrops of Aa lava are common.

In a representative profile the surface layer is extremely stony black peat about 8 inches thick. The substratum is fragmental Aa lava that has a little soil material in voids and cracks. The soil is neutral in reaction.

Permeability is very rapid. Runoff is very slow, and the erosion hazard is no more than slight. In places roots penetrate to a depth of 2 feet.

Representative profile: Island of Maui, lat. 20°41′56″ N. and long. 156°22′37″ W.

1—0 to 8 inches, black (5YR 2/1) extremely stony peat, dark reddish brown (5YR 3/2) when dry; weak, very fine, granular structure; soft, very friable, nonsticky and nonplastic; abundant roots; porous; high in organic-matter content; low bulk density; 50 to 70 percent gravel, cobblestones, and stone-size fragments of Aa lava; neutral; clear, irregular boundary. 2 to 8 inches thick.

IIC—8 to 20 inches, fragmental Aa lava that contains a little soil material from the overlying horizon in cracks; abundant roots in cracks; organic matter and soil material decrease with depth.

The layer of peat ranges from 2 to 8 inches in thickness. It ranges from 5YR to 10YR in hue and from 1 to 2 in chroma when moist.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 5; woodland group 3)

Kaipoioi Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash and in material weathered from cinders. They are moderately sloping to steep. Elevations range from 3,500 to 6,000 feet. The annual rainfall amounts to 30 to 45 inches. Afternoon cloud cover is common most of the year. The mean annual soil temperature is 56° F. Kaipoioi soils are geographically associated with Laumaia, Olinda, Pane, and Kula soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of kikuyugrass, rattailgrass, sweet vernalgrass, white clover, and Yorkshire foggrass.

Kaipoioi loam, 7 to 40 percent slopes (KDIE).—This soil is on smooth to rolling high mountain slopes. Included in mapping were small areas of Laumaia and Olinda soils and a few scattered rock outcrops.

In a representative profile the surface layer is black loam about 10 inches thick. The subsoil, about 51 inches thick, is black and very dark brown silt loam or silty clay loam that has subangular blocky structure. The substratum is ash and cinders. The soil is neutral in the surface layer and mildly alkaline to neutral in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 2.6 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 60 inches or more.

Representative profile: Island of Maui, lat. 20°46′04″ N. and long. 156°17′34″ W.

Ap—0 to 5 inches, black (10YR 2/1) loam, very dark brown (10YR 2/2) when dry; strong, fine and very fine, granular structure; soft, very friable, nonsticky and nonplastic; abundant fine and very fine roots; many, very fine, interstitial pores; many sand-size aggregates that are more resistant than the matrix; neutral; clear, wavy boundary. 4 to 6 inches thick.

A1—5 to 10 inches, black (10YR 2/1) loam, very dark brown (10YR 2/2) when dry; strong, fine and very fine, granular structure; slightly hard, very friable, nonsticky and nonplastic; abundant fine and very fine roots; many very fine pores; many, hard, sand-size aggregates that are resistant to crushing; neutral; clear, wavy boundary. 4 to 7 inches thick.

B21—10 to 17 inches, black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) when dry; weak, fine, subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; abundant fine roots; many fine and very fine pores; thin, patchy, gelatinlike coatings on peds; mildly alkaline; gradual, wavy boundary. 6 to 8 inches thick.

B22—17 to 30 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) when dry; weak, medium and fine, subangular blocky structure; hard, very friable, slightly sticky and plastic; plentiful fine roots; many fine pores; thin, patchy, gelatinlike coatings on peds; neutral; gradual, wavy boundary. 10 to 13 inches thick.

B23—30 to 45 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) when dry; weak, medium and fine, subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; few fine and very fine roots; many fine and very fine pores; thin, patchy, gelatinlike coatings on peds; neutral; gradual, wavy boundary. 13 to 17 inches thick.

B24—45 to 61 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many fine and very fine pores; thin, nearly continuous, gelatinlike coatings on peds; gritty feel that disappears when rubbed; neutral.

The depth to bedrock is more than 60 inches. The A horizon ranges from 5YR to 10YR in hue. In places dusky-red ash and cinder layers, 2 to 4 inches thick, occur in the A horizon. The B horizon ranges from 5YR to 10YR in hue; from 2 to 3 in value when moist; and, in chroma, from 1 to 2 when moist and 2 to 4 when dry. The B horizon ranges from silt loam to silty clay loam in texture.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 13; woodland group 11)

Kaipoioi very rocky loam, 7 to 40 percent slopes (KDVE).—This soil is similar to Kaipoioi loam, 7 to 40 percent slopes, except that rock outcrops cover 10 to 25 percent of the surface. Workability is very difficult. Included in mapping were small, very steep areas and small, eroded spots.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 13; woodland group 11)

Kalae Series

This series consists of well-drained soils on uplands on the islands of Molokai and Lanai. These soils developed in material weathered from basic igneous rock. They are gently sloping to steep. Elevations range from 750 to 2,200 feet. The annual rainfall amounts to 30 to 50 inches; most of it occurs from November to April. The mean annual soil temperature is 70° F. Kalae soils are generally upslope from Lahaina soils.

These soils are used for pineapple and pasture. The natural vegetation consists of guava, lantana, hilograss, yellow foxtail, Natal redtop, and kikuyugrass.

Kalae silty clay, 2 to 7 percent slopes (KcB).—This soil is gently sloping and occupies smooth uplands. On Lanai, small areas were included where the slope is as much as 10 percent.

In a representative profile the surface layer is dark reddish-brown silty clay about 15 inches thick. The upper part of the subsoil, about 26 inches thick, is dark-red silty clay that has subangular blocky structure. It is compact in place. The lower part, about 21 inches thick, is dark-red and reddish-brown silt loam. The substratum is dark-brown silt loam and soft, weathered rock. The soil is strongly acid throughout the profile.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Molokai, lat. 21°10′28″ N. and long. 157°02′37″ W.

Ap1—0 to 9 inches, dark reddish-brown (2.5YR 3/4) silty clay, weak red (2.5YR 4/2) when dry; cloddy, breaking to moderate, very fine to medium, granular structure; hard, friable, sticky and plastic; few roots; moderately high bulk density; common, hard, earthy lumps that break down when rubbed; slight effervescence with hydrogen peroxide; strongly acid; abrupt, smooth boundary. 7 to 9 inches thick.

Ap2—9 to 15 inches, dark reddish-brown (2.5YR 3/4) silty clay, weak red (2.5YR 4/2) when dry; cloddy, breaking to weak, fine to coarse, subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine and fine, tubular pores and few, medium, tubular pores; firm in place; moderately high bulk density; slight effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 4 to 8 inches thick.

B21t—15 to 26 inches, dark-red (2.5YR 3/6) silty clay, red (2.5YR 4/6) when dry; strong, very fine and fine, subangular blocky structure; very hard, firm, sticky and plastic; few roots; few, very fine, tubular pores; thin, continuous clay films; many, hard, earthy lumps that break down after prolonged rubbing; compact in place; upper part of this horizon has pockets that are slightly smeary and very friable and are dark reddish brown (2.5YR 3/4) when moist; slight effervescence with hydrogen peroxide; strongly acid; gradual, wavy boundary. 7 to 15 inches thick.

B22t—26 to 41 inches, dark-red (2.5YR 4/6), moist and dry, silty clay; strong, very fine and fine, subangular blocky structure; very hard, firm, sticky and plastic; few roots; few, very fine, tubular pores; thin, continuous clay films on peds; many, hard, earthy lumps that break down after prolonged rubbing; compact in place; slight effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 13 to 16 inches thick.

B31—41 to 53 inches, dark-red (2.5YR 3/6) silt loam; yellowish red (5YR 4/6, dry) when crushed; moderate, fine and very fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few roots; common, very fine, tubular pores and few, fine, tubular pores; few, patchy clay films; strongly acid; gradual, wavy boundary. 5 to 12 inches thick.

B32—53 to 62 inches, reddish-brown (5YR 4/4, moist) silt loam; moderate, fine and medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; no roots; common, very fine and fine, tubular pores; dark illuviation cutans on ped faces; strongly acid; gradual, irregular boundary. 1 to 12 inches thick.

C—62 to 67 inches, dark-brown (10YR 3/3 and 7.5YR 3/4, moist) silt loam; weak, fine and very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many, very fine, tubular pores; about 30 percent of this horizon is made up of soft, weathered rock; strongly acid.

The depth to bedrock is more than 5 feet. The upper part of the B horizon is mixed with the A horizon in most cultivated areas. The A horizon ranges from 2.5YR to 5YR in hue and, in chroma, from 4 to 5 when moist and 2 to 4 when dry. The B2t horizon ranges from 2.5YR to 10R in hue, from 3 to 4 in value when moist or dry, and from 3 to 6 in chroma when moist or dry.

This soil is used mainly for pasture and pineapple. (Capability classification IIe if irrigated, IIIc if nonirrigated; pineapple group 5; pasture group 6; woodland group 5)

Kalae silty clay, 7 to 15 percent slopes (KcC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for pasture and pineapple. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Kalae silty clay, 5 to 15 percent slopes, severely eroded (KcC3).—This soil occurs on Molokai. It has a profile like that of Kalae silty clay, 2 to 7 percent slopes, except that most of the surface layer and in places part of the subsoil have been removed by erosion. In many places gravelly, relatively soft rock fragments have been brought into the surface layer through cultivation and erosion. Runoff is medium, and the erosion hazard is moderate to severe. Included in mapping were small areas where the slope is less than 5 percent.

This soil is used mostly for pasture; small areas are used for pineapple. (Capability classification IVe, irrigated or nonirrigated; pineapple group 6; pasture group 6; woodland group 5)

Kalae silty clay, 15 to 25 percent slopes, severely eroded (KcD3).—This soil occurs as narrow areas on sharp slope breaks. It has a profile like that of Kalae silty clay, 2 to 7 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by erosion. In cultivated fields the plow layer consists of a mixture of soil material and gravelly, relatively soft rock fragments. Runoff is rapid, and the erosion hazard is severe. Workability is difficult because of moderately steep slopes.

Although suitability is marginal, this soil is used for pineapple where it occurs in association with less sloping Kalae and Lahaina soils. It is also used for pasture. (Capability classification VIe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Kalae silty clay, 25 to 40 percent slopes, severely eroded (KcE3).—Nearly all of this soil occurs near the golf course on West Molokai. It is on steep ridges and sides of the gulches. It has a profile like that of Kalae silty clay, 2 to 7 percent slopes, except that the surface layer and part of the subsoil have been removed by erosion. Runoff is rapid to very rapid, and the erosion hazard is very severe. There are bare spots that are difficult to vegetate because of strong winds and low fertility. There are a few gullies.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Kalapa Series

This series consists of well-drained soils at the base of slopes on the island of Kauai. These soils developed in material weathered from basic igneous rock and in colluvium. They are moderately sloping to very steep. Elevations range from 200 to 1,200 feet. The annual rainfall amounts to 60 to 100 inches. The mean annual soil temperature ranges from 69° to 74° F. Kalapa soils are geographically associated with Hihimanu and Hanamaulu soils.

These soils are used mainly for water supply, woodland, wildlife habitat, and pasture. A small acreage is used for irrigated sugarcane. The natural vegetation consists of guava, lantana, joee, sensitiveplant, pilipiliula, ohia, Japanese tea, and ferns.

Kalapa silty clay, 40 to 70 percent slopes (KdF).—This soil is on uplands.

In a representative profile the surface layer is dark reddish-brown silty clay about 10 inches thick. The subsoil, about 40 inches thick, ranges from dark-red to dark reddish-brown silty clay and clay that has subangular blocky structure. The substratum is dark-brown, dusky-red, and dark-red silty clay and soft, highly weathered rock. The soil is very strongly acid throughout the profile.

Permeability is moderately rapid. Runoff is very rapid, and the erosion hazard is severe to very severe. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°55′14″ N. and long. 159°26′00.3″ W.

A1—0 to 10 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; moderate, fine, subangular blocky structure; very hard, firm, sticky and plastic; plentiful fine and very fine roots; slight effervescence with hydrogen peroxide; very strongly acid; abrupt, wavy boundary. 8 to 12 inches thick.

B21t—10 to 20 inches, dark-red (2.5YR 3/6) silty clay, reddish brown (2.5YR 4/4) when dry; weak, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; few medium, and plentiful fine and very fine roots; many fine and very fine pores; nearly continuous, thin clay films; upper 4 to 5 inches mixed with material from the A horizon by earthworms; very strongly acid; clear, wavy boundary. 8 to 11 inches thick.

B22t—20 to 37 inches, dark-red (2.5YR 3/6) clay that exhibits bands of weak red (2.5YR 4/2), reddish brown (2.5YR 4/4) when dry; moderate, very fine, subangular blocky structure; very hard, firm, very sticky and plastic; few medium, fine, and very fine roots; many fine and very fine pores; continuous, thin clay films; very strongly acid; clear, smooth boundary. 15 to 19 inches thick.

B23t—37 to 44 inches, dark-red (2.5YR 3/6) clay, red (2.5YR 4/6) when dry; red, white, and yellow sand-size particles; moderate, fine and very fine, subangular blocky structure; very hard, firm, very sticky and plastic; few fine and very fine roots; many fine and very fine pores; continuous, moderately thick clay films; very strongly acid; clear, smooth boundary. 6 to 8 inches thick.

B24t—44 to 50 inches, dark reddish-brown (5YR 3/4) gravelly clay, dark reddish brown (2.5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; very hard, firm, very sticky and plastic; few fine roots; common fine and very fine pores; nearly continuous, moderately thick clay films; gravel is highly weathered; very strongly acid; clear, smooth boundary. 4 to 7 inches thick.

C—50 to 60 inches, dark-brown (7.5YR 3/2), dusky-red (10R 3/2), and dark-red (10R 3/6) silty clay; weak red (10R 4/2) when dry; many, fine, red and white, sand-size particles; weak, fine and very fine, subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; few fine and very fine pores; patchy, moderately thick clay films; very strongly acid.

The A horizon ranges from 5YR to 7.5YR in hue and from 2 to 4 in chroma. The B horizon ranges from 2.5YR to 5YR in hue, from 3 to 4 in value, and from 3 to 6 in chroma. The depth to soft, highly weathered rock ranges from 40 inches to more than 60 inches. In places a few stones and boulders occur throughout the solum.

This soil is used for water supply, pasture, and woodland. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Kalapa silty clay, 20 to 40 percent slopes (KdE).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for pasture, water supply, wildlife habitat, and woodland. A small acreage is used for sugarcane. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Kalapa silty clay, 8 to 20 percent slopes (KdD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for sugarcane, pasture, wildlife habitat, and woodland. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Kalapa very rocky silty clay, 40 to 70 percent slopes (KEHF).—This soil is similar to Kalapa silty clay, 40 to 70 percent slopes, except that 10 to 40 percent of the acreage is covered by rock outcrop. Runoff is very rapid, and the erosion hazard is severe to very severe.

This soil is used for water supply, pasture, and woodland. (Capability classification VIIs, nonirrigated; pasture group 8; woodland group 14)

Kalaupapa Series

This series consists of well-drained upland soils underlain by pahoehoe bedrock at a depth of about 14 inches. These soils occur on the Kalaupapa peninsula on the island of Molokai (fig. 5). They developed in relatively recent volcanic ash. They are gently sloping to moderately steep. Elevations range from nearly sea level to 400 feet. The annual rainfall amounts to 35 to 50 inches. The mean annual soil temperature is 74° F. Kalaupapa soils are geographically associated with Haleiwa and Jaucas soils.

These soils are used for pasture. The natural vegetation consists of lantana, guava, bermudagrass, kukaipuaa, joee, and Java plum.

Kalaupapa very rocky silty clay loam, 3 to 25 percent slopes (KFID).—This soil occurs as one large area. It is shallow, and there are many stones and cobblestones on the surface and few to many in the profile. Rock outcrops cover about 15 percent of the surface.

In a representative profile the surface layer is dark-brown silty clay loam about 6 inches thick. The subsoil, about 8 inches thick, is dark yellowish-brown, nearly massive silt loam. Hard pahoehoe bedrock occurs at a depth of about 14 inches. The soil is neutral throughout the profile.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. Roots penetrate to the bedrock. Cultivation is impractical because of shallowness, the many stones, and the rock outcrops.

Representative profile: Island of Molokai, lat. 21°11′28″ N. and long. 156°57′42″ W.

A1—0 to 6 inches, dark-brown (10YR 3/3 moist, 4/3 dry) silty clay loam; strong, fine and medium, granular structure; hard, firm, sticky and plastic; many roots; many interstitial pores; few to common pebbles and stones; moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 4 to 6 inches thick.

B2—6 to 14 inches, dark yellowish-brown (10YR 3/4 moist, 4/4 dry) silt loam; weak, fine, subangular blocky structure to massive; soft, very friable, slightly sticky and slightly plastic; common roots; many, very fine, tubular pores and common, fine, tubular pores; common pebbles; loose in place; slight effervescence with hydrogen peroxide; neutral; abrupt, wavy boundary. 3 to 12 inches thick.

IIR—14 inches, hard pahoehoe bedrock.

The depth to pahoehoe bedrock is typically about 14 inches, but it ranges from 7 to 18 inches. The A and B horizons range from 7.5YR to 10YR in hue. The texture of the A horizon is typically silty clay loam, but in a few areas

Figure 5.—Soils of the Kalaupapa series. These soils formed in ash from lava that erupted from the volcanic crater at upper right.

it is silt loam. The texture of the B horizon ranges from silty clay loam to silt loam.

This soil is used for pasture. Most of the pastures are unimproved, and much of the area is covered with lantana. Mechanical clearing of brush is difficult. (Capability classification VIIs, nonirrigated; pasture group 5; woodland group 13)

Kalihi Series

This series consists of poorly drained soils on bottom lands on the island of Kauai. These soils developed in alluvium derived from basic igneous materials. They are nearly level. Elevations range from 50 to 100 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 74° F. Kalihi soils are geographically associated with Kaena and Waikomo soils.

These soils are used for irrigated sugarcane. All of the soils are cultivated.

Kalihi clay (Ke).—This soil is on bottom lands.

In a representative profile the surface layer is dark-brown and very dark grayish-brown, mottled clay about 16 inches thick. The subsoil, about 30 inches thick, is dark-gray, mottled, massive clay. The substratum is mottled, grayish-brown and dark-gray clay. The surface layer is neutral to slightly acid. The subsoil is slightly acid to strongly acid.

Permeability is slow. Runoff is slow, and erosion is not a hazard. The available water capacity is about 1.5 inches per foot of soil. Roots penetrate to a depth of 60 inches. Workability is difficult.

Representative profile: Island of Kauai, lat. 21°54′13.4″ N. and long. 159°25′16.1″ W.

Ap1—0 to 8 inches, dark-brown (10YR 3/3) clay, dark gray (10YR 4/1) when dry; few, fine, distinct mottles of yellowish brown (10YR 5/6) and brown (10YR 5/3) and a few black stains; weak, fine, subangular blocky structure; very hard, firm, very sticky and very plastic; abundant roots; moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 6 to 10 inches thick.

Ap2—8 to 16 inches, very dark grayish-brown (10YR 3/2) clay, very dark gray (10YR 3/1) when dry; few, fine, distinct mottles of yellowish brown and reddish brown; weak, fine, subangular blocky structure; extremely hard, firm, very sticky and very plastic; abundant roots; moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 6 to 10 inches thick.

B21g—16 to 27 inches, dark-gray (2Y 4/1) clay, grayish brown (10YR 5/2) when dry; common, medium, distinct mottles of yellowish brown, reddish brown, and yellowish red; massive; extremely hard, firm, very sticky and very plastic; abundant roots; many fine and very fine pores; slightly acid; gradual, smooth boundary. 9 to 12 inches thick.

B22g—27 to 46 inches, dark-gray (5Y 4/1) clay, gray (2.5Y 5/1) when dry; many, medium, distinct mottles of strong brown, reddish brown, and yellowish red; massive; extremely hard, firm, very sticky and very plastic; plentiful roots; common very fine pores; strongly acid; gradual, smooth boundary. 17 to 21 inches thick.

C1g—46 to 60 inches, grayish-brown (2.5Y 5/2) and dark-gray (5Y 4/1) clay, gray (5Y 5/1) when dry; massive; extremely hard, firm, very sticky and very plastic; few roots; few fine pores; neutral; gradual, smooth boundary. 12 to 15 inches thick.

C2g—60 to 70 inches, dark-gray (5Y 4/1), olive-gray (5Y 5/2), and yellowish-brown (10YR 5/6) clay; olive (5Y 5/3) with mottles of brownish yellow (10YR 6/6) when dry; massive; extremely hard, firm, very sticky and very plastic; few roots; few very fine pores; slight effervescence with hydrogen peroxide; neutral.

The A horizon ranges from 2 to 3 in value and from 1 to 3 in chroma. Mottles range from none to few. The B horizon ranges from neutral to 2.5Y and 5Y in hue, from 4 to 5 in value, and from 0 to 1 in chroma. Mottles range from common to many.

This soil is used for irrigated sugarcane. (Capability classification IIIw if irrigated, IVw if nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Kaloko Series

This series consists of poorly drained soils on coastal plains on the islands of Kauai and Oahu. These soils developed in alluvium derived from basic igneous rock; the alluvium has been deposited over marly lagoon deposits. The soils are nearly level. Elevations range from sea level to 20 feet. The annual rainfall amounts to 20 to 25 inches. The mean annual soil temperature is 73° F. Kaloko soils are geographically associated with Nohili soils on Kauai and with Keaau, Pearl Harbor, and Waialua soils on Oahu.

In this survey area a noncalcareous variant of the Kaloko series was mapped. This soil, Kaloko clay, noncalcareous variant, is described in alphabetical order, along with other mapping units of this series.

These soils are used for irrigated sugarcane and pasture. The natural vegetation consists of kiawe, klu, bermudagrass, and annuals.

Kaloko clay (Kfa).—This soil is nearly level and occurs on coastal plains. Included in the areas mapped on Oahu were small areas that consist mainly of coral fragments or marly material; areas of clayey, very poorly drained soils that are underlain by peat or muck; and small areas of dark reddish-brown, very deep, moderately well drained alluvial soils.

In a representative profile the surface layer is dark-brown clay about 12 inches thick. The subsoil, about 8 inches thick, is dark reddish-brown and weak-red clay. Below this is mottled, white to light-gray, platy silty clay about 13 inches thick. This is underlain by dark greenish-gray and dark-gray massive silty clay. The soil is mildly alkaline to neutral throughout the profile.

Permeability is moderately slow to slow. Runoff is slow to very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.6 inches per foot of soil. Roots penetrate to a depth of about 40 inches or to the water table in undrained areas. Workability is somewhat difficult.

Representative profile: Island of Kauai, lat. 22°01′6.5″ N. and long. 159°46′10.1″ W.

Ap—0 to 12 inches, dark-brown (7.5YR 3/2) clay; common, fine, distinct, red mottles and yellowish-white specks; weak, fine, subangular blocky structure; very hard, firm, very sticky and very plastic; abundant roots; moderate reaction with hydrogen peroxide; violent reaction with hydrochloric acid; mildly alkaline; clear, smooth boundary. 8 to 15 inches thick.

B2—12 to 20 inches, dark reddish-brown (5YR 3/3) and weak-red (2.5YR 5/2) clay; many, fine, distinct mottles of brownish yellow (10YR 6/6), white (2.5Y 8/2), and reddish yellow (5YR 6/6); moderate, fine, angular and subangular blocky structure; very hard, firm, very sticky and very plastic; plentiful roots; many fine pores; thin, patchy coatings that look like illuviation cutans; slight reaction to hydrogen peroxide; violent reaction to hydrochloric acid; mildly alkaline; abrupt, smooth boundary. 7 to 11 inches thick.

IIC1g—20 to 29 inches, mottled white (2.5Y 8/1), reddish-brown (5YR 5/4), strong-brown (7.5YR 5/8), dark-brown (7.5YR 3/2), and gray (5Y 6/1) silty clay; rubbed color is light yellowish brown (2.5Y 6/3); weak, medium and thick plates; salt crystals between some plates; hard, firm, sticky and plastic; few roots; few fine and medium pores; violent reaction to hydrochloric acid; mildly alkaline; abrupt, smooth boundary. 8 to 11 inches thick.

IIC2sag—29 to 33 inches, layers of light-gray (N 6/0), gray (N 5/0), dark-gray (5Y 4/1), pink (7.5YR 8/4), grayish-brown (2.5Y 5/2), and reddish-brown (5YR 4/4) silty clay; rubbed color is olive gray (5Y 5/2); moderate, medium and thick plates; hard, friable, sticky and plastic; few roots; few fine pores; salt crystals make up about 50 percent of volume; neutral; abrupt, smooth boundary. 12 to 15 inches thick.

IIIC3g—33 to 43 inches, thickest plates are dark greenish-gray (5BG 4/1) silty clay; other plates are dark-gray (N 4/0), gray (5Y 5/1), and light-gray (5Y 6/1) silty clay; rubbed color is dark greenish gray (5BG 4/1); moderate, thin and thick plates; hard, friable, sticky and plastic; few roots; common fine and medium pores; moderate effervescence with hydrochloric acid; neutral; abrupt, smooth boundary. 9 to 11 inches thick.

IIIC4sag—43 to 60 inches, dark greenish-gray (5BG 4/1), light greenish-gray (5GY 7/1), greenish-gray (5GY 6/1), and dark greenish-gray (5GY 4/1) silty clay; rubbed color is greenish gray (5BG 5/1); massive; friable, sticky; common salt crystals; moderate effervescence with hydrochloric acid; mildly alkaline.

The A horizon ranges from 5YR to 7.5YR in hue and from 1 to 2 in chroma. Mottles in the A horizon range from few to common. The B horizon ranges from 2.5YR to 10YR in hue and from 2 to 4 in chroma. The depth to the light-colored calcareous C horizon ranges from 12 to 20 inches. The depth to the water table varies, because all the soils are artificially drained. Unless the soils are drained, the water table generally is at a depth of 12 to 20 inches.

This soil is used for irrigated sugarcane and pasture. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7)

Kaloko clay loam (Kf).—This soil is on the Mana plain on the island of Kauai. This soil has a profile like that of Kaloko clay, except for the texture of the surface layer and horizontal lenses of sand in the underlying material. It is easier to work than that soil. Runoff is very slow, and there is no hazard of erosion.

This soil is used for sugarcane. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7)

Kaloko clay, noncalcareous variant (Kfb).—This soil occurs in slight depressions on the coastal plains on the island of Oahu. It is more acid and grayer than is typical of the Kaloko series. It is underlain by noncalcareous material. The annual rainfall amounts to 40 to 60 inches.

The surface layer is very dark gray clay. The subsoil is gray or grayish-brown prismatic clay. The substratum is massive clay and silty clay. This soil is slightly acid to neutral throughout.

Included in mapping were small areas of very deep, well-drained alluvial soils in drainageways.

Permeability is slow. Runoff is ponded to very slow, and the erosion hazard is none to slight. The available water capacity is 1.6 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

This soil is used for pasture and sugarcane. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7)

Kamaole Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently to moderately sloping. Elevations range from 1,500 to 2,300 feet. The annual rainfall amounts to 15 to 25 inches; most of it occurs in winter. The mean annual soil temperature is 69° F. Kamaole soils are geographically associated with Kaimu, Keawakapu, Kula, and Waiakoa soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of bermudagrass, castorbean, false mallow, feather fingergrass, and kiawe.

Kamaole very stony silt loam, 3 to 15 percent slopes (KGKC).—This soil is on uplands. Included in mapping were small areas of Keawakapu and Kula soils. Also included were small areas where slopes have been removed. Outcrops of Aa lava are common.

In a representative profile the surface layer is dark-brown and dark reddish-brown silt loam and silty clay loam about 8 inches thick. The subsoil, about 12 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The substratum is fragmental Aa lava that has very little soil material in voids. The soil is medium acid and slightly acid in the surface layer and mildly alkaline in the subsoil.

Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 2 feet.

Representative profile: Island of Maui, lat. 20°45′00″ N. and long. 156°21′44″ W.

A11—0 to 2 inches, dark-brown (10YR 3/3) very stony silt loam, brown (10YR 4/3) when dry; moderate, thin and very thin, platy structure; soft, friable, slightly sticky and slightly plastic; abundant fine roots that have a tendency to mat on plate faces; common fine pores; few, fine, black concretions; 10 to 15 percent stones; slight effervescence with hydrogen peroxide; medium acid; abrupt, smooth boundary. 1 to 3 inches thick.

A12—2 to 8 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark reddish gray (5YR 4/2) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful fine roots; many fine and very fine pores; few, fine, black concretions; few moderately weathered pebbles; slight effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 4 to 7 inches thick.

B2—8 to 20 inches, dark reddish-brown (5YR 3/2) cobbly silty clay, dark reddish brown (5YR 3/3) when dry; moderate, very fine and fine, subangular blocky structure; hard, firm, very sticky and very plastic; few roots; many fine pores; few, fine, black concretions; thin, patchy clay films on peds; few sand-size aggregates that are more resistant than the matrix; 10 to 20 percent weathered gravel and cobblestones; strong effervescence with hydrogen peroxide; mildly alkaline; clear, wavy boundary. 10 to 14 inches thick.

IIC—20 inches, fragmental Aa lava that contains a little soil material in voids.

The depth to fragmental Aa lava ranges from 16 to 24 inches. The A horizon ranges from 5YR to 10YR in hue, from 2 to 3 in value when moist and 3 to 4 when dry, and from 2 to 3 in chroma when moist and 2 to 4 when dry. The texture is silt loam or silty clay loam. The B horizon ranges from 5YR to 7.5YR in hue and from 2 to 3 in value when moist. The texture is silty clay loam or silty clay.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 3)

Kamaole extremely stony silt loam, 3 to 15 percent slopes (KGLC).—This soil is similar to Kamaole very stony silt loam, 3 to 15 percent slopes, except that stones cover 3 to 15 percent of the surface. Included in mapping were small areas of rock outcrop.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 3)

Kaneohe Series

This series consists of well-drained soils on terraces and alluvial fans on the windward side of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. In a few places they developed in volcanic ash and in material weathered from cinders. The soils are gently sloping to very steep. Elevations range from 100 to 1,000 feet. The annual rainfall, which is fairly well distributed throughout the year, amounts to 70 to 90 inches. The mean annual soil temperature is 71° F. Kaneohe soils are geographically associated with Alaeloa, Lolekaa, and Waikane soils.

These soils are used for pasture, homesites, and urban development. The natural vegetation consists of guava, Boston fern, sensitive plant, glenwoodgrass, and hilograss.

Kaneohe silty clay, 3 to 8 percent slopes (KgB).—This soil occupies uniform slopes. Included in mapping were small areas of reddish-colored soils and areas of dark-brown soils that formed in gravelly alluvium.

In a representative profile the surface layer is dark reddish-brown silty clay about 14 inches thick. The subsoil, 40 to more than 50 inches thick, is dusky-red and dark-red silty clay that has subangular blocky structure. The substratum is soft, weathered gravel. The soil is slightly acid in the surface layer and strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight. The available water capacity is 1.2 inches per foot in the surface layer and 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°22′44″ N. and long. 157°47′36″ W.

Ap—0 to 14 inches, dark reddish-brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) when dry; strong, very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant very fine and fine, and few medium roots; many, very fine and fine, tubular and interstitial pores; common wormholes and worm casts; few, soft, highly weathered pebbles; slightly acid; clear, wavy boundary. 8 to 14 inches thick.

B21—14 to 22 inches, dusky-red (10R 3/4) silty clay, dark red (10R 3/6) when dry; weak, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; abundant very fine and fine, and few medium roots; many, very fine and fine, tubular pores and few, medium, tubular pores; common, soft, strong-brown, yellow, and gray, highly weathered pebbles; thin, patchy clay films on ped faces; strongly acid; gradual, smooth boundary. 7 to 12 inches thick.

B22—22 to 34 inches, dark-red (2.5YR 3/4) silty clay, red (2.5YR 4/6) when dry; weak, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic, and smeary; plentiful fine roots; many, very fine and fine, tubular pores; common highly weathered rock fragments; thin, patchy clay films on peds and in pores; strongly acid; gradual, wavy boundary. 10 to 14 inches thick.

B23t—34 to 60 inches, dusky-red (10R 3/4) silty clay, dark red (2.5YR 3/6) when moist; strong, fine, blocky and subangular blocky structure; hard, friable, sticky and slightly plastic, and smeary; few fine roots; many, very fine and fine, tubular pores; thin, patchy clay films on peds; common highly weathered rock fragments and a few hard boulder cores; strongly acid.

Weathered gravel makes up 5 to 25 percent of the soil mass and increases in size, amount, and hardness with depth. The A horizon ranges from 5YR to 10R in hue, from 2 to 4 in chroma, and, in value, from 3 to 6 when dry. The B horizon ranges from 3 to 4 in value when moist or dry, and from 4 to 6 in chroma when moist or dry. The B horizon ranges from slightly plastic to plastic in consistence. This soil tends to dehydrate irreversibly upon drying, particularly in the B horizon. The B23t ranges from silty clay to silty clay loam in texture.

This soil is used for pasture and golf courses. (Capability classification IIe, nonirrigated; pasture group 8; woodland group 7)

Kaneohe silty clay, 8 to 15 percent slopes (KgC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small eroded spots and gravelly areas.

This soil is used for pasture. (Capability classification IIIe, nonirrigated; pasture group 8; woodland group 7)

Kaneohe silty clay, 30 to 65 percent slopes (KHOF).—This soil occurs on terrace faces and along drainageways. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because of the slope. Included in mapping were small eroded spots and gravelly areas. Also included were small areas where the slope is less than 30 percent.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Kaneohe silty clay loam, 5 to 15 percent slopes (KHMC).—This soil has a profile like that of Kaneohe silty clay, 3 to 8 percent slopes, except that the texture throughout the profile is silty clay loam. There are large amounts of volcanic ash and cinders in the subsoil. Volcanic ash and cinders generally occur below a depth of 20 inches. The soil is extremely acid to very strongly acid. Included in mapping were small eroded spots, gravelly areas, and steep slopes.

This soil is used for pasture and homesites. (Capability classification IIIe, nonirrigated; pasture group 8; woodland group 7)

Kaneohe silty clay loam, 15 to 30 percent slopes (KHME).—This soil has a profile like that of Kaneohe silty clay, 3 to 8 percent slopes, except that the texture throughout the profile is silty clay loam. There are considerable amounts of volcanic ash and cinders in the subsoil. Volcanic ash and cinders generally occur below a depth of 20 inches. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because of the slope. The soil is extremely acid to very strongly acid.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Kaneohe silty clay loam, 30 to 65 percent slopes (KHMF).—This soil has a profile like that of Kaneohe silty clay, 3 to 8 percent slopes, except that the texture throughout the profile is silty clay loam. Large amounts of volcanic ash and cinders occur at a depth below 20 inches. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Included in mapping were small eroded spots, gravelly areas, and small stony areas where the slope is up to 70 percent.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Kanepuu Series

This series consists of well-drained soils on uplands on the island of Lanai. These soils formed in material derived from basic igneous rock. They are gently sloping and moderately sloping. Elevations range from 1,500 to 2,000 feet. The annual rainfall amounts to 20 to 25 inches, most of which occurs from November to April. In most places these soils are exposed to strong trade winds. The mean annual soil temperature is 70° F. Kanepuu soils are upslope from Lahaina soils.

These soils are used for wildlife habitat and pasture. The natural vegetation consists of dallisgrass, uhaloa, lantana, and molassesgrass.

Kanepuu silty clay, 3 to 7 percent slopes (KhB).—This soil occurs on the northern plateau of Lanai. The slopes are smooth. Included in mapping were a few small areas of Blown-out land.

In a representative profile the surface layer is dark reddish-brown silty clay about 11 inches thick. The subsoil, 40 to more than 50 inches thick, is silty clay that has subangular blocky structure. It is dark reddish brown in the upper part and dark brown in the lower part. The substratum is soft, weathered rock. The soil is slightly acid to neutral throughout the profile.

Permeability is moderate, and runoff is slow. The hazard of water erosion is slight, but the hazard of wind erosion is severe in areas exposed to trade winds. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Lanai, lat. 20°51′54″ N. and long. 156°54′54″ W.

A11—0 to 3 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; strong, very fine to medium, granular structure; hard, firm, sticky and plastic; many interstitial pores; many roots; violent effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 3 to 4 inches thick.

A12—3 to 11 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; weak, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; many roots; common, very fine, tubular pores; moderately high bulk density; violent effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 8 inches thick.

B1—11 to 15 inches, dark reddish-brown (5YR 3/2) silty clay, reddish brown (5YR 4/3) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine, tubular pores; moderately high bulk density; slight effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 3 to 4 inches thick.

B21—15 to 21 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; strong, very fine and fine, subangular blocky structure; hard, friable, very sticky and very plastic; few roots; many, very fine and fine, tubular pores; ped surfaces have a metallic sheen; compact in place; no effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 5 to 6 inches thick.

B22t—21 to 36 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; strong, very fine and fine, angular and subangular blocky structure; very hard, firm, sticky and very plastic; few roots; many, very fine, tubular pores; ped surfaces have almost continuous red clay films; ped surfaces have metallic sheen; many, hard, earthy lumps that persist when rubbed; compact in place; slightly acid; gradual, wavy boundary. 15 to 19 inches thick.

B23t—36 to 53 inches, dark-brown (7.5YR 3/4), moist and dry, silty clay; strong, coarse, subangular blocky structure breaking to strong, very fine and fine, angular blocky and subangular blocky; hard, firm, sticky and plastic; few roots; many, very fine, tubular pores; almost continuous red clay films on ped surfaces; many, hard, earthy lumps that persist when rubbed; compact in place but less so than the B22t horizon; slightly acid; gradual, wavy boundary. 15 to 20 inches thick.

B24t—53 to 61 inches, dark-brown (7.5YR 3/2), moist and dry, silty clay; moderate, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic; few roots; many, very fine, tubular pores; common red clay films on ped surfaces; firm in place; few strongly weathered rock fragments; slightly acid.

The depth to bedrock is more than 5 feet. In most years the soil is dry in some places to a depth of 10 to 40 inches for more than 90 cumulative days. The A horizon is 2 to 3 in chroma when moist. The A and B1 horizons have a moderate concentration of heavy minerals. The B horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when moist, and from 2 to 4 in chroma when moist and 3 to 4 when dry.

This soil is used for pasture and wildlife habitat. (Capability classification IIe if irrigated, IIIc if nonirrigated; pasture group 3)

Kanepuu silty clay, 3 to 7 percent slopes, eroded (KhB2).—This soil has a profile like that of Kanepuu silty clay, 3 to 7 percent slopes, except that it consists essentially of subsoil; the surface layer has been removed by wind erosion. Much of the area is relatively smooth and is barren. Some areas have a hummocky topography caused by blowouts and deposition of windblown material. Runoff is medium. The hazard of water erosion is moderate, and the hazard of wind erosion is severe. Included in mapping were small areas that are not eroded or are only slightly eroded.

This soil is used for wildlife habitat and pasture. (Capability classification IIe if irrigated, IIIc if nonirrigated; pasture group 3)

Kanepuu silty clay, 7 to 15 percent slopes (KhC).—On this soil, runoff is slow to medium. The hazard of water erosion is slight to moderate, but the hazard of wind erosion is severe in areas exposed to the trade winds. Workability is slightly difficult because of the slope.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe, irrigated or nonirrigated; pasture group 3)

Kanepuu silty clay, 7 to 15 percent slopes, eroded (KhC2).—This soil has a profile like that of Kanepuu silty clay, 3 to 7 percent slopes, except that the surface layer has been removed by wind erosion. Runoff is rapid, and the hazard of wind and water erosion is severe. Most of the area has a relatively smooth surface, but some areas have a hummocky topography caused by blowouts and deposition of windblown material. Much of the area is barren. Included in mapping were severely eroded areas where small gullies are common.

This soil is used for wildlife habitat and pasture. Vegetation is difficult to establish, because of drying winds and low rainfall. Capability classification IIIe if irrigated, IVe if nonirrigated; pasture group 3)

Kapaa Series

This series consists of well-drained soils on uplands on the islands of Kauai and Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to extremely steep. Elevations range from 200 to 800 feet. The annual rainfall amounts to 80 to 120 inches. The mean annual soil temperature is 71° F. Kapaa soils are geographically associated with Halii and Puhi soils on Kauai and with Paaloa soils on Oahu.

These soils are used for sugarcane, pasture, pineapple, orchard and truck crops, woodland, wildlife habitat, and water supply. The natural vegetation consists of ricegrass, hilograss, yellow foxtail, Christmas berry, false staghornfern, guava, rhodomyrtus, melastoma, and associated plants.

Kapaa silty clay, 3 to 8 percent slopes (KkB).—This soil is on broad ridges in the uplands. Included in mapping were about 300 acres on Kauai, south of Puu Kolo peak and southwest of Knudsen gap. This soil formed in volcanic ejecta. The surface layer and the upper part of the subsoil contain less gibbsite than is typical.

In a representative profile the surface layer is dark yellowish-brown silty clay about 14 inches thick. The subsoil, about 46 inches thick, is yellowish-red and reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The surface layer is strongly acid. The subsoil is medium acid to very strongly acid.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°2′42″ N. and long. 159°23′31″ W.

Ap—0 to 14 inches, dark yellowish-brown (10YR 4/4) silty clay, dark yellowish brown (10YR 4/4) when dry; weak, fine, granular structure; slightly hard, friable, sticky and plastic; abundant roots; matted at bottom of horizon; many pores; about 10 percent of volume made up of yellowish-red (5YR 4/6) material turned up by plowing; sand-size soil aggregates, resistant to crushing, that break down with prolonged rubbing; slight reaction to hydrogen peroxide; a few angular gibbsite aggregates, up to 1 inch across, on surface and mixed in soil; strongly acid; abrupt, smooth boundary. 12 to 14 inches thick.

B21—14 to 22 inches, yellowish-red (5YR 4/6) silty clay, reddish brown (5YR 4/4) when dry; weak, medium, subangular blocky structure; hard, friable, sticky and plastic; very few roots; many fine and medium pores; thin coatings in pores, patchy coatings on ped faces; coatings look like clay films; about 5 percent weathered pebbles impregnated with gibbsite; medium acid; clear, smooth boundary. 4 to 8 inches thick.

B22—22 to 31 inches, yellowish-red (5YR 4/6) light clay loam, strong brown (7.5YR 4/6) when dry; weak, medium and fine, subangular blocky structure; hard, friable, sticky and plastic, and weakly smeary; very few roots; many, medium, fine and very fine pores; gelatinlike coatings in pores, patchy on ped faces; about 25 percent soft, weathered pebbles impregnated with gibbsite; medium acid; clear, smooth boundary. 8 to 10 inches thick.

B23—31 to 38 inches, reddish-brown (5YR 4/4) silty clay, strong brown (7.5YR 5/6) when dry; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; very few roots; many, medium, fine and very fine pores; gelatinlike coatings in pores, patchy on ped faces; about 10 percent soft, weathered pebbles impregnated with gibbsite; discontinuous bands and lenses of yellowish material that is presumed to be gibbsite; medium acid; clear, smooth boundary. 6 to 12 inches thick.

B24—38 to 45 inches, yellowish-red (5YR 4/6) silty clay, yellowish red (5YR 5/6) when dry; weak, medium and fine, subangular blocky structure; hard, friable, slightly sticky and plastic; very few roots; many, medium, fine and very fine pores; about 30 percent soft, weathered pebbles impregnated with gibbsite, also impregnated with lesser amounts of other whitish material that looks like halloysite; some soft and hard, reddish-yellow (7.5YR 6/8) material; medium acid; clear, wavy boundary. 6 to 15 inches thick.

B25—45 to 60 inches, yellowish-red (5YR 4/8) light clay loam, strong brown (7.5YR 5/6) when dry; massive; hard, friable, sticky and plastic, and weakly smeary; no roots; many, medium, fine and very fine pores; 25 to 40 percent soft, weathered pebbles impregnated with gibbsite and lesser amounts of whitish material that looks like halloysite; vertical bands of red (2.5YR 4/6) that has 1/16-inch edge of dark reddish brown (2.5YR 3/4); very strongly acid.

The A horizon ranges from 7.5YR to 2.5Y in hue, from 2 to 4 in chroma, and from 2 to 4 in value. The B horizon ranges from 5YR to 7.5YR in hue, from 3 to 8 in chroma, and from 3 to 4 in value. In places the B horizon is light clay loam and silty clay loam. In some places hard, angular, weathered rock fragments and concretions occur in any horizon and range from few to many.

This soil is used for sugarcane, pasture, pineapple, orchards, truck crops, wildlife habitat, and woodland. (Capability classification IIIs, nonirrigated; sugarcane group 2; pineapple group 7; pasture group 10; woodland group 9)

Kapaa silty clay, 8 to 15 percent slopes (KkC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were 202 acres on Kauai, south of Puu Kolo peak and southwest of Knudsen gap. This soil formed in volcanic ejecta. The surface layer and the upper part of the subsoil contain less gibbsite than is typical.

This soil is used for sugarcane, pasture, pineapple, orchards, wildlife habitat, and woodland. (Capability classification IIIe, nonirrigated; sugarcane group 2; pineapple group 8; pasture group 10; woodland group 9)

Kapaa silty clay, 15 to 25 percent slopes (KkD).—On this soil, runoff is medium and the erosion hazard is moderate.

Included in mapping was a small area on Kauai, south of Puu Kolo peak and southwest of Knudsen gap. This soil formed in volcanic ejecta. The surface layer and the upper part of the subsoil contain less gibbsite than is typical.

This soil is used for sugarcane, pineapple, pasture, orchards, wildlife habitat, and woodland. (Capability classification IVe, nonirrigated; sugarcane group 2; pineapple group 8; pasture group 10; woodland group 9)

Kapaa silty clay, 25 to 40 percent slopes (KkE).—On this soil, runoff is rapid and the erosion hazard is moderate to severe. Part of the surface layer has been removed by erosion.

This soil is used for pasture, wildlife habitat, and woodland. (Capability classification VIe, nonirrigated; pasture group 10; woodland group 9)

Kapaa silty clay, 40 to 100 percent slopes (KlG).—On this soil, runoff is very rapid and the erosion hazard is very severe. Most of the surface layer has been removed by erosion.

Included in mapping were small, narrow areas on ridgetops that have an ironstone sheet, 1/8 to 1/2 inch thick, about 10 to 18 inches below the surface. These soils are mottled and in many places have a thin gray layer, 1/2 inch to 3 inches thick, below the surface layer. Rock outcrop, Stony steep land, Rough broken land, eroded spots, and Rough mountainous land make up about 25 percent of the acreage.

This soil is used for water supply, wildlife habitat, and woodland. (Capability classification VIIe, nonirrigated; pasture group 10; woodland group 14)

Kapuhikani Series

This series consists of well-drained, extremely stony soils on uplands on the leeward slopes of West Molokai. These soils are underlain by bedrock at a depth of about 24 inches. They developed in material derived from olivine basalt. They are gently sloping and moderately sloping. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 10 to 15 inches. Most of the rain occurs during storms from November to April. The mean annual soil temperature is 75° F. Kapuhikani soils are geographically associated with Holomua and Molokai soils.

These soils are used for wildlife habitat and pasture. The natural vegetation consists of kiawe, zinnia, ilima, and uhaloa.

Kapuhikani extremely stony clay, 3 to 15 percent slopes (KKTC).—This soil contains many stones on the surface and throughout the profile. Included in mapping were areas of Very stony land and Very stony land, eroded. Each of these included land types makes up about 10 percent of the acreage.

In a representative profile the surface and subsurface layers are dark-brown, very sticky and very plastic clay about 20 inches thick. The clay shrinks and cracks widely when dry and swells when wet. The substratum consists of about 7 inches of yellowish-brown and pale-brown, highly weathered rock that has an accumulation of calcium carbonate. Bedrock occurs at a depth of about 27 inches.

Permeability is slow. Runoff is slow to medium, and the erosion hazard is slight to moderate. Roots are affected by the bedrock. Tillage for pasture or other uses is impractical because of the abundant stones and shallowness. The shrink-swell potential is very high.

Representative profile: Island of Molokai, lat. 21°06′18″ N. and long. 157°18′34″ W.

A1—0 to 4 inches, dark-brown (10YR 3/3), moist or dry, extremely stony clay; strong, very fine and fine, granular structure; hard, firm, very sticky and very plastic; few roots; many interstitial pores; violent effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid, confined mainly to few calcium carbonate fragments less than 1 millimeter in diameter; mildly alkaline; gradual, smooth boundary. 2 to 4 inches thick.

AC—4 to 20 inches, dark-brown (10YR 3/3), moist or dry, clay; weak, coarse, prismatic structure breaking to weak, coarse, subangular and angular blocky; very hard, very firm, very sticky and very plastic; few roots; many, fine, tubular pores; many olivine crystals less than 1 millimeter in diameter; common pressure cutans and slickensides; common calcium carbonate fragments up to 1 inch long; very firm in place; violent effervescence with hydrogen peroxide; moderate effervescence with hydrochloric acid, confined mainly to calcium carbonate fragments; mildly alkaline; gradual, smooth boundary. 12 to 18 inches thick.

Cca—20 to 27 inches, variegated yellowish-brown (10YR 5/6) and very pale brown (10YR 8/3), highly weathered olivine basalt that has calcium carbonate accumulation; violent effervescence with hydrochloric acid; moderately alkaline. 3 to 9 inches thick.

R—27 inches, hard olivine basalt.

This soil is 20 to 31 inches deep over hard olivine basalt. Stoniness ranges from very stony to extremely stony. In many places the stones cover most of the surface layer. The content of olivine crystals ranges from few to many throughout the profile. In most years the soil is dry more than 6 months. The A horizon is typically 10YR in hue, but in places the hue is 7.5YR. This horizon ranges from 2 to 3 in value and chroma. Slickensides in the AC horizon range from common to many and are weakly to strongly grooved.

This soil is used for wildlife habitat and pasture. (Capability classification VIIs, nonirrigated; pasture group 1)

Kaupo Series

This series consists of well-drained soils on alluvial fans on the island of Maui. These soils developed in a mixture of volcanic ash and alluvium derived from basic igneous rock. They are gently sloping to moderately steep. Elevations range from nearly sea level to 1,000 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 75° F. Kaupo soils are geographically associated with Makaalae and Waiakoa soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of apple-of-Sodom, bermudagrass, castorbean, guineagrass, kikuyugrass, koa haole, lantana, and oi.

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Kaupo very stony silty clay loam, 3 to 25 percent slopes (KLUD).—This soil is on alluvial fans. Included in mapping were small areas of very stony silty clay. Also included were small areas from which stones have been removed.

In a representative profile the surface layer is very dark brown silty clay loam about 6 inches thick. The subsoil, about 13 inches thick, is very dark grayish-brown silty clay loam that has subangular blocky structure. The substratum is very dark grayish-brown very cobbly clay loam and fragmental Aa lava that contains very little soil material in voids. The soil is slightly acid in the surface layer and neutral in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is 1.4 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 40 inches.

Representative profile: Island of Molokai, lat. 21°06′18″ N. and long. 157°18′34″ W.

Ap—0 to 6 inches, very dark brown (10YR 2/2) very stony silty clay loam, dark grayish brown (10YR 4/2) when dry; strong, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant fine and very fine roots; many fine pores; common, very fine, earthy lumps; 30 to 40 percent gravel, cobblestones, and stones; weak effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 4 to 8 inches thick.

B2—6 to 19 inches, very dark grayish-brown (10YR 3/2) cobbly silty clay loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; abundant fine and very fine roots; common fine pores; 40 to 50 percent gravel and cobblestones; neutral; clear, wavy boundary. 10 to 15 inches thick.

C1—19 to 27 inches, very dark grayish-brown (10YR 3/2) very cobbly clay loam, dark grayish brown (10YR 4/2) when dry; massive; soft, very friable, slightly sticky and slightly plastic; abundant fine and very fine roots; many fine pores; 60 to 70 percent gravel and cobblestones; neutral; clear, irregular boundary. 6 to 10 inches thick.

IIC2—27 inches, fragmental Aa lava that contains a little soil material in cracks.

The depth to fragmental Aa lava ranges from 20 to 40 inches. The A horizon has a texture of silt loam or silty clay loam. The B horizon is cobbly clay loam or cobbly silty clay loam.

This soil is used for pasture land and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 3; woodland group 1)

Kaupo extremely stony silty clay, 3 to 25 percent slopes (KLVD).—This soil has a profile like that of Kaupo very stony silty clay loam, 3 to 25 percent slopes, except that the surface layer is silty clay and the soil is extremely stony.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 3; woodland group 1)

Kawaihapai Series

This series consists of well-drained soils in drainageways and on alluvial fans on the coastal plains on the islands of Oahu and Molokai. These soils formed in alluvium derived from basic igneous rock in humid uplands.

They are nearly level to moderately sloping. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 30 to 50 inches. The mean annual soil temperature is 73° F. Kawaihapai soils are geographically associated with Haleiwa, Waialua, and Jaucas soils.

These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of kiawe, koa haole, lantana, and bermudagrass.

Kawaihapai clay loam, 0 to 2 percent slopes (KIA).—This soil occupies smooth slopes. Included in mapping were small areas where the slope is 3 to 7 percent and the texture is silty clay. Also included were small areas of poorly drained soils and small areas of Jaucas soils. At the mouth of the Pelekunu and Wailau Valleys on Molokai, this soil receives more rainfall than is typical of the series. The natural vegetation consists of guava, honohono, kukui, and hala.

In a representative profile the surface layer is dark-brown clay loam about 22 inches thick. The next layer is dark-brown stratified sandy loam 32 inches thick. The substratum is stony and gravelly. The soil is neutral in reaction throughout the profile.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more. In some places this soil is subject to flooding.

Representative profile: Island of Oahu, lat. 21°24′26″ N. and long. 157°59′08″ W.

Ap1—0 to 12 inches, dark-brown (7.5YR 4/2) clay loam, very dark brown (7.5YR 2/2) when moist; weak, medium and coarse, granular structure; hard, firm, sticky and plastic; abundant fine and very fine roots; common, fine, tubular and interstitial pores; 5 percent rounded basaltic gravel; moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 6 to 12 inches thick.

Ap2—12 to 22 inches, dark-brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/2) when moist; weak, medium and coarse, subangular blocky structure; hard, firm, sticky and plastic; abundant roots; common, fine and very fine, tubular pores; 5 percent rounded basaltic gravel; moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 6 to 10 inches thick.

IIC1—22 to 32 inches, dark-brown (7.5YR 4/4) sandy loam; massive; slightly hard, very friable, slightly sticky and slightly plastic; abundant fine and very fine roots; common, fine, tubular pores; 5 percent rounded basaltic gravel; moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 8 to 10 inches thick.

IIIC2—32 to 54 inches, dark-brown (7.5YR 4/4) sandy loam; massive; slightly hard, very friable, slightly sticky and slightly plastic; plentiful very fine and fine roots; common, fine, tubular pores; stratified bands of sand, silt, and gravel; moderate effervescence with hydrogen peroxide; neutral.

The A horizon ranges from 5YR to 10YR in hue, from 2 to 3 in value when moist, and from 2 to 3 in chroma. It ranges from clay loam to silty clay loam in texture and in places is gravelly or stony. The C horizon is variable within short distances and is strongly stratified. It ranges from sandy loam to silty clay loam in texture.

This soil is used for sugarcane, truck crops, pasture, and orchards. (Capability classification I if irrigated, IIc if nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Kawaihapai clay loam, 2 to 6 percent slopes (KIB).—On this soil, runoff is slow and the erosion hazard is slight. This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Kawaihapai clay loam, 6 to 15 percent slopes (KIC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult because of the slope. Included in mapping were small, very stony areas in drainageways.

This soil is used for sugarcane and pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Kawaihapai stony clay loam, 0 to 2 percent slopes (KlaA).—This soil is similar to Kawaihapai clay loam, 0 to 2 percent slopes, except that there are enough stones to hinder, but not prevent, cultivation. Workability is slightly difficult because of stoniness.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIs, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Kawaihapai stony clay loam, 2 to 6 percent slopes (KlaB).—This soil is similar to Kawaihapai clay loam, 0 to 2 percent slopes, except that there are enough stones to hinder, but not prevent, cultivation. Runoff is slow, and the erosion hazard is slight.

Included in mapping were small areas of silty clay and small areas where the slope is 6 to 15 percent.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Kawaihapai very stony clay loam, 0 to 15 percent slopes (KlbC).—This soil is similar to Kawaihapai clay loam, 0 to 2 percent slopes, except that it has enough stones to prevent cultivation. Runoff is medium, and the erosion hazard is moderate. Workability is impractical unless the stones are removed.

This soil is used for pasture. (Capability classification VIs, nonirrigated; pasture group 3; woodland group 1)

Kawaihapai silty clay loam, 2 to 7 percent slopes (KlcB).—This soil occurs in narrow drainageways near Kalae, Molokai. In places the slope is as much as 12 percent near the walls of gulches.

This soil differs from the typical Kawaihapai soil in the following respects: It occurs at higher elevations (750 to 1,750 feet); the annual rainfall amounts to 40 to 55 inches; and the soil is strongly acid in the surface layer and medium acid in the subsoil.

This soil is used for pasture. Nearly all areas are in kikuyugrass and kaimiclover. The soil receives runoff from higher areas; and, consequently, lack of moisture is less limiting than on the surrounding soils. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Keaau Series

This series consists of poorly drained soils on coastal plains on the island of Oahu. These soils developed in alluvium deposited over reef limestone or consolidated coral sand. They are nearly level and gently sloping. Elevations range from 5 to 40 feet. The annual rainfall amounts to 20 to 35 inches. Most of the rainfall occurs between November and April. The mean annual soil temperature is 73° F. Keaau soils are geographically associated with Kaloko, Mokuleia, and Pearl Harbor soils.

These soils are used for sugarcane and pasture. The natural vegetation consists of kiawe, bermudagrass, bristly foxtail, and fingergrass.

Keaau clay, 0 to 2 percent slopes (KmA).—This soil occurs on lowlands on the coastal plains. Included in mapping were small areas of coral sand and dark-colored, sticky and plastic clay on fans above the Keaau soils.

In a representative profile the surface layer is very dark grayish-brown clay about 15 inches thick. The subsoil, about 19 inches thick, is very dark grayish-brown and dark-brown, mottled clay that has subangular and angular blocky structure. The substratum is white to very pale brown reef limestone or consolidated coral sand. The soil is mildly alkaline in the surface layer and subsoil and moderately alkaline in the substratum. The water table is at a depth of 1½ to 3 feet.

Permeability is slow. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.5 inches per foot of soil. Roots are restricted by the consolidated coral sand, reef limestone, and water table. Workability is difficult because the soil is very sticky and very plastic. The shrink-swell potential is high.

Representative profile: Island of Oahu, lat. 21°34′44″ N. and long. 158°09′13″ W.

Ap—0 to 15 inches, very dark grayish-brown (10YR 3/2) clay, very dark grayish brown (10YR 4/2) when dry; moderate, fine and very fine, granular structure; hard, firm, very sticky and very plastic; abundant very fine and fine roots; common medium, fine, and very fine interstitial pores; common wormholes and worm casts; many coral sand grains; few fine fragments of weathered basalt; few, fine, faint, brown mottles; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; mildly alkaline; clear, wavy boundary. 10 to 15 inches thick.

B21—15 to 26 inches, very dark grayish-brown (10YR 3/2) silty clay; moderate, fine and medium, subangular and angular blocky structure; hard, firm, sticky and plastic; plentiful fine and very fine roots; many, very fine, tubular pores; few coral sand grains; few highly weathered basalt fragments; continuous pressure cutans; few, fine, faint, brown mottles; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid on sand grains but none on soil mass; mildly alkaline; clear, wavy boundary. 8 to 12 inches thick.

B22—26 to 34 inches, dark-brown (7.5YR 3/2 moist, 7.5YR 4/2 dry) clay; strong, very fine and fine, subangular and angular blocky structure; extremely hard, firm, very sticky and very plastic; plentiful fine and very fine roots; common, very fine and fine, tubular pores; many, fine, distinct, yellowish-red (5YR 4/6 dry)) mottles in pores and on ped faces; continuous pressure cutans; few, fine, highly weathered basalt fragments; strong effervescence with hydrogen peroxide; mildly alkaline; abrupt, smooth boundary. 6 to 8 inches thick.

IIC1m—34 to 39 inches, variegated pattern of white to light brownish-gray (10YR 8/2 to 10YR 6/2) fine shell fragments and coral sand; very hard and consolidated; no roots; few fine pores; slight effervescence with hydrogen peroxide; violent effervescence with hydrochloric acid; moderately alkaline; abrupt, wavy boundary. 3 to 10 inches thick.

IIIC2—39 to 57 inches, very pale brown (10YR 7/3), moist and dry, coral sand; single grain; water table in this layer; moderately alkaline.

The depth to consolidated coral sand or reef limestone ranges from 24 to 35 inches. The A horizon ranges from 1 to 2 in chroma. The B horizon ranges from silty clay to clay in texture and from 10YR to 7.5YR in hue. The degree of mottling is variable and ranges from faint to distinct throughout the B horizon.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Keaau stony clay, 2 to 6 percent slopes (KmaB).—This soil has a profile like that of Keaau clay, 0 to 2 percent slopes, except that there are sufficient stones to hinder machine cultivation. Runoff is slow, and the erosion hazard is slight.

This soil is used for sugarcane and pasture. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7; woodland group 4)

Keaau clay, saline, 0 to 2 percent slopes (KmbA).—This soil has a profile like that of Keaau clay, 0 to 2 percent slopes, except that it is strongly affected by salts. It occurs in depressions adjacent to the ocean or in pockets within the limestone areas where seepage water evaporates. The surface structure is platy or vesicular. The dominant vegetation is pickleweed; some areas are barren.

Under natural conditions, this soil is either idle or is used for pasture. Many areas, however, are being drained and filled for use for sugarcane, industrial sites, homesites, and parks. New sugarcane areas are made by draining and filling with waste from sugarcane mills. (Capability classification VIw, nonirrigated; pasture group 7; woodland group 4)

Keahua Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 600 to 1,500 feet. The annual rainfall amounts to 15 to 25 inches. The mean annual soil temperature is 73° F. Keahua soils are geographically associated with Haliimaile, Molokai, Paia, and Waiakoa soils.

These soils are used for sugarcane, pasture, and wildlife habitat. Small acreages are used for pineapple, truck crops, and homesites. The natural vegetation consists of buffelgrass, feather fingergrass, ilima, kiawe, lantana, pitted beardgrass, and uhaloa.

Keahua silty clay loam, 3 to 7 percent slopes (KnB).—This soil is on uplands. Included in mapping were small areas of Haliimaile and Molokai soils, and small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock. Also included were small areas of silty clay and some areas that are nearly level.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 10 inches thick. The subsoil, about 50 inches thick, is dark reddish-brown silty clay loam and very dark gray clay loam that has subangular blocky structure. The substratum is dominantly soft, weathered basic igneous rock. The soil is slightly acid in the surface layer and slightly acid to neutral in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°49′56″ N. and long. 156°23′08″ W.

Ap1—0 to 5 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark reddish brown (5YR 3/3) when dry; weak, very fine, granular structure and weak, very fine and fine, subangular blocky; common clods up to 2 inches in diameter; soft friable, slightly sticky and plastic; plentiful roots; many very fine pores; common sand-size aggregates that are resistant to crushing; common, fine, black concretions; violent effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 3 to 6 inches thick.

Ap2—5 to 10 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, coarse and medium, subangular blocky structure; common clods up to 2 inches in diameter; soft, friable, slightly sticky and plastic; abundant roots; many very fine pores; common sand-size aggregates that are resistant to crushing; common, fine, black concretions; violent effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 4 to 6 inches thick.

B1—10 to 15 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, coarse and medium, subangular blocky structure; soft, very friable, slightly sticky and plastic; plentiful roots; many fine pores; few sand-size aggregates that are resistant to crushing; few, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 4 to 7 inches thick.

B21—15 to 24 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; moderate, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few roots; many fine and medium pores; firm in place; few sand-size aggregates that are resistant to crushing; few, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 8 to 11 inches thick.

B22—24 to 33 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few roots; common fine and medium pores; nearly continuous pressure cutans; firm in place; few, fine, black concretions; slight effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 8 to 11 inches thick.

IIB3—33 to 62 inches, very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, slightly sticky and plastic; few fine roots; common fine pores; nearly continuous pressure cutans; firm in place; many sand-size aggregates that are resistant to crushing; neutral; gradual, wavy boundary. 27 to 32 inches thick.

IIC—62 to 70 inches, very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, slightly sticky and plastic; few fine roots; common fine pores; nearly continuous pressure cutans; firm in place; many sand-size aggregates that are resistant to crushing; contains 60 to 70 percent highly weathered rock fragments.

The solum is more than 60 inches thick. The A horizon ranges from 5YR to 7.5YR in hue; from 2 to 3 in value when moist or dry; and from 2 to 3 in chroma when moist and 2 to 4 when dry. The B horizon ranges from 2 to 3 in value when moist and 3 to 4 when dry, and from 1 to 4 in chroma when moist or dry.

This soil is used for sugarcane. Small areas are used for pineapple, pasture, and truck crops. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Keahua silty clay loam, 7 to 15 percent slopes (KnC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for sugarcane and pasture. Small acreages are used for pineapple and truck crops. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 3; pasture group 2)

Keahua cobbly silty clay loam, 3 to 7 percent slopes (KnaB).—This soil has a profile like that of Keahua silty clay loam, 3 to 7 percent slopes, except that it is cobbly on the surface. Included in mapping were small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock. Also included were small areas of silty clay.

This soil is used for sugarcane. A few acres are used for truck crops. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Keahua cobbly silty clay loam, 7 to 15 percent slopes (KnaC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock.

This soil is used for sugarcane and pasture. A few acres are used for truck crops. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Keahua cobbly silty clay loam, 15 to 25 percent slopes (KnaD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas that are not cobbly. Also included were a few steep areas.

This soil is used for sugarcane and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 2)

Keahua very stony silty clay loam, 7 to 25 percent slopes (KnbD).—This soil has a profile like that of Keahua silty clay loam, 3 to 7 percent slopes, except that stones cover as much as 3 percent of the surface. Runoff is slow to medium, and the erosion hazard is slight to moderate.

Included in mapping were small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock. In a few places stones cover 3 to 15 percent of the surface.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 2)

Keahua silty clay, 7 to 15 percent slopes (KncC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock.

This soil is used for pineapple, pasture, and homesites. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 3; pasture group 2)

Keahua cobbly silty clay, 7 to 15 percent slopes (KnhC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were small areas that are 20 to 40 inches deep over soft, weathered basic igneous rock.

This soil is used for pasture. Small acreages are used for truck crops. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Keahua stony silty clay, 7 to 15 percent slopes (KnsC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were small, moderately steep areas.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Kealia Series

This series consists of somewhat poorly drained and poorly drained soils on coastal flats (fig. 6) on the islands of Molokai and Maui. These soils are nearly level. Elevations range from sea level to 10 feet. The annual rainfall amounts to 10 to 25 inches. The mean annual soil temperature is 75° F. Kealia soils are geographically associated with Jaucas, Mala, and Pulehu soils.

These soils are used for wildlife habitat, pasture, and urban development. The natural vegetation consists of salt-tolerant plants, such as pickleweed, Australian saltbush, and kiawe. Kiawe is generally stunted and grows in the better drained areas. Large areas are barren.

Kealia silt loam (KMW).—This soil is poorly drained and has a high content of salt. Ponding occurs in low areas after a heavy rain. When the soil dries, salt crystals accumulate on the surface. The soil has a brackish water table that fluctuates with the tides; the water table is nearer the surface along the shoreline than in inland areas. The slope ranges from 0 to 1 percent.

In a representative profile the surface layer is dark reddish-brown silt loam about 3 inches thick. Below this are stratified layers of silt loam, loam, and fine sandy loam. A brackish water table occurs at a depth of 12 to 40 inches. The subsurface layers are dark reddish brown to dark reddish gray in the upper part and dark grayish brown to black near the zone of the water table. The soil has a high concentration of salts and is moderately alkaline.

Permeability is moderately rapid. Runoff is slow to very slow. The hazard of water erosion is no more than slight, but the hazard of wind erosion is severe when the soil is dry and the surface layer becomes loose and fluffy.

Representative profile: Island of Molokai, lat. 21°06'39" N. and long. 157°05'01" W.

A1sa—0 to 3 inches, dark reddish-brown (5YR 3/3), moist and dry, silt loam; moderate, medium and thin, platy structure; hard, friable, slightly sticky and nonplastic; few roots; many very fine, fine, and medium pores; banding of dark-brown (7.5YR 3/2) material that has similar texture and structure; moderately alkaline; clear, wavy boundary. 2 to 4 inches thick.

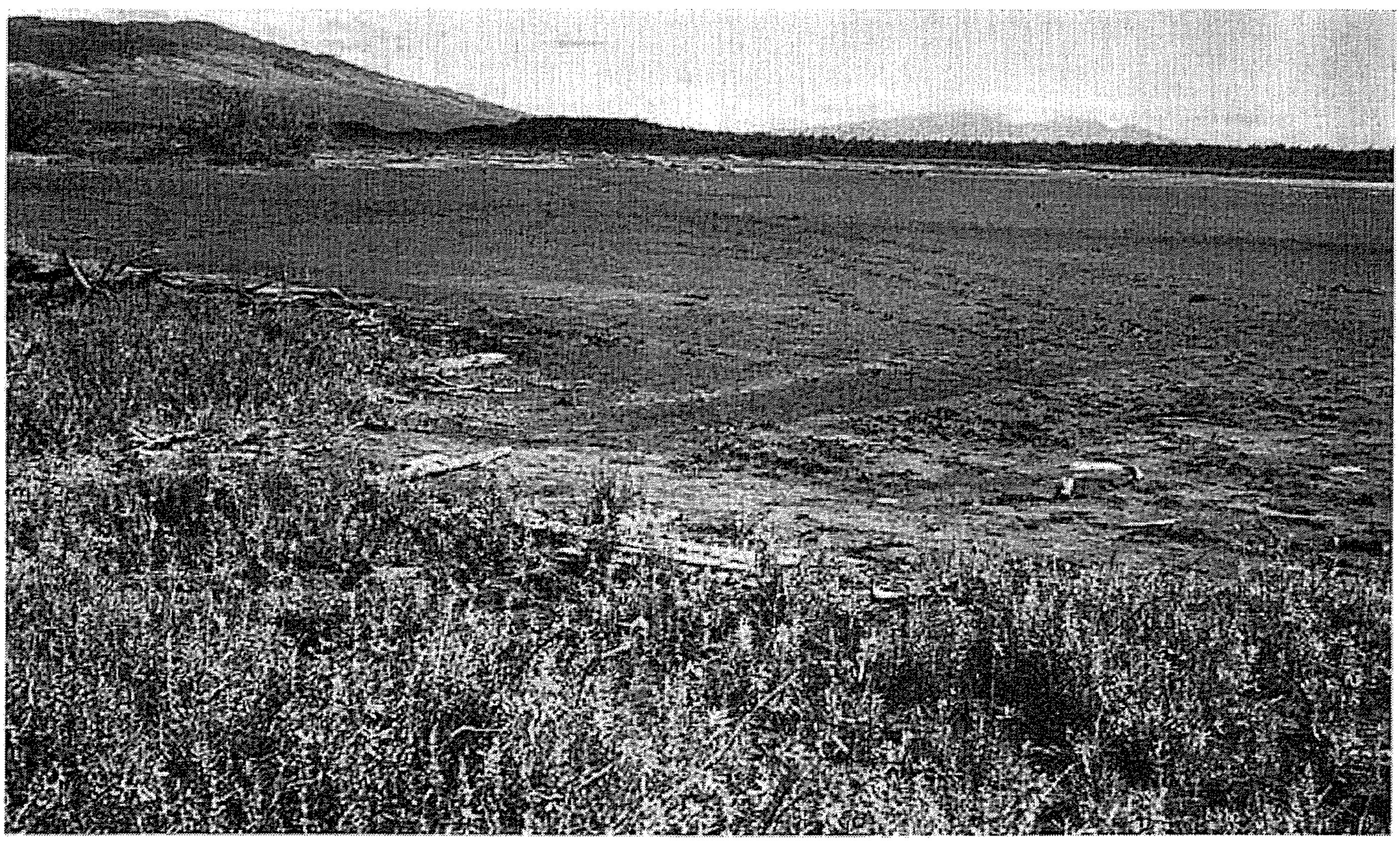

Figure 6.—Typical view of Kealia silt loam. Poor drainage and saline conditions restrict vegetation to salt-tolerant plants, such as pickleweed. Many areas are barren.

C1sa—3 to 8 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/3) when dry; weak, medium and thin, platy structure breaking to weak, medium and fine, subangular blocky; soft, friable, slightly sticky and nonplastic; few roots; few pores; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; moderately alkaline; clear, wavy boundary. 4 to 6 inches thick.

C2sa—8 to 19 inches, dark reddish-brown (5YR 3/3) loam, reddish brown (5YR 4/3) when dry; massive; soft, very friable, nonsticky and nonplastic; common roots; many interstitial pores; the lower 4 inches has weak, thin, platy structure and contains some black sand between the plates; has a pseudosand appearance under hand lens; few black concretions less than 1 millimeter in size; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; moderately alkaline; clear, wavy boundary. 10 to 12 inches thick.

C3sa—19 to 27 inches, dark reddish-brown (5YR 3/3) fine sandy loam, reddish brown (5YR 4/3) when dry; weak, fine, subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; many roots; many fine pores; few black concretions less than 1 millimeter in size; slight effervescence with hydrogen peroxide or hydrochloric acid; moderately alkaline; abrupt, wavy boundary. 4 to 9 inches thick.

C4sa—27 to 34 inches, black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) when dry; single grain; loose, nonsticky and nonplastic; few roots; common pieces of weathered coral up to 2 inches in diameter; slight effervescence with hydrochloric acid; mildly alkaline; clear, wavy boundary. 3 to 8 inches thick.

C5sa—34 to 63 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) when dry; massive; hard, very friable, slightly sticky and slightly plastic; common pieces of weathered coral up to 2 inches in diameter; water table begins at a depth of 35 inches; slight effervescence with hydrochloric acid; mildly alkaline.

The A horizon has platy structure in places or it is loose and fluffy. It ranges from silt loam to silty clay loam in texture. The depth to the water table ranges from 12 to 40 inches.

This soil is used for wildlife habitat and pasture, but it has low grazing value. It is not used for crops, because of poor drainage and high salt content. Small areas are used for urban development. (Capability classification VIIw, nonirrigated; pasture group 1)

Keawakapu Series

This series consists of well-drained, extremely stony soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to moderately steep. Elevations range from 100 to 800 feet. The annual rainfall amounts to 10 to 20 inches. Most of the rainfall occurs in fall and winter. The mean annual soil temperature is 76° F. Keawakapu soils are geographically associated with Kamaole, Makena, and Oanapuka soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of feather fingergrass, ilima, kiawe, uhaloa, and zinnia.

Keawakapu extremely stony silty clay loam, 3 to 25 percent slopes (KNXD).—This soil is on low uplands. Included in mapping were small areas of Kamaole and Oanapuka soils.

In a representative profile the surface layer, about 2 inches thick, is dark reddish-brown extremely stony silt loam that has platy structure. The subsoil, about 16 inches thick, is dark reddish-brown silty clay loam and silty clay that has prismatic and subangular blocky structure. The substratum is fragmental Aa lava that has a little soil material in the voids. The soil is neutral in the surface layer and subsoil.

Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to a depth of 30 inches.

Representative profile: Island of Maui, lat. 20°48′12″ N. and long. 156°25′58″ W.

A1—0 to 2 inches, dark reddish-brown (5YR 3/3) extremely stony silt loam, reddish brown (5YR 4/4) when dry; moderate, medium and thick, platy structure; soft, very friable, slightly sticky and slightly plastic; plentiful fine roots; common fine and very fine pores; has gritty feel; few, fine, black concretions; 15 to 30 percent stones; delayed strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 1 to 4 inches thick.

B21—2 to 9 inches, dark reddish-brown (5YR 3/3) very stony silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, coarse, prismatic structure; soft, friable, sticky and plastic; plentiful fine roots; common fine pores; few, hard, sand-size aggregates that are resistant to crushing; few, fine, black concretions; 15 to 30 percent stones; strong effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 5 to 10 inches thick.

B22—9 to 18 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; many fine and medium pores; nearly continuous, thin coatings on peds; common, hard, sand-size aggregates that are resistant to crushing; about 5 percent cobblestones and stones; few, fine, black concretions; strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 7 to 10 inches thick.

IIC—18 inches, fragmental Aa lava that contains a little soil material in the voids.

The depth of the soil over fragmental Aa lava ranges from 12 to 30 inches. Stones cover 3 to 15 percent of the surface. The A horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when moist, and from 2 to 3 in chroma when moist and 3 to 4 when dry. The B horizon ranges from 3 to 4 in value when dry and from 3 to 4 in chroma when moist. The texture is silty clay loam or silty clay. In a few places the lower part of the B horizon and the IIC horizon effervesce with hydrochloric acid.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 1)

Kekaha Series

This series consists of well-drained soils on alluvial fans and flood plains on the island of Kauai. These soils developed in alluvium washed from upland soils. They are nearly level to steep. Elevations range from nearly sea level to 150 feet. The annual rainfall amounts to 20 to 25 inches. The mean annual soil temperature is 74° F. Kekaha soils are geographically associated with Lualualei and Nohili soils.

These soils are used for irrigated sugarcane, pasture, and wildlife habitat. The natural vegetation consists of koa haole, kiawe, klu, and fingergrass.

Kekaha silty clay, 0 to 2 percent slopes (KoA).—This soil is on flood plains and alluvial fans. Included in mapping were small areas of stony soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 21 inches thick. The subsoil is dark reddish-brown silty clay and clay more than 49 inches thick. The substratum is clayey alluvium. The soil is mildly alkaline to neutral throughout the profile.

Permeability is moderate. Runoff is slow, and there is no erosion hazard. The available moisture capacity is about 1.8 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°59′0″ N. and long. 159°43′19″ W.

Ap1—0 to 7 inches, dark reddish-brown (5YR 3/2) silty clay, dark reddish brown (5YR 3/3) when dry; moderate, fine and very fine, granular structure; very hard, friable, sticky and plastic; plentiful roots; strong effervescence with hydrogen peroxide; mildly alkaline; clear, smooth boundary. 6 to 8 inches thick.

Ap2—7 to 14 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; weak and moderate, fine and very fine, subangular blocky structure; very hard, friable, sticky and plastic; plentiful roots; moderate effervescence with hydrogen peroxide; mildly alkaline; clear, smooth boundary. 6 to 8 inches thick.

A1b—14 to 21 inches, dark reddish-brown (5YR 3/3) silty clay; bands of dark reddish brown (5YR 2/2), reddish brown (5YR 4/4) when dry; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; plentiful roots; many fine and medium pores; thin, patchy clay coatings in pores and on peds; moderate effervescence with hydrogen peroxide; mildly alkaline; abrupt, smooth boundary. 6 to 9 inches thick.

B21—21 to 28 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; massive; medium, subangular blocky structure in places; very hard, firm, sticky and plastic; few roots; many fine and medium pores; moderate effervescence with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 5 to 9 inches thick.

B22—28 to 44 inches, dark reddish-brown (2.5YR 3/4) clay, reddish brown (2.5YR 4/3) when dry; weak, medium and coarse, prismatic structure; very hard, firm, sticky and plastic; few roots; many fine and medium pores; moderate effervescence with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 12 to 20 inches thick.

B23—44 to 70 inches, dark reddish-brown (2.5YR 3/4) clay, weak red (2.5YR 4/2) when dry; weak, medium, subangular blocky structure; hard, firm, sticky and plastic; few roots; many fine pores; common patchy pressure cutans; vertical channels that exhibit coatings that look like clay films; moderate effervescence with hydrogen peroxide; neutral.

In places the A horizon is extremely stony or is clay. The B horizon ranges from 2.5YR to 5YR in hue.

This soil is used for irrigated sugarcane and pasture. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2; woodland group 4)

Kekaha silty clay, 2 to 6 percent slopes (KoB).—On this soil, runoff is medium and the erosion hazard is slight to moderate. Included in mapping were a few small areas of stony soils and small areas where the slope is more than 6 percent.

This soil is used for irrigated sugarcane and pasture. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2; woodland group 4)

Kekaha clay, 0 to 2 percent slopes (KobA).—This soil is underlain by marine clay and has mottles in the subsoil. Workability is difficult. Runoff is slow, and there is no erosion hazard.

This soil is used for irrigated sugarcane and pasture. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2; woodland group 4)

Kekaha extremely stony silty clay loam, 0 to 35 percent slopes (KOYE).—On this soil, runoff is slow to medium and the erosion hazard is no more than moderate.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 2; woodland group 4)

Kemoo Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to very steep. Elevations range from 300 to 1,200 feet. The annual rainfall amounts to 35 to 60 inches, most of which occurs between November and April. The mean annual soil temperature is 71° F. Kemoo soils occur mainly on the windward slopes of the Waianae Range and from Waimea Bay to Kahuku on the Koolau Range. They are geographically associated with Halawa, Mahana, and Paumalu soils.

These soils are used mainly for pasture. Small areas are used for sugarcane. The natural vegetation consists of guava, koa haole, Christmas berry, lantana, and bermudagrass.

Kemoo silty clay, 12 to 20 percent slopes (KpD).—This soil occurs on uplands. Included in mapping were small areas of silty clay loam or silt loam. These areas are at the higher elevations. The soils in these included areas have a concentration of heavy minerals in the surface layer. Also included were small, eroded spots and stony areas.

In a representative profile the surface layer is very dusky red to dark reddish-brown, subangular blocky silty clay about 12 inches thick. The subsoil, about 55 inches thick, is dark reddish-brown to dusky-red silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is slightly acid in the surface layer and slightly acid to neutral in the subsoil.

Permeability is moderate to moderately rapid. Runoff is medium, and the erosion hazard is moderate. The available water capacity is 1.4 inches per foot of soil. Workability is slightly difficult because of the slope. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°33′00″ N. and long. 158°07′23″ W.

Ap1—0 to 4 inches, very dusky red (2.5YR 2/2) silty clay, dusky red (2.5YR 3/2) when dry; moderate, very fine, granular and subangular blocky structure; very hard, firm, sticky and plastic; abundant fine, medium, and coarse roots; common, very fine and fine, interstitial and tubular pores; strong effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 3 to 5 inches thick.

Ap2—4 to 12 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; strong, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic; abundant fine, medium, and coarse roots; many, very fine, tubular pores; strong effervescence with hydrogen peroxide; slightly acid; gradual, smooth boundary. 6 to 9 inches thick.

B1—12 to 20 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, medium, subangular blocky structure breaking to strong, fine and very fine, subangular blocky; hard, firm, sticky and plastic; abundant fine, medium, and coarse roots; many, very fine, tubular pores; thin, patchy clay films on ped faces; slight effervescence with hydrogen peroxide; slightly acid; abrupt, smooth boundary. 6 to 8 inches thick.

B21t—20 to 34 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, medium, subangular blocky structure breaking to strong, very fine, subangular and angular blocky; slightly hard, friable, sticky and very plastic; common medium and fine roots; many, very fine and fine, tubular pores; thin, continuous clay films on ped faces and a few lined pores; slight effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 12 to 14 inches thick.

B22t—34 to 58 inches, dusky-red (10YR 3/4) silty clay, dark red (10R 3/4) when dry; moderate, medium and coarse, subangular blocky structure breaking to strong, fine and very fine, angular and subangular blocky; hard but brittle, friable, sticky and very plastic; many medium, few fine and coarse roots; common, very fine and fine, tubular pores; moderately thick, continuous clay films on ped faces and in pores; few slickensides; slight effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 20 to 26 inches thick.

B23t—58 to 66 inches, dusky-red (10R 3/4) silty clay, dark red (10R 3/4) when dry; moderate, medium and coarse, subangular blocky structure breaking to strong, fine and very fine, angular and subangular blocky; hard but brittle, friable, sticky and very plastic; few coarse roots; many, very fine, tubular pores; moderately thick, continuous clay films on ped faces and in pores; common slickensides; slight effervescence with hydrogen peroxide; neutral.

In most places there are no manganese concretions within the solum. In places there are a few stones or boulder cores. The A horizon ranges from 5YR to 2.5YR in hue, from 2 to 3 in value when moist or dry, and from 2 to 4 in chroma when moist or dry. The B horizon ranges from 2.5YR to 10R in hue and from 4 to 6 in chroma when dry.

This soil is used mainly for pasture. Small areas at lower elevations are used for sugarcane. (Capability classification IVe, nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Kemoo silty clay, 2 to 6 percent slopes (KpB).—On this soil, runoff is slow to medium and the erosion hazard is slight. Workability is easy.

This soil is used for sugarcane and pasture. (Capability classification IIe, nonirrigated; sugarcane group 1; pineapple group 5; pasture group 5; woodland group 5)

Kemoo silty clay, 6 to 12 percent slopes (KpC).—On this soil, runoff is medium and the erosion hazard is slight to moderate. Workability is slightly difficult because of the slope. Included in mapping were small, eroded areas.

This soil is used for sugarcane and pasture. (Capability classification IIIe, nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Kemoo silty clay, 20 to 35 percent slopes (KpE).—On this soil, runoff is medium to rapid and the erosion hazard is moderate to severe. Workability is difficult because of the slope. Included in mapping were small, eroded spots and areas of Stony land and of Rock outcrop.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 5; woodland group 5)

Kemoo silty clay, 35 to 70 percent slopes (KpF).—This soil occurs on side slopes along drainageways. Runoff is rapid, and the erosion hazard is severe. Included in mapping were small, eroded spots, stony areas, and outcrops.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 5; woodland group 15)

Kemoo-Badland complex (KPZ).—Kemoo silty clay makes up 40 to 80 percent of this complex. The slope ranges from 10 to 70 percent. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Badland consists of nearly barren areas that have remained after removal of the Kemoo soil by erosion. On this soil, runoff is rapid and the erosion hazard is very severe. About 80 percent of Badland is oriented in the direction of the trade winds.

Included in mapping were small areas of Rock outcrop, Stony land, Stony steep land, and Rock land.

This complex is used for pasture. (Kemoo part is in capability classification VIIe, nonirrigated; pasture group 5; woodland group 5. Badland part is in capability classification VIIIe)

Koele Series

This series consists of well-drained soils on fans and in drainageways on the islands of Lanai, Maui, and Molokai. These soils formed in alluvium derived from basic igneous material. They are gently sloping to steep. Elevations are mainly between 1,000 and 2,000 feet, but some areas are near sea level. The annual rainfall amounts to 15 to 35 inches, except that on Maui it amounts to 35 to 50 inches. Most of the rainfall occurs from November to April. The mean annual soil temperature is about 68° F. Koele soils are geographically associated with Alaeloa, Kanepuu, and Lahaina soils.

These soils are used for pineapple, pasture, and wildlife habitat. The natural vegetation consists of lantana, Natal redtop, dallisgrass, molassesgrass, and pilipiliula.

Koele silty clay loam, 3 to 7 percent slopes (KrB).—This soil occurs on fans and in drainageways.

In a representative profile the surface layer is dark-brown silty clay loam about 18 inches thick. The next layer, 30 to more than 40 inches thick, consists of stratified, dark-brown alluvium that ranges from silty clay loam to coarse sandy loam in texture. The soil is slightly acid to medium acid, except that the surface layer is generally very strongly acid in areas used for pineapple.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.6 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Lanai, lat. 20°51′54″ N. and long. 156°57′07″ W.

Ap—0 to 18 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; strong, fine, subangular blocky structure breaking to strong, fine, granular; hard, friable, slightly sticky and slightly plastic; many fine and medium roots; many, fine and medium, interstitial pores; 15 percent pebble-size rock fragments; moderate effervescence with hydrogen peroxide; very strongly acid; abrupt, smooth boundary. 17 to 19 inches thick.

AC—18 to 33 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; weak, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; very few roots in upper part; common interstitial pores; 20 percent pebble-size rock fragments; moderate effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 13 to 17 inches thick.

C1—33 to 36 inches, dark-brown (7.5YR 3/2) sandy clay loam, dark reddish gray (5YR 4/2) when dry; massive; hard, friable, slightly sticky and slightly plastic; 80 percent coarse sand and fine gravel; no effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 2 to 5 inches thick.

IIC2—36 to 43 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 4/2) when dry; weak, very fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common, fine, interstitial pores; 20 percent fine sand and fine gravel in pockets; slightly acid; clear, wavy boundary. 5 to 9 inches thick.

IIIC3—43 to 55 inches, dark-brown (7.5YR 3/2), stratified fine sand and coarse sandy loam, brown (7.5YR 4/2) when dry; single grain, but some parts are massive; soft, friable, slightly sticky and slightly plastic; common, fine, weathered rock particles that break down to clay loam after prolonged rubbing; slightly acid.

The depth to bedrock is more than 5 feet. In some places a few stones and coarse gravel occur on the surface and throughout the profile. The thickness, texture, and consistence of the layers in the C horizon vary considerably within a short distance. The texture of the layers is fine sand, coarse sandy loam, coarse sandy clay loam, silt loam, or silty clay loam. The thickness of the contrasting textural layers ranges from ½ inch to more than 12 inches.

Nearly all of this soil is used for pineapple. (Capability classification IIe if irrigated, IIIc if nonirrigated; pineapple group 2; pasture group 3)

Koele silty clay loam, 7 to 15 percent slopes (KrC).—On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope.

This soil is used for pineapple and wildlife habitat. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 3; pasture group 3)

Koele silty clay loam, 15 to 25 percent slopes (KrD).—This soil occurs on foot slopes adjacent to very steep mountainsides. Runoff is medium, and the erosion hazard is moderate to severe. Workability is difficult because of the slope. There are a few gullies.

This soil is used for pasture and wildlife habitat. (Capability classification IVe, irrigated or nonirrigated; pineapple group 3; pasture group 3)

Koele-Badland complex (KRL).—This complex occurs mainly in large gulches. It consists of Koele soils at the bottoms of gulches and Badland on the sides of gulches. The Koele soils are similar to Koele silty clay loam, 3 to 7 percent slopes, except that the slope is mainly 7 to 20 percent. These soils make up 60 to 80 percent of the acreage. Badland consists of highly weathered rock, mainly along the sides of gulches. It makes up 20 to 40 percent of the acreage. The slope is 40 to 70 percent. There are a few rock outcrops and scattered stones and boulders. In most places there are many deep, vertical gullies on the Koele soils where the slope is more than 10 percent. The Koele soils are easily eroded if they are bare of vegetation. Vegetation on these soils consists of molassesgrass, dallisgrass, pilipiliula, lantana, and Natal redtop. The Badland part of this complex has little vegetation, and many of the areas are bare.

A small area of this complex occurs near Cape Halawa, Molokai. It is at elevations ranging from nearly sea level to 500 feet. Another area occurs in Lanai at elevations of more than 1,000 feet.

This complex is used for pasture and wildlife habitat. (Koele part is in capability classification VIe, nonirrigated; pasture group 3. Badland part is in capability classification VIIIe)

Koele rocky complex (KRX).—This complex occurs near Nakalele Point on West Maui. The topography is hilly. The slope is mainly 20 to 35 percent but ranges from 15 to 60 percent. The Koele soils have a profile like that of Koele silty clay loam, 3 to 7 percent slopes, except that the texture throughout the profile is mainly clay loam. These soils make up 30 to 50 percent of the complex. The remaining area consists of rocky gulches and knolls. Stony areas are common, especially on knolls. Most areas are covered with brushy vegetation, such as lantana, guava, and Christmas berry. Grasses are common among the brush. A few areas are bare, and wind and water erosion are active.

This complex is used for pasture. (Capability classification VIs, nonirrigated; pasture group 3)

Kokee Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock, probably mixed with volcanic ash. They are gently sloping to very steep. Elevations range from 3,400 to 4,200 feet. The annual rainfall amounts to 60 to 70 inches. The mean annual soil temperature is 59° F. Kokee soils are geographically associated with Paaiki and Kunuweia soils.

These soils are used for water supply, wildlife habitat, and woodland. The natural vegetation consists of ohialehua, puakeawe, blackberry, yellow foxtail, koa, plantain, uki uki, redwood, and associated plants.

Kokee silty clay loam, 0 to 35 percent slopes (KSKE).—This soil is undulating to steep and occurs on uplands. Included in mapping were some small, narrow areas of alluvial soils.

In a representative profile the surface layer, about 8 inches thick, is dark-brown silty clay loam and silt loam that has subangular blocky structure. The subsoil, about 34 inches thick, is strong-brown and dark-brown silty clay loam and silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is very strongly acid throughout the profile.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is slight to moderate. Roots penetrate to a depth of 20 inches or more, depending on the depth to weathered rock.

Representative profile: Island of Kauai, lat. 22°07′59.6″ N. and long. 159°39′22.8″ W.

A11—0 to 4 inches, dark-brown (7.5YR 3/2) silty clay loam, brown (7.5YR 4/2) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; moderate, delayed effervescence with hydrogen peroxide; very strongly acid; clear, smooth boundary. 4 to 8 inches thick.

A12—4 to 8 inches, dark-brown (7.5YR 3/3) silt loam, brown (7.5YR 4/3) when dry; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant roots; many fine pores; slight, delayed effervescence with hydrogen peroxide; very strongly acid; clear, smooth boundary. 0 to 5 inches thick.

B1—8 to 14 inches, dark-brown (7.5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) when dry; weak, fine, subangular blocky structure; slightly hard, friable, sticky and plastic, and weakly smeary; abundant roots; many fine and very fine pores; slight, delayed effervescence with hydrogen peroxide; very strongly acid; clear, smooth boundary. 0 to 6 inches thick.

B21t—14 to 23 inches, strong-brown (7.5YR 5/6) heavy silty clay loam, dark brown (7.5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic, and weakly smeary; plentiful roots; many fine pores; thin, nearly continuous clay films on peds and in pores; conspicuous, yellowish, "sugary" coatings; weak pressure cutans; very strongly acid; gradual, smooth boundary. 8 to 12 inches thick.

B22t—23 to 32 inches, dark-brown (7.5YR 5/4) heavy silty clay loam, strong brown (7.5YR 4/6) when dry; strong, very fine, subangular and angular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine pores; thin, patchy clay films; conspicuous, yellow, "sugary" coatings; weak pressure cutans; very strongly acid; clear, wavy boundary. 8 to 13 inches thick.

B23t—32 to 42 inches, dark-brown (10YR 4/3) silty clay, brown (7.5YR 4/4) when dry; strong, fine and very fine, angular and subangular blocky structure; hard, firm, very sticky and very plastic; few roots; many fine pores; thin, patchy clay films; conspicuous, yellow, "sugary" coatings; very strongly acid; clear, wavy boundary. 8 to 12 inches thick.

C—42 inches, hard and soft, weathered rock. The hard material is gray (5YR 5/1), light gray (N 7/0) when dry. It has many black coatings in pores, as well as some red, orange, and light-yellow coatings. The soft material is dark-brown (7.5YR 4/2) silty clay; firm, sticky and plastic; few roots; many fine pores; very strongly acid.

The A horizon ranges from 7.5YR to 10YR in hue, from 2 to 3 in chroma, and from 2 to 3 in value. The A12 and B1 horizons are lacking in some profiles. The B2 horizon ranges from 7.5YR to 10YR in hue, from 3 to 6 in chroma, and from 3 to 4 in value. The depth to weathered rock ranges from 28 to more than 56 inches.

This soil is used for water supply, wildlife habitat, and woodland. (Capability classification VIe, nonirrigated; pasture group 12; woodland group 10)

Kokee silty clay loam, 35 to 70 percent slopes (KSKF).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for water supply, wildlife habitat, and woodland. (Capability classification VIIe, nonirrigated; pasture group 12; woodland group 10)

Koko Series

This series consists of well-drained soils on fans and volcanic spurs on the island of Oahu. These soils developed in alluvium washed from deposits of volcanic ash, cinders, and tuff. They are gently sloping to moderately steep. Elevations range from nearly sea level to 200 feet. The annual rainfall amounts to 15 to 25 inches, most of which occurs between November and April. The mean annual soil temperature is 74° F. Koko soils occur near Koko Head, Koko Crater, and Diamond Head. They are geographically associated with Lualualei soils.

These soils are used for homesites, pasture, and truck crops. The natural vegetation consists of kiawe, klu, koa haole, fingergrass, and bristly foxtail.

Koko silt loam, 2 to 6 percent slopes (KsB).—This soil occupies smooth slopes. Included in mapping were small eroded spots, small nearly level areas, and small areas that have a buried profile. Gravelly soils are on foot slopes and along drainageways.

In a representative profile the surface layer is dark reddish-brown silt loam about 16 inches thick. The subsoil, about 32 inches thick, is dark reddish-brown or dark-brown silt loam, loam, or clay loam that has subangular blocky structure. The substratum consists of cinders and tuff. The soil is neutral in reaction throughout the profile.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is 2.1 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°16′48″ N. and long. 157°42′12″ W.

Ap—0 to 8 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/4) when dry; weak, very fine and fine, granular structure; slightly hard, very friable, nonsticky and slightly plastic; plentiful very fine, and few medium roots; common, very fine, interstitial pores; neutral; gradual, smooth boundary. 5 to 9 inches thick.

A1—8 to 16 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/4) when dry; weak, fine and medium, subangular blocky structure breaking to weak, fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; plentiful very fine and medium roots; common, very fine and medium, tubular pores; neutral; clear, smooth boundary. 8 to 10 inches thick.

B21—16 to 25 inches, dark reddish-brown (5YR 3/4) silt loam, reddish brown (5YR 4/4) when dry; weak, fine and medium, subangular blocky structure; slightly hard, very friable, sticky and plastic; plentiful very fine and medium roots; common, very fine and medium, tubular pores; neutral; gradual, smooth boundary. 8 to 11 inches thick.

B22—25 to 33 inches, dark reddish-brown (5YR 3/4) clay loam, reddish brown (5YR 4/4) when dry; moderate, fine to coarse, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful fine, and few medium and coarse roots; common, fine, tubular pores and few, medium and coarse, tubular pores; neutral; gradual, smooth boundary. 6 to 10 inches thick.

B23—33 to 41 inches, dark reddish-brown (5YR 3/4) clay loam, yellowish red (5YR 4/6) when dry; moderate, fine and medium, subangular blocky structure; hard, firm, sticky and plastic; plentiful very fine and fine, common fine, and few coarse roots; common, fine and medium, tubular pores and few, coarse, tubular pores; neutral; clear, wavy boundary. 6 to 8 inches thick.

B3—41 to 48 inches, dark-brown (7.5YR 4/4) loam, strong brown (7.5YR 5/6) when dry; weak, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic; few fine roots; few, fine and medium, tubular pores; common fine cinder fragments; neutral. 4 to 8 inches thick.

IIC—48 inches, cinders and tuff.

The depth to tuff and cinders ranges from 37 to 56 inches. Fragments of tuff are common in the profile on the windward side of craters. The texture of the solum is silt loam, loam, clay loam, or silty clay loam. The B horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when moist and from 4 to 5 when dry. It ranges from 4 to 5 in chroma when moist and from 4 to 8 when dry.

This soil is used for homesites, truck crops, and pasture. (Capability classification IIe if irrigated, VIc if nonirrigated; pasture group 2)

Koko silt loam, 6 to 12 percent slopes (KsC).—On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope.

This soil is used for homesites and pasture. (Capability classification IIIe if irrigated, VIe if nonirrigated; pasture group 2)

Koko silt loam, 12 to 25 percent slopes (KsD).—This soil is similar to Koko silt loam, 2 to 6 percent slopes, except that it is on fans on foot slopes of volcanic craters. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because of the slope.

This soil is used for homesites and pasture. (Capability classification IVe if irrigated, VIe if nonirrigated; pasture group 2)

Kokokahi Series

This series consists of moderately well drained soils on talus slopes and alluvial fans on the island of Oahu. These soils developed in colluvium and alluvium derived from basic igneous rock. They are moderately sloping to steep. Elevations range from nearly sea level to 125 feet. The annual rainfall amounts to 20 to 35 inches. The mean annual soil temperature is 74° F. Kokokahi soils occur in the vicinity of Kaneohe and Pearl Harbor and are geographically associated with Alaeloa and Jaucas soils.

These soils are used for pasture and homesites. The natural vegetation consists of kiawe, koa haole, klu, bristly foxtail, piligrass, and bermudagrass.

Kokokahi clay, 6 to 12 percent slopes (KtC).—This soil is on talus slopes and alluvial fans. Included in mapping were small areas where the slope is 2 to 6 percent and small areas along drainageways where the slope is 20 to 35 percent. Also included were wet soils within drainageways.

In a representative profile the surface layer is very dark gray and dark gray clay about 14 inches thick. The next layer, about 12 inches thick, is dark grayish-brown clay that has subangular blocky structure. The substratum is grayish-brown and light brownish-gray clay 14 to more than 20 inches thick. These soils are very sticky and very plastic, and they crack widely upon drying. They are slightly acid to neutral in the surface layer and slightly acid to mildly alkaline below.

Permeability is slow to moderately slow. Runoff is medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.6 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult because of the sticky, plastic nature of the clay and the narrow range of moisture content within which the soil can be cultivated. The shrink-swell potential is high.

Representative profile: Island of Oahu, lat. 21°25′48″ N. and long. 157°45′52″ W.

A11—0 to 2 inches, very dark gray (10YR 3/1), moist and dry, clay; strong, fine, granular structure; extremely hard, very firm, very sticky and very plastic; abundant fine and very fine roots; common, very fine, tubular and interstitial pores; common, fine, black concretions; few, fine, angular fragments of basalt; moderate effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 1 to 3 inches thick.

A12—2 to 14 inches, dark-gray (10YR 4/1), moist and dry, clay; strong, fine, subangular blocky structure; very hard, very firm, very sticky and very plastic; plentiful very fine roots and few medium roots; common, very fine and fine, tubular pores; few, fine, black concretions; few, fine, angular fragments of basalt; moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 8 to 12 inches thick.

AC—14 to 26 inches, dark grayish-brown (2.5Y 4/2), moist and dry, clay; irregularly shaped large blocks that break to moderate, fine, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; common very fine roots and few medium roots; many, very fine, tubular pores; many distinct slickensides; common black stains; slight effervescence with hydrogen peroxide; few pebble-size fragments of basalt; mildly alkaline; gradual, smooth boundary. 10 to 14 inches thick.

C1—26 to 38 inches, grayish-brown (2.5Y 5/2), moist and dry, clay; large irregularly shaped blocks that break to moderate, fine and medium, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few very fine roots; few, very fine, tubular pores; common deeply grooved slickensides; common black stains; few pebble-size fragments of basalt; common fine gypsum crystals; slight effervescence with hydrogen peroxide; neutral; abrupt, smooth boundary. 8 to 14 inches thick.

C2—38 to 44 inches, light brownish-gray (2.5YR 6/2) clay, olive brown (2.5YR 4/3) when dry; weak, medium, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; common, very fine and fine, tubular pores; slightly acid.

A few stones occur throughout the profile. The AC horizon ranges from 2.5Y to 5Y in hue, from 3 to 5 in value when moist, and from 2 to 4 in chroma. Wide, deep cracks (2 inches or more wide and 20 to 30 inches deep) are common when the soil is dry.

This soil is used for pasture and homesites. (Capability classification VIe, nonirrigated; pasture group 3)

Kokokahi very stony clay, 0 to 35 percent slopes (KTKE).—This soil is similar to Kokokahi clay, 6 to 12 percent slopes, except that there are many stones and boulders on the surface and throughout the profile. In most places the slope ranges from 10 to 25 percent. Runoff is medium to rapid, and the erosion hazard is moderate to severe.

This soil is used for pasture. It is generally too stony for cultivated crops. (Capability classification VIs, nonirrigated; pasture group 3)

Kolekole Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in old gravelly alluvium mixed with volcanic ash. They are gently sloping to moderately steep. Elevations range from 500 to 1,200 feet. The annual rainfall amounts to 35 to 50 inches, most of which occurs between November and April. The mean annual soil temperature is 71° F. Kolekole soils occur on the windward slopes of the Waianae Range. They are geographically associated with Kunia, Mahana, and Wahiawa soils.

These soils are used for sugarcane, pineapple, and pasture. The natural vegetation consists of guava, lantana, bermudagrass, and Natal redtop.

Kolekole silty clay loam, 1 to 6 percent slopes (KuB).—This soil occurs on smooth slopes. Included in mapping were small areas of Kunia and Mahana soils, small eroded spots, and steep side slopes along drainageways.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 12 inches thick. The subsoil, about 48 inches thick, is dark reddish-brown silty clay loam and silty clay that has subangular and angular blocky structure. The substratum is old gravelly alluvium. A compact, panlike layer typically occurs at a depth of 24 to 40 inches. The soil is extremely acid to strongly acid in the surface layer and medium acid to very strongly acid in the subsoil.

Permeability is moderately rapid to the panlike layer and moderate in the compact subsoil. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. Roots are restricted by the compact layer.

Representative profile: Island of Oahu, lat. 21°26′48″ N. and long. 158°03′47″ W.

Ap1—0 to 4 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/4) when dry; weak, fine and very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant fine roots; many, very fine, interstitial pores; common, very fine, shiny specks; common, very fine, earthy lumps that are difficult to rub down; very slight effervescence with hydrogen peroxide; extremely acid; clear, smooth boundary. 3 to 9 inches thick.

Ap2—4 to 12 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/4) when dry; weak, fine and medium, subangular blocky structure and weak, very fine, granular; slightly hard, very friable, slightly sticky and slightly plastic; abundant fine roots; common, very fine, tubular and interstitial pores; many, very fine, earthy lumps that are difficult to break down; dark reddish-brown (2.5YR 3/4) material from horizon below (10 percent); common, very fine, shiny specks; extremely acid; clear, wavy boundary. 7 to 10 inches thick.

B21—12 to 20 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; moderate, very fine and fine, subangular and angular blocky structure; very hard, friable, sticky and plastic; plentiful fine roots; common, fine and very fine, tubular pores; few, fine, earthy lumps; few shiny specks; medium acid; gradual, smooth boundary. 6 to 8 inches thick.

B22—20 to 25 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; moderate, very fine and fine, subangular and angular blocky structure; hard, firm, sticky and plastic; few fine roots; common, very fine and fine, tubular pores; few, very fine, earthy lumps; patchy pressure cutans on ped surfaces; few, very fine, shiny specks; strongly acid; gradual, smooth boundary. 2 to 7 inches thick.

B23—25 to 32 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; moderate, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common, fine, tubular pores; weak, continuous pressure cutans on ped surfaces; few earthy lumps; few shiny specks; very strongly acid; clear, smooth boundary. 6 to 8 inches thick.

B24—32 to 38 inches, dark reddish-brown (2.5YR 3/4) silty clay, red (2.5YR 5/8) when dry; weak, fine and very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common very fine, fine, and medium pores; few, thin, patchy clay films; few, very fine, earthy lumps; few shiny specks; very strongly acid; abrupt, wavy boundary. 2 to 6 inches thick.

B25tb—38 to 60 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when moist; strong, very fine and fine, subangular and angular blocky structure; very hard, friable, sticky and plastic; compact in place; horizon is capped by a massive, banded, brittle pan (1/16 inch to 3/8 inch thick) that has a troweled surface; no roots; very few, very fine, tubular pores; continuous, strong pressure cutans on all ped surfaces that increase with depth; many rock cores that retain original form; common light-colored sand grains; continuous dark-red and red clay films on about 50 percent of ped faces; very strongly acid.

The greatest variation in the series is in the depth to the panlike layer. The depth to this layer is typically 24 to 40 inches, but it ranges from 15 to 50 inches. The A horizon ranges from 2 to 3 in value and chroma when moist and from 3 to 4 when dry. The B horizon, above the B25tb, ranges from 2 to 3 in value when moist and from 3 to 5 when dry. It ranges from 4 to 6 in chroma when moist and from 4 to 8 when dry. The B25tb horizon ranges from silty clay loam to silty clay in texture. It is capped by a brittle, banded, panlike layer that forms an abrupt boundary with the upper part of the B horizon. A black, thick layer of decomposed roots, 1/4 to 1/2 inch thick, commonly rests on the pan. The amount of highly weathered rock fragments varies considerably within short distances but normally makes up between 30 and 40 percent of the volume.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIe if irrigated, IIIe if nonirrigated; sugarcane group 1; pineapple group 5; pasture group 6; woodland group 6)

Kolekole silty clay loam, 6 to 12 percent slopes (KuC).—On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Kolekole silty clay loam, 12 to 25 percent slopes (KuD).—This soil occurs on narrow side slopes, mainly along drainageways. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because of the slope. Included in mapping were small, eroded spots.

This soil is used for pasture and pineapple. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Koloa Series

This series consists of well-drained soils on slopes of old volcanic vents and upland ridges on the island of Kauai. These soils are underlain by hard rock at a depth of 20 to 40 inches. They developed in material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 74° F. Koloa soils are geographically associated with Mamala and Waikomo soils.

These soils are used for irrigated sugarcane. The natural vegetation is mainly koa haole.

Koloa stony silty clay, 3 to 8 percent slopes (KvB).—This soil occurs on upland slopes. Included in mapping were small areas that are more than 40 inches deep.

In a representative profile the surface layer is dark reddish-brown stony silty clay about 7 inches thick. The subsoil, about 13 inches thick, is dark-red and dark reddish-brown stony silty clay that has subangular blocky structure. The substratum is hard rock. The soil is slightly acid to neutral throughout the profile.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.8 inches per foot of soil. Roots penetrate to the bedrock.

Representative profile: Island of Kauai, lat. 21°53′5.6″ N. and long. 159°26′15″ W.

Ap—0 to 7 inches, dark reddish-brown (5YR 3/3) stony silty clay, weak red (2.5YR 4/2) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant roots; 10 to 20 percent stones; violent effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 5 to 7 inches thick.

B21—7 to 13 inches, dark reddish-brown (2.5YR 3/3) stony silty clay, dark reddish brown (2.5YR 3/4) when rubbed, dark reddish brown (5YR 3/3) when dry; weak, fine, subangular blocky structure; very hard, firm, sticky and plastic; plentiful roots; common fine pores; 10 to 20 percent stones; strong effervescence with hydrogen peroxide; patchy glaze on peds; some highly weathered pebbles; neutral; gradual, smooth boundary. 6 to 8 inches thick.

B22—13 to 20 inches, dark-red (2.5YR 3/5) stony silty clay, dark red (2.5YR 3/6) when dry; weak, fine and very fine, subangular blocky structure; pockets where structure is strong, very fine, subangular blocky; very hard, firm, very sticky and plastic; plentiful roots; many fine pores; 15 to 30 percent stones; moderate effervescence with hydrogen peroxide; continuous pressure cutans; many highly weathered pebbles; black coatings inside pebbles; neutral; abrupt, irregular boundary. 7 to 10 inches thick.

R—20 inches, hard pahoehoe rock that has a thin, weathered crust; vesicles in rock have black coatings that effervesce with hydrogen peroxide.

The A horizon ranges from 2.5YR to 5YR in hue, from 3 to 4 in chroma, and from 2 to 3 in value. The B horizon ranges from 10R to 5YR in hue and from 3 to 5 in chroma. The depth to bedrock ranges from 20 to 25 inches.

This soil is used for sugarcane. (Capability classification IIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 5; woodland group 5)

Koloa stony silty clay, 8 to 15 percent slopes (KvC).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for irrigated sugarcane. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 5; woodland group 5)

Koloa stony silty clay, 15 to 25 percent slopes (KvD).—On this soil, runoff is medium and the erosion hazard is moderate to severe. Included in mapping were small areas where the slope is more than 40 percent.

This soil is used for irrigated sugarcane, pasture, woodland, and wildlife habitat. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 5; woodland group 5)

Kolokolo Series

This series consists of well-drained soils on bottom lands on the island of Kauai. These soils developed in alluvium washed from upland soils. They are level to gently sloping. Elevations range from about 50 to 500 feet. The annual rainfall amounts to 60 to 150 inches. The mean annual soil temperature is 73° F. Kolokolo soils are geographically associated with Hanalei soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of pangolagrass, kikuyugrass, guava, pandanus, paragrass, glenwoodgrass, ricegrass, hau, and mango.

Kolokolo clay loam (Kw).—This soil is on stream bottoms. The slope ranges from 0 to 2 percent.

In a representative profile the surface layer is very dark brown clay loam about 19 inches thick. The next layer is dark-brown, very dark grayish-brown, and brown loam to silty clay loam more than 41 inches thick. Below this is stratified alluvium. The soil is neutral throughout the profile.

Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. This soil is subject to damaging overflow.

Representative profile: Island of Kauai, lat. 22°02′48″ N. and long. 159°21′38.7″ W.

A1—0 to 19 inches, very dark brown (10YR 2/3) clay loam, dark brown (10YR 3/3) when dry; moderate, fine, subangular blocky structure; very hard, friable, sticky and plastic; plentiful fine, very fine, and micro roots; slight effervescence with hydrogen peroxide; few pebbles; neutral; abrupt, irregular boundary. 16 to 23 inches thick.

C1—19 to 28 inches, dark-brown (7.5YR 3/2) loam, brown (7.5YR 4/4) when dry; massive; slightly hard, friable, slightly sticky and plastic; plentiful fine and very fine roots; many medium, fine, and very fine pores; slight effervescence with hydrogen peroxide; material looks sandy until rubbed; many worm casts of dark material from A1 horizon; few pebbles; neutral; clear, smooth boundary. 6 to 11 inches thick.

C2—28 to 46 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; weak, fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few fine and very fine roots; many medium, fine, and very fine pores; slight effervescence with hydrogen peroxide; few pebbles; neutral; gradual, smooth boundary. 16 to 20 inches thick.

C3—46 to 60 inches, brown (10YR 4/3), moist and dry, silty clay loam; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few fine and very fine roots; many fine and very fine pores; slight effervescence with hydrogen peroxide; material looks sandy until rubbed; common black stains; few pebbles; neutral.

In places the A horizon is loam. It ranges from 7.5YR to 10YR in hue and from 2 to 3 in chroma and value. The C horizon ranges from 7.5YR to 10YR in hue, from 2 to 3 in chroma, and from 3 to 4 in value.

This soil is used for pasture. (Capability classification IIw, irrigated or nonirrigated; pasture group 8; woodland group 7)

Kolokolo extremely stony clay loam (KUL).—This soil is similar to Kolokolo clay loam, except that it is extremely stony. The stones and boulders make cultivation impractical. The soil is subject to damaging overflow. Included in mapping were some extremely bouldery areas and some areas where the slope is as much as 12 percent.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 8; woodland group 7)

Koolau Series

This series consists of poorly drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are nearly level to moderately steep. Elevations range from 750 to 5,200 feet. The annual rainfall amounts to 120 to 200 inches. The mean annual soil temperature is 62° F. Koolau soils are geographically associated with Pooku and Alakai soils.

These soils are used for water supply and wildlife habitat. A small area is used for pasture and sugarcane. The natural vegetation consists of false staghornfern, melastoma, ohia, treefern, lacefern, guava, lantana, glenwoodgrass, ricegrass, and hilograss.

Koolau silty clay, 0 to 8 percent slopes (KVSB).—This soil is on upland ridges.

In a representative profile the surface layer is mottled light brownish-gray and gray silty clay about 11 inches thick. The subsoil, 21 inches thick, is mottled pale-yellow and gray silty clay. The substratum is mottled light olive-brown clay loam. The soil is very strongly acid to extremely acid throughout the profile.

Permeability is rapid above the substratum and moderately slow in the substratum. Runoff is slow, and the erosion hazard is no more than slight. Roots penetrate to a depth of about 24 inches.

Representative profile: Island of Kauai, lat. 22°09′47.6″ N. and long. 159°27′42.4″ W.

O1—2 inches to 0, undecomposed leaves and stems of uluhe-fern.

A11—0 to 7 inches, coarsely mottled, light brownish-gray (2.5YR 6/2 and 10YR 6/2) silty clay, light gray (2.5Y 7/1) when dry; brown stains in root channels; massive; very hard, firm, sticky and plastic; abundant roots; extremely acid; abrupt, smooth boundary. 6 to 8 inches thick.

A12—7 to 11 inches, gray (2.5Y 5/1) silty clay, light gray (10YR 7/1) when dry; coarse mottles of yellow (10YR 7/6) and coatings of brown (10YR 5/3) in pores; massive; very hard, very firm, sticky and plastic; few roots; many medium wormholes; many fine and very fine pores; extremely acid; abrupt, smooth boundary. 4 to 6 inches thick.

B21—11 to 23 inches, pale-yellow (5Y 7/3) silty clay, white (5Y 8/1) when dry; coarsely mottled with light yellowish brown (10YR 6/4) and strong brown (7.5YR 5/6); weak, fine, subangular blocky structure; very hard, firm, sticky and plastic; few roots; many medium, fine, and very fine pores; very strongly acid; gradual, smooth boundary. 10 to 14 inches thick.

B22g—23 to 27 inches, gray (N 5/0) light silty clay, light gray (5Y 7/2) when dry; mottled with very pale brown (10YR 7/3), yellow (10YR 7/6), and strong brown (7.5YR 5/8); coatings of light brown (7.5YR 6/4) in some pores; massive, but exhibits horizontal lenses that are very firm; hard, friable, sticky and plastic, and weakly smeary; no roots; many medium, fine, and very fine pores; thin, patchy coatings in pores; coatings look like clay fims; extremely acid; gradual, smooth boundary. 3 to 6 inches thick.

B23g—27 to 32 inches, gray (5Y 5/1) clay loam, pale yellow (5Y 7/3) when dry; mottles of yellowish brown (10YR 5/6), light olive brown (2.5YR 5/4), red (2.5YR 4/8), and brown (10YR 4/3); coatings of very pale brown (10YR 7/3); weak, thick, platy structure breaking to weak, fine, angular and subangular blocky; slightly hard, friable, sticky and plastic, and smeary; no roots; few medium pores and many fine and very fine pores; moderately thick coatings in some pores; coatings look like clay films; very strongly acid; clear, smooth boundary. 4 to 6 inches thick.

C—32 to 60 inches, light olive-brown (2.5Y 5/4) clay loam, brownish yellow (10YR 6/6) when dry; coatings and horizontal bands of very pale brown (10YR 7/4), brown (7.5YR 5/4), dark grayish brown (10YR 4/2), dark red (2.5YR 3/6), and dark reddish brown (5YR 3/3); thin (1/8 inch thick), hard, discontinuous bands of ironstone; weak, medium, platy structure; hard, very firm, sticky and plastic; no roots; no pores; thin coatings between plates; very strongly acid.

The A horizon ranges from 1 to 2 in chroma and from 4 to 6 in value. Mottles in the A horizon range from none to many. The B horizon ranges from 5Y to 10YR in hue, from 0 to 3 in chroma, and from 4 to 7 in value. The water table is at a depth of 2 to 4 feet.

This soil is used mostly for water supply and wildlife habitat. A small acreage is used for pasture and sugarcane. (Capability classification VIw, nonirrigated; pasture group 11; woodland group 16)

Koolau silty clay, 8 to 30 percent slopes (KVSE).—On this soil, runoff is medium and the erosion hazard is slight to moderate.

This soil is used for water supply and wildlife habitat. (Capability classification VIw, nonirrigated; pasture group 11; woodland group 16)

Kula Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to steep. Elevations range from 2,000 to 3,500 feet. The annual rainfall amounts to 25 to 40 inches. The mean annual soil temperature is 66° F. Kula soils are geographically associated with Kaipoioi, Kamaole, and Pane soils.

These soils are used for pasture, truck crops, orchard crops, and wildlife habitat. The natural vegetation consists of bermudagrass, black wattle, Natal redtop, oi, rattailgrass, and yellow foxtail.

Kula cobbly loam, 12 to 20 percent slopes (KxaD).—This soil is on intermediate uplands. Included in mapping were small areas of Kaipoioi and Kamaole soils. Also included were small areas of gently sloping soils.

In a representative profile the surface layer is dark reddish-brown loam about 8 inches thick. The subsoil, about 46 inches thick, is dark reddish-brown loam, silt loam, and silty clay loam that has subangular blocky structure. The substratum is slightly weathered basic igneous rock. The soil is slightly acid in the surface layer and slightly acid to neutral in the subsoil.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.8 inches per foot of soil. In places roots penetrate to rock.

Representative profile: Island of Maui, lat. 20°45′40″ N. and long. 156°19′22″ W.

A1—0 to 8 inches, dark reddish-brown (5YR 3/2) cobbly loam, dark reddish brown (5YR 3/4) when dry; weak, fine, granular structure; soft, friable, nonsticky and nonplastic; abundant fine roots; many medium pores; many very small, red and black particles visible under hand lens; slight effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 7 to 10 inches thick.

B21—8 to 19 inches, dark reddish-brown (5YR 3/2) loam, dark reddish brown (5YR 3/4) when dry; moderate, medium, subangular blocky structure; soft, friable, slightly sticky and slightly plastic; abundant fine roots; many medium pores; slightly acid; gradual, wavy boundary. 8 to 13 inches thick.

B22—19 to 30 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/4) when dry; moderate, coarse, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; abundant fine roots; many medium and coarse pores; neutral; abrupt, irregular boundary. 10 to 12 inches thick.

IIB23b—30 to 42 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; strong, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant fine roots; many fine and medium pores; nearly continuous, gelatinlike coatings on peds; many sand-size aggregates that are resistant to crushing; common worm casts 10 to 15 millimeters in size; many very fine roots matted along surfaces of worm casts; neutral; clear, wavy boundary. 10 to 13 inches thick.

IIB3b—42 to 54 inches, dark reddish-brown (5YR 3/2) silty clay loam, reddish brown (5YR 4/4) when dry; strong, fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; plentiful fine roots and many fine and medium pores; 30 to 40 percent weathered andesite and basalt fragments; neutral; clear, wavy boundary. 10 to 14 inches thick.

IICb—54 inches, weathered andesite and basalt that has thin seams of soil material in cracks.

The depth to slightly weathered andesite and basalt ranges from 45 to 62 inches. In some places rock outcrop occupies 0.1 to 3 percent of the surface. The A horizon ranges from 5YR to 10YR in hue, from 2 to 3 in value when moist and 3 to 4 when dry, and from 2 to 3 in chroma when moist and 2 to 4 when dry. The B horizon ranges from 5YR to 10YR in hue, from 3 to 4 in value when moist or dry, and from 2 to 4 in chroma when moist. The B horizon ranges from loam to silty clay loam in texture. The IIB horizon has strong to moderate subangular blocky structure.

This soil is used for pasture. Small areas are used for truck and orchard crops. Most of the cobblestones have been removed in areas where truck crops are grown. (Capability classification IVe, irrigated or nonirrigated; pasture group 4; woodland group 2)

Kula loam, 4 to 12 percent slopes (KxC).—This soil has a profile like that of Kula cobbly loam, 12 to 20 percent slopes, except that it is nearly free of cobblestones.

This soil is used for truck crops and pasture. (Capability classification IIIe, irrigated or nonirrigated; pasture group 4; woodland group 2)

Kula loam, 12 to 20 percent slopes (KxD).—This soil has a profile like that of Kula cobbly loam, 12 to 20 percent slopes, except that it is nearly free of cobblestones. Included in mapping were small, stony areas and a few rock outcrops, mainly on knolls and the sides of small gulches.

This soil is used for pasture and truck crops. (Capability classification IVe, irrigated or nonirrigated; pasture group 4; woodland group 2)

Kula very rocky loam, 12 to 40 percent slopes (KxbE).—This soil has a profile like that of Kula cobbly loam, 12 to 20 percent slopes, except that rock outcrops cover 10 to 25 percent of the surface. Runoff is medium, and the erosion hazard is moderate.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 4; woodland group 2)

Kunia Series

This series consists of well-drained soils on upland terraces and fans on the island of Oahu. These soils developed in old alluvium. They are nearly level to moderately sloping. Elevations range from 700 to 1,000 feet. The mean annual rainfall amounts to 30 to 40 inches, most of which occurs from November to April. The mean annual soil temperature is 71° F. Kunia soils occur on the foot slopes of the Waianae Range, near Schofield Barracks. They are geographically associated with Kolekole, Lahaina, and Wahiawa soils.

These soils are used for sugarcane, pineapple, homesites, and military reservations. Most areas are cultivated, and the natural vegetation is not significant.

Kunia silty clay, 0 to 3 percent slopes (KyA).— This soil occurs on broad, smooth slopes. Included in mapping were small areas of Kolekole soils and small areas of red, clayey soils at lower elevations.

In a representative profile the surface layer is dark reddish-brown silty clay about 22 inches thick. The subsoil, 40 to 71 inches thick, is dark reddish-brown silty clay and silty clay loam that has subangular blocky structure. The substratum is dark reddish-brown gravelly silty clay. Manganese concretions occur throughout the profile. The surface layer is medium acid to extremely acid, and the subsoil is slightly acid to strongly acid.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°28′42″ N. and long. 158°03′43″ W.

Ap1—0 to 3 inches, dark reddish-brown (5YR 2/2) silty clay, dark reddish brown (5YR 3/3) when dry; moderate, fine and very fine, granular structure; hard, friable, sticky and plastic; abundant roots; many fine and very fine, interstitial pores; strong effervescence with hydrogen peroxide; extremely acid; clear, wavy boundary. 2 to 9 inches thick.

Ap2—3 to 22 inches, dark reddish-brown (5YR 2/2) silty clay, dark reddish brown (5YR 3/3) when dry; weak, fine and medium, subangular blocky structure; hard, firm, sticky and plastic; few fine roots; common, very fine, tubular and interstitial pores; compacted by tillage; few, fine and very fine, black concretions; few charcoal specks; strong effervescence with hydrogen peroxide; extremely acid; abrupt, smooth boundary. 9 to 19 inches thick.

B1—22 to 29 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark reddish brown (2.5YR 2/4) when moist; weak, fine and medium, subangular blocky structure; slightly hard, firm, sticky, and plastic; no roots; common, very fine, tubular pores; few, patchy pressure cutans; few, fine and very fine, black concretions; strongly acid; clear, wavy boundary. 5 to 18 inches thick.

B2—29 to 47 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate, very fine and fine, subangular blocky structure; slightly hard, firm, sticky and plastic; no roots; common, fine, tubular pores; weak, patchy pressure cutans; few black concretions; slight effervescence with hydrogen peroxide on soil mass but strong on the black concretions; slightly acid; clear, wavy boundary. 8 to 36 inches thick.

B3—47 to 74 inches, dark reddish-brown (2.5YR 3/6) silty clay loam, dark red (2.5YR 3/4) when moist; moderate, medium, blocky structure breaking to moderate, fine, subangular blocky; hard, firm, sticky and plastic; few, very fine, tubular pores coated with black stains; strong, continuous pressure cutans; few hard rock cores; few worm casts; very slight effervescence with hydrogen peroxide on soil mass; few, fine, black concretions that show moderate effervescence with hydrogen peroxide; medium acid.

In places this soil is underlain by gravelly alluvium below a depth of 4 feet, particularly where the alluvial fans have been dissected by drainageways. The Ap horizon ranges from 5YR to 2.5YR in hue and from 3 to 4 in value when dry. The B horizon ranges from 3 to 6 in chroma when dry. The B3 horizon ranges from silty clay to silty clay loam.

This soil is used for sugarcane, pineapple, homesites, and military reservations. (Capability classification I if irrigated, IIIc if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 3; woodland group 1)

Kunia silty clay, 3 to 8 percent slopes (KyB).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small areas of nearly level soils and small areas of Kolekole soils.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 3; woodland group 1)

Kunia silty clay, 8 to 15 percent slopes (KyC).—This soil occurs on narrow side slopes, mainly along drainageways. Runoff is medium, and the erosion hazard is moderate. Included in mapping were small, eroded areas.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 3; pasture group 3; woodland group 1)

Kunuweia Series

This series consists of well-drained, very gravelly soils on ridgetops on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are nearly level to strongly sloping. Elevations range from 3,500 to 4,000 feet. The annual rainfall amounts to 70 to 150 inches. The mean annual soil temperature is 58° F. Kunuweia soils are geographically associated with Kokee soils.

These soils are used for water supply, wildlife habitat, and woodland. The natural vegetation consists of ohia, koa, redwood, blackwood, blackberry, mokihana, olopua, maile, hilograss, ricegrass, uki, uki uki, and ferns.

Kunuweia very gravelly clay loam, 0 to 15 percent slopes (KZC).—This soil is on the tops of ridges in the uplands. Included in mapping were a few areas where the slope is up to 30 percent. Also included was an area, southeast of Kalihiwai reservoir, that is at a lower elevation and is poorly drained.

In a representative profile the surface layer is dark-brown very gravelly clay loam about 12 inches thick. The subsoil, more than 36 inches thick, is yellowish-brown, light yellowish-brown, and dark reddish-brown, massive clay loam. It contains thin, discontinuous ironstone seams and thin, scalelike fragments of ironstone. The substratum is soft, weathered rock. The soil is very strongly acid throughout.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. Root penetration is limited to the A horizon and the soft material in the B2ir horizon.

Representative profile: Island of Kauai, lat. 22°08′8.4″ N. and long. 159°38′28″ W.

A1—0 to 12 inches, dark-brown (10YR 4/3) very gravelly clay loam, brown (7.5YR 5/2) when dry; strong, fine and very fine, granular structure; loose, friable, sticky and slightly plastic; abundant roots; moderate, delayed effervescence with hydrogen peroxide; gravel consists of ironstone pebbles, mostly smooth; few pieces of ironstone, up to 10 inches across, scattered over the surface and in the A1 horizon; very strongly acid; abrupt, smooth boundary. 11 to 14 inches thick.

B2ir—12 to 60 inches, plinthite that has ¼- to 1-inch seams of extremely hard, very dusky red (2.5YR 2/2) ironstone; yellowish-brown (10YR 5/4), light yellowish-brown (10YR 6/4), and dark reddish-brown (5YR 3/4) clay loam, reddish yellow (7.5YR 6/6) when dry; massive; slightly hard, friable, slightly sticky and plastic, and smeary; few fine and very fine roots. In the upper 12 inches of this horizon, the seams are numerous and appear to be not oriented; below 12 inches, they are few and appear to encircle older boulder cores.

The A horizon has a purplish cast in some areas. In some places there is a thin mat of very dark brown to black organic matter, humus, and roots on the surface. On the surface and in the A horizon are chunks of extremely hard ironstone.

This soil is used for water supply, wildlife habitat, and woodland. (Capability classification VIs, nonirrigated; pasture group 12; woodland group 12)

Lahaina Series

This series consists of well-drained soils on uplands on the islands of Lanai, Maui, Molokai, and Oahu. These soils developed in material weathered from basic igneous rock. They are nearly level to steep. Elevations range from 10 to 1,500 feet. The annual rainfall amounts to 20 to 35 inches, most of which occurs in fall and winter. The mean annual soil temperature is 72° F. Lahaina soils are geographically associated with Helemano, Hoolehua, Kahana, Molokai, Pamoa, and Wahiawa soils.

These soils are used for sugarcane and pineapple. Small acreages are used for truck crops, pasture, homesites, and wildlife habitat. The natural vegetation consists of bermudagrass, feather fingergrass, ilima, kiawe, lantana, oi, and uhaloa.

Lahaina silty clay, 3 to 7 percent slopes (LaB).—This soil is on smooth uplands. Included in mapping were small areas that are underlain by consolidated sand at a depth below 30 inches. Cobblestones are common on the surface in a few places. In some places, near the coastal plains, the profile contains fragments of coral, stones, gravel, or sand.

In a representative profile the surface layer is dark reddish-brown, silty clay about 15 inches thick. The subsoil, about 45 inches thick, is dusky-red and dark reddish-brown subangular blocky silty clay and silty clay loam. The substratum is soft, weathered basic igneous rock. These soils are medium acid in the surface layer and slightly acid to medium acid in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot in the surface layer and about 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°55′28″ N. and long. 156°40′27″ W.

Ap1—0 to 7 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; weak, fine to coarse, granular structure; hard, friable, very sticky and very plastic; abundant roots; many fine and very fine pores; many black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; common, small, earthy lumps that break down on persistent rubbing; strong effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 6 to 9 inches thick.

Ap2—7 to 15 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; weak, medium and coarse, subangular blocky structure; hard, friable, very sticky and very plastic; abundant roots; few medium and fine pores; compacted by machinery; many black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; violent effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 6 to 9 inches thick.

B1—15 to 23 inches, dusky-red (10R 3/3) silty clay, dark reddish brown (2.5YR 3/4) when dry; weak, medium and coarse, subangular blocky structure; hard, friable, very sticky and very plastic; abundant roots; many fine and very fine pores; many black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; violent effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 4 to 10 inches thick.

B21—23 to 31 inches, dusky-red (10R 3/3) silty clay, dusky red (10R 3/4) when dry; moderate, medium and coarse, subangular blocky structure; hard, friable, sticky and plastic; plentiful roots; many fine and very fine pores; nearly continuous pressure cutans on ped surfaces; many black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; violent effervescence with hydrogen peroxide; medium acid; gradual, wavy boundary. 6 to 15 inches thick.

B22—31 to 46 inches, dark reddish-brown (2.5YR 3/4) heavy silty clay loam, dark red (2.5YR 3/6) when dry; moderate, medium, subangular blocky structure in place, breaking to moderate, very fine, subangular blocky when disturbed; hard, friable, sticky and plastic; very few roots; many medium and fine pores; very compact in place; nearly continuous pressure cutans on ped surfaces; few weathered basalt stones and boulders; many black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; slight effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 10 to 18 inches thick.

B3—46 to 60 inches, dark reddish-brown (2.5YR 3/4) heavy silty clay loam, dark red (2.5YR 3/6) when dry; strong, medium and coarse, subangular blocky structure; hard, friable, sticky and plastic; many fine pores; many, small, patchy pressure cutans on ped faces; common black concretions (1 to 3 millimeters) that effervesce with hydrogen peroxide; many strongly weathered basalt particles (¼ millimeter to 2 millimeters); common, weathered basalt stones; slight effervescence with hydrogen peroxide; medium acid.

The solum ranges from 36 to more than 60 inches in thickness. The A horizon ranges from 5YR to 10R in hue, and from 3 to 4 in chroma when moist and 3 to 6 when dry. The B horizon ranges from 2.5YR to 10R in hue and from 3 to 4 in chroma when moist and 3 to 6 when dry.

This soil is used for sugarcane and pineapple. Small acreages are used for truck crops, pasture, and homesites. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 3; woodland group 1)

Lahaina silty clay, 0 to 3 percent slopes (LaA).—On this soil runoff is slow and the erosion hazard is no more than slight.

This soil is used for sugarcane and pineapple. (Capability classification I if irrigated, IIIc if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 3; woodland group 1)

Lahaina silty clay, 3 to 7 percent slopes, severely eroded (LaB3).—This soil has a profile like that of Lahaina silty clay, 3 to 7 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by erosion. A few areas are eroded to soft, weathered rock. In places there are small dunes formed by winddrifted soil material. Blown-out spots occur between the dunes. The erosion hazard is moderate to severe. Included in mapping were small, nearly level areas.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 3; woodland group 1)

Lahaina silty clay, 7 to 15 percent slopes (LaC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small, steep areas and areas where a few cobblestones and stones are on the surface.

This soil is used for sugarcane and pineapple. Small acreages are used for truck crops, pasture, and wildlife habitat. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 3; pasture group 3; woodland group 1)

Lahaina silty clay, 7 to 15 percent slopes, severely eroded (LaC3).—This soil has a profile like that of Lahaina silty clay, 3 to 7 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by erosion. Runoff is medium, and the erosion hazard is severe. Included in mapping were small blown-out spots and gullies and small, very stony areas that are eroded to weathered rock.

This soil is used for sugarcane and pineapple. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 3; pasture group 3; woodland group 1)

Lahaina silty clay, 15 to 25 percent slopes (LaD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas where most of the surface layer and, in places, part of the subsoil have been removed by erosion.

This soil is used for sugarcane. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 3; pasture group 3; woodland group 1)

Lahaina silty clay, 15 to 25 percent slopes, severely eroded (LaD3).—This soil has a profile like that of Lahaina silty clay, 3 to 7 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by erosion. Runoff is medium, and the erosion hazard is severe. Included in mapping were small areas that are eroded to soft, weathered rock.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, irrigated or nonirrigated; pasture group 3; woodland group 1)

Lahaina silty clay, 25 to 40 percent slopes, severely eroded (LaE3).—This soil has a profile like that of Lahaina silty clay, 3 to 7 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by erosion. Runoff is medium to rapid, and the erosion hazard is severe. Included in mapping were small, gently sloping areas and small areas that are eroded to weathered rock.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, irrigated or nonirrigated; pasture group 3; woodland group 1)

Laumaia Series

This series consists of well-drained soils on the island of Maui. These soils developed in volcanic ash and cinders. They are moderately sloping to very steep. Elevations range from 5,500 to 8,000 feet. The annual rainfall amounts to 35 to 70 inches. These soils are subject to cloud cover or fog most of the year. The mean annual soil temperature is 53° F. Laumaia soils are geographically associated with Kaipoioi and Uma soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of mamane, puakeawe, spear thistle, sweet vernalgrass, and Yorkshire foggrass.

Laumaia loam, 7 to 40 percent slopes (LME).—This soil is on complex, high mountain slopes. Included in mapping were small areas of Kaipoioi and Uma soils. Also included were small areas of eroded, extremely stony soils and rock outcrops.

In a representative profile, the surface layer is very dark brown or black loam about 9 inches thick. The subsoil, about 33 inches thick, is very dark brown silty clay loam and silt loam that has subangular blocky structure or is massive. The substratum consists of hard, cemented layers of volcanic ash and cinders interbedded with loamy soil material. The soil is mildly alkaline in the surface layer and neutral to medium acid in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°42′56″ N. and long. 156°18′16″ W.

A1—0 to 9 inches, black (10YR 2/1) loam, very dark brown (10YR 2/2) when dry; moderate, medium and fine, granular structure; soft, very friable, nonsticky and nonplastic, and weakly smeary; abundant fine and very fine roots; many fine pores; many fine, gritty particles and highly weathered cinders; weak effervescence with hydrogen peroxide; mildly alkaline; clear, wavy boundary. 8 to 11 inches thick.

B21—9 to 15 inches, very dark brown (10YR 2/2) silty clay loam, dark brown (10YR 3/3) when dry; moderate, medium, subangular blocky structure; soft, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine and very fine roots; many fine pores; patchy, gelatinous coatings on peds; weak effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 5 to 7 inches thick.

B22—15 to 24 inches, very dark brown (10YR 2/2) silty clay loam, dark yellowish brown (10YR 3/4) when dry; moderate, medium, subangular blocky structure; soft, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine roots; many fine pores; patchy, gelatinous coatings on peds; few highly weathered cinders less than 1 millimeter in diameter; neutral; clear, wavy boundary. 6 to 12 inches thick.

B23—24 to 32 inches, very dark brown (10YR 2/2) silt loam, dark yellowish brown (10YR 3/4) when dry; weak, coarse, subangular blocky structure; soft, very friable, slightly sticky and slightly plastic and weakly smeary; abundant fine roots; many fine and medium pores; few root channels ½ inch in diameter; neutral; clear, wavy boundary. 7 to 10 inches thick.

B3—32 to 42 inches, very dark brown (10YR 2/2) silt loam, dark yellowish brown (10YR 3/4) when dry; massive; soft, friable, slightly sticky and slightly plastic and weakly smeary; abundant very fine roots; many fine pores; many very highly weathered cinders; neutral; abrupt, wavy boundary. 9 to 11 inches thick.

IICm—42 to 51 inches, dark yellowish-brown (10YR 3/4) volcanic ash and cinders, light yellowish brown (10YR 6/4) when dry; hard and strongly cemented; abrupt, smooth boundary. 8 to 12 inches thick.

IIIAb—51 inches, very dark grayish-brown (10YR 3/2) gritty silt loam, brown (10YR 4/3) when dry; massive; soft, very friable, nonsticky and nonplastic; below this horizon are alternate layers of cemented ash and cinders and buried, moderately smeary bands of silt loam, to a depth of 4 to more than 7 feet.

The depth to ash and cinders is more than 40 inches. The A horizon ranges from 2 to 3 in value when moist or dry and from 1 to 2 in chroma when moist. The B horizon ranges from 5YR to 10YR in hue, from 2 to 3 in value when moist, and from 1 to 3 in chroma when moist. The texture is silty clay loam or silt loam.

These soils are used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 13; woodland group 11)

Laumaia loam, 40 to 70 percent slopes (LMF).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas of shallow soils on local cinder cones.

This soil is used for pasture and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 13; woodland group 11)

Laumaia extremely stony loam, 7 to 40 percent slopes (LNE).—This soil has a profile like that of Laumaia loam, 7 to 40 percent slopes, except that stones cover 3 to 15 percent of the surface. Included in mapping were small, very steep areas and areas dissected by small drainageways.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 13; woodland group 11)

Lava Flows, Aa

Lava flows, Aa (rLW) consists of areas of geologically recent lava flows on the island of Maui. The flows are a mass of clinkery, hard, glassy, sharp pieces of lava on rough to undulating topography. The areas are difficult to traverse. Elevations range from nearly sea level to 8,000 feet. The annual rainfall amounts to 20 to 75 inches.

This miscellaneous land type is used for water supply, wildlife habitat, and recreation. Vegetation is limited to lichens, a few grasses, herbs, shrubs, and scrubby trees. (Capability classification VIIIs, nonirrigated)

Lawai Series

This series consists of moderately well drained to somewhat poorly drained soils at the base of hills on the island of Kauai. These soils developed in alluvium and in colluvial material. They are nearly level to moderately steep. Elevations range from 500 to 800 feet. The annual rainfall amounts to 80 to 150 inches. The mean annual soil temperature is 72° F. Lawai soils are geographically associated with Halii and Hihimanu soils.

These soils are used for sugarcane. Prior to the closing of two canneries on the island, much of this soil was used for pineapple. The natural vegetation consists of guava, joee, melastoma, sensitiveplant, hilograss, and ricegrass.

Lawai silty clay, 0 to 8 percent slopes (LcB).—This soil is on colluvial slopes, alluvial fans, and stream bottoms.

In a representative profile the surface layer is dark-brown and very dark grayish-brown silty clay about 14 inches thick. The subsoil, more than 48 inches thick, is brown to dark-brown silty clay that has subangular and angular blocky structure. The substratum is clayey alluvium and colluvium. The surface layer is medium acid to strongly acid. The subsoil is medium acid.

Permeability is moderate to moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°57′26.2″ N. and long. 159°27′35.5″ W.

Ap1—0 to 8 inches, very dark grayish-brown (10YR 3/2) silty clay, very dark grayish brown (10YR 3/2) when dry; weak, fine and very fine, subangular blocky structure; very hard, friable, sticky and plastic; abundant very fine, fine, and medium roots; many, fine and very fine, interstitial pores; common very fine, fine, and medium, tubular pores; about 40 percent of the material is from the Ap2 horizon, mixed by tillage; strongly acid; clear, broken boundary. 6 to 10 inches thick.

Ap2—8 to 14 inches, dark-brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/2) when dry; weak, very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant micro, very fine, fine, and medium roots; plentiful, micro and very fine, tubular pores; many, very fine, interstitial pores; weak, nearly continuous pressure cutans; about 20 percent of the material is from the Ap1 horizon, mixed by tillage; medium acid; clear, wavy boundary. 5 to 8 inches thick.

B21—14 to 26 inches, dark-brown (7.5YR 4/4) silty clay, dark brown (7.5YR 3/2) when dry; weak, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant micro, very fine, fine, and medium roots; common micro and very fine, tubular pores; many, very fine, interstitial pores; weak, nearly continuous pressure cutans; some yellowish, sugarlike granules in pores and on ped faces; medium acid; gradual, smooth boundary. 10 to 14 inches thick.

B22—26 to 42 inches, dark-brown (7.5YR 3/4) silty clay, dark brown (7.5YR 3/2) when dry; moderate, coarse, angular blocky structure with horizontal cleavage planes that give the appearance of lamination; breaks to very fine and fine, subangular blocky structure; very hard, firm, sticky and plastic; very few micro roots; nearly continuous pressure cutans; few higher chroma, sugarlike granules and light-red coatings in pores; few fine, yellowish-white concretions; less than 5 percent weathered rock; medium acid; gradual, smooth boundary. 14 to 18 inches thick.

B23—42 to 53 inches, dark-brown (7.5YR 3/3) silty clay, dark brown (7.5YR 3/4) when rubbed, dark brown (10YR 3/3) when dry; coatings in pores have a higher chroma; moderate, fine and very fine, angular and subangular blocky structure; very hard, firm, sticky and plastic; no roots; common micro and very fine, tubular pores; continuous pressure cutans; higher chroma, sugarlike granules on ped faces; light-red coatings around some old pebbles; about 5 percent weathered rock; medium acid; gradual, smooth boundary. 9 to 13 inches thick.

B24—53 to 60 inches, dark-brown (7.5YR 3/4) silty clay, brown (7.5YR 4/2) when dry; moderate, coarse to very fine, angular and subangular blocky structure; hard, firm, sticky and plastic; no roots; few micro, very fine, and fine, tubular pores; continuous pressure cutans; coatings of dark brown (10YR 4/3) on some large ped faces; higher chroma, sugarlike granules in some pores and on some ped faces; few, very fine, yellowish-white concretions; about 5 percent weathered rock; medium acid.

The A horizon ranges from 7.5YR to 2.5Y in hue, from 3 to 4 in value, and from 1 to 4 in chroma. The B horizon ranges from 2 to 4 in value and from 2 to 4 in chroma.

This soil is used for sugarcane. (Capability classification IIIw, nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Lawai silty clay, 8 to 15 percent slopes (LcC).—On this soil, runoff is medium and the erosion hazard is slight to moderate.

This soil is used for sugarcane. (Capability classification IIIe, nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Lawai silty clay, 15 to 25 percent slopes (LcD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas where the slope is as much as 40 percent.

This soil is used for sugarcane, pasture, water supply, and wildlife habitat. (Capability classification IVe, nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Leilehua Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to moderately sloping. Elevations range from 900 to 1,200 feet. The annual rainfall amounts to 60 to 80 inches and is fairly well distributed throughout the year. The mean annual soil temperature is 70° F. Leilehua soils are geographically associated with Manana, Paaloa, and Wahiawa soils.

These soils are used for sugarcane, pineapple, and pasture. The natural vegetation consists of guava, Formosa koa, eucalyptus, and bermudagrass.

Leilehua silty clay, 2 to 6 percent slopes (LeB).—This soil occurs as broad areas, as well as narrow areas bordered by gulches. Included in mapping were small areas of Manana soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 12 inches thick. It contains concentrations of heavy minerals. The subsoil, about 36 inches thick, is dark reddish-brown and dusky-red silty clay and clay that has subangular blocky structure. The substratum is dark reddish-brown clay mixed with weathered gravel. The soil is extremely acid throughout the profile.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. Roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°29′02″ N. and long. 157°59′40″ W.

Ap—0 to 12 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; moderate, fine to coarse, granular structure; very hard, firm, sticky and very plastic; plentiful roots; common, very fine, interstitial pores and many, fine, interstitial pores; many very fine glistening specks; common, fine, gray particles presumed to be titanium oxide; few chunks and pockets of dusky-red material mixed by tillage from a lower horizon; decomposing pineapple trash throughout horizon; lower part of horizon contains 1-inch layer of pineapple trash; extremely acid; abrupt, smooth boundary. 6 to 12 inches thick.

B21—12 to 17 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; few fragments and pockets of dusky-red material mixed by tillage; weak, medium and coarse, subangular blocky structure; hard, firm, sticky and plastic; plentiful roots; common, very fine and fine, tubular pores; many very fine glistening specks; common, fine, gray material presumed to be titanium oxide; compacted by tillage; extremely acid; abrupt, smooth boundary. 5 to 7 inches thick.

B22—17 to 22 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; weak, coarse, subangular blocky structure breaking to moderate, very fine and fine, subangular blocky; hard, firm, sticky and plastic; few fine roots; many, very fine and fine, tubular pores; many very fine glistening specks; common fine fragments of gray material presumed to be titanium oxide; numerous, very firm, earthy lumps; extremely acid; abrupt, smooth boundary. 5 to 7 inches thick.

B23t—22 to 31 inches, dusky-red (10R 3/3) silty clay, dusky red (10R 3/4) when dry; weak, coarse and medium, subangular blocky structure; few pockets where structure is moderate, very fine, subangular blocky; hard, friable, sticky and very plastic; very few roots; many, very fine and fine, tubular pores and common, medium, tubular pores; thin, patchy clay films and weak pressure cutans on peds; extremely acid; clear, smooth boundary. 9 to 12 inches thick.

B24t—31 to 41 inches, dark reddish-brown (2.5YR 3/4, 3/3 when crushed) clay, dark reddish brown (2.5YR 4/4) when dry; weak, coarse, subangular blocky structure breaking to moderate, very fine and fine, subangular blocky; hard, firm, sticky and very plastic; no roots; many, very fine and fine, tubular pores; common, very firm, earthy lumps; nearly continuous pressure cutans on ped faces; many, thin, patchy clay films; extremely acid; abrupt, wavy boundary. 9 to 13 inches thick.

B25t—41 to 48 inches, dark reddish-brown (2.5YR 3/4, 3/3 when crushed) heavy silty clay, dark reddish brown (2.5YR 4/4) when dry; many, fine, distinct, dark reddish-brown (2.5YR 3/4) coatings on ped faces; moderate, very fine, subangular blocky structure; hard, firm, sticky and plastic; no roots; many, very fine and fine, tubular pores; many, very firm, earthy lumps; peds have a brittle feel; common iron segregations; few pockets of strongly weathered gravel; continuous pressure cutans on ped faces; many, thin, patchy clay films; extremely acid; clear, wavy boundary. 7 to 9 inches thick.

C1—48 to 62 inches, dark reddish-brown (2.5YR 3/3) clay, dark reddish brown (2.5YR 3/4) when dry; moderate, very fine to medium, subangular blocky structure; very hard, firm, sticky and very plastic; no roots; many, very fine and fine, tubular pores; dark reddish-brown (2.5YR 3/4) coatings on ped faces; continuous pressure cutans on ped faces, some of which appear to be clay films; many, very firm, earthy lumps; few strongly weathered pebbles; extremely acid; gradual, wavy boundary. 14 to 16 inches thick.

C2—62 to 75 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 4/4) when dry; dark reddish-brown (2.5YR 3/4), stringy, patchy clay films on ped faces; moderate, very fine to medium, subangular blocky structure; hard, firm, sticky and plastic; many, very fine and fine, tubular pores; continuous pressure cutans on ped faces; many weathered pebbles; extremely acid.

The A horizon ranges from 5YR to 2.5YR in hue, from 3 to 4 in value when dry and 2 to 3 when moist, and from 3 to 6 in chroma when dry and 3 to 4 when moist. The B horizon ranges from 2.5YR to 10R in hue, from 2 to 3 in value when moist, and from 4 to 6 in chroma when dry and 3 to 4 when moist. The depth to strongly weathered gravel in the C horizon ranges from 40 inches to more than 60 inches. In many places the A horizon is mixed with the B horizon as a result of deep cultivation.

This soil is used for sugarcane, pineapple, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 2; pineapple group 5; pasture group 8; woodland group 7)

Leilehua silty clay, 6 to 12 percent slopes (LeC).—On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 2; pineapple group 6; pasture group 8; woodland group 7)

Lihue Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are gently sloping to steep. Elevations range from nearly sea level to 800 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 73° F. Lihue soils are geographically associated with Ioleau and Puhi soils.

These soils are used for irrigated sugarcane, pineapple, pasture, truck crops, orchards, wildlife habitat, woodland, and homesites. The natural vegetation consists of lantana, guava, koa haole, joee, kikuyugrass, molassesgrass, guineagrass, bermudagrass, and Java plum.

Lihue silty clay, 0 to 8 percent slopes (LhB).—This soil is on the tops of broad interfluves in the uplands. Included in mapping were small areas of a soil that has a very dark grayish-brown surface layer and a mottled subsoil.

In a representative profile the surface layer is dusky-red silty clay about 12 inches thick. The subsoil, more than 48 inches thick, is dark-red and dark reddish-brown, compact silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The surface layer is strongly acid. The subsoil is slightly acid to neutral.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°59′06.7″ N. and long. 159°21′50″ W.

Ap1—0 to 6 inches, dusky-red (2.5YR 3/2) silty clay, yellowish red (5YR 4/8) when dry; cloddy breaking to weak, fine and medium, subangular blocky structure; very hard, firm, sticky and plastic; abundant roots; common very fine and fine pores; many black concretions; strong effervescence with hydrogen peroxide; strongly acid; abrupt, smooth boundary. 4 to 8 inches thick.

Ap2—6 to 12 inches, dusky-red (2.5YR 3/2) silty clay, yellowish red (5YR 4/6) when dry; massive; very hard, friable, sticky and plastic; many roots; many very fine and fine pores; many, very fine, black concretions; strong effervescence with hydrogen peroxide; strongly acid; abrupt, smooth boundary. 4 to 8 inches thick.

B21—12 to 21 inches, dark reddish-brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) when dry; moderate, medium to very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; many, fine, black concretions; moderate effervescence with hydrogen peroxide; nearly continuous glaze on ped surfaces, glaze looks like clay films; slightly acid; clear, broken boundary. 7 to 10 inches thick.

B22—21 to 27 inches, dark reddish-brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) when dry; strong, very fine, subangular blocky structure; very hard, friable, sticky and plastic; many roots; many very fine and fine pores; nearly continuous glaze on ped faces; common, black concretions; weak effervescence with hydrogen peroxide; few, fine, black, manganese dioxide stains on ped faces; neutral; clear, smooth boundary. 5 to 8 inches thick.

B23—27 to 48 inches, dark reddish-brown (2.5YR 3/4) silty clay, red (2.5YR 4/6) when dry; strong, very fine, subangular and angular blocky structure; hard, firm, sticky and plastic; few roots; many very fine and fine pores; continuous glaze on ped faces, glaze looks like thick clay films; superimposed on the glaze is dark-red (10R 3/6) material that looks like pseudosand under magnification; large, black coatings on primary structural units; neutral; gradual, smooth boundary, 15 to 30 inches thick.

B24—48 to 60 inches, dark-red (2.5YR 3/6) silty clay, red (2.5YR 4/6) when dry; strong, very fine, subangular and angular blocky structure; hard, firm, slightly sticky and plastic; no roots; many very fine and fine pores; thin, patchy coatings that look like clay films; many distinct pressure cutans; ped surfaces have superimposed on them stringy, dark-red (10R 3/6) pseudosand or frostlike coatings; this condition is more prevalent than in the B23 horizon; neutral.

The A horizon ranges from 10R to 5YR in hue, from 2 to 3 in chroma, and from 2 to 3 in value. The B horizon ranges from 10R to 2.5YR in hue and from 4 to 6 in chroma.

This soil is used for sugarcane, pineapple, pasture, truck crops, orchards, wildlife habitat, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 5; woodland group 5)

Lihue silty clay, 8 to 15 percent slopes (LhC).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, pasture, truck crops, orchards, wildlife habitat, and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Lihue silty clay, 15 to 25 percent slopes (LhD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for sugarcane, pineapple, pasture, wildlife habitat, and woodland. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Lihue silty clay, 25 to 40 percent slopes, eroded (LhE2).—This soil is similar to Lihue silty clay, 0 to 8 percent slopes, except that the surface layer is thin. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture, woodland, and wildlife habitat. Small areas are used for pineapple and sugarcane. (Capability classification VIe, nonirrigated; pasture group 5; woodland group 5)

Lihue gravelly silty clay, 0 to 8 percent slopes (LIB).—This soil is similar to Lihue silty clay, 0 to 8 percent slopes, except that it contains ironstone-gibbsite pebbles and has brighter colors in the B horizon. Included in mapping in the Eleele area and north of the town of Hanamaulu were small areas of soils that have a dark yellowish-brown, friable subsoil.

This soil is used for sugarcane, pasture, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 5; woodland group 5)

Lihue gravelly silty clay, 8 to 15 percent slopes (LIC).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were areas where the slope is as much as 25 percent.

This soil is used for sugarcane, pasture, wildlife habitat, and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Lolekaa Series

This series consists of well-drained soils on fans and terraces on the windward side of the island of Oahu. These soils developed in old, gravelly colluvium and alluvium. They are gently sloping to very steep. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 70 to 90 inches and is well distributed throughout the year. The mean annual soil temperature is 71° F. Lolekaa soils are geographically associated with Alaeloa and Waikane soils.

These soils are used for pasture, homesites, orchards, and truck crops. The natural vegetation consists of guava, Christmas berry, californiagrass, hilograss, and ricegrass.

Lolekaa silty clay, 3 to 8 percent slopes (LoB).—This soil is on terraces and fans. Included in mapping were small areas of Kaneohe soils on uplands and Hanalei soils in narrow drainageways. Also included were small areas of nearly level Lolekaa soils.

In a representative profile the surface layer is dark-brown silty clay about 10 inches thick. The subsoil is 46 to more than 70 inches thick. The upper part is dark-brown silty clay that has subangular blocky structure, and the lower part is dark yellowish-brown loam that has subangular blocky structure. The substratum is strongly weathered gravel. The soil is strongly acid in the surface layer and strongly acid to extremely acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. Soft, weathered gravel is common in the subsoil but does not affect use and management of the soil for farming. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°24′57″ N. and long. 157°48′43″ W.

Ap—0 to 10 inches, dark-brown (10YR 3/3) silty clay, dark yellowish brown (10YR 3/4) when dry; strong, very fine and fine, subangular blocky structure; very hard, friable, sticky and plastic; abundant fine and medium roots; many, very fine and fine, interstitial tubular pores; many, very fine, hard, earthy lumps;

strongly acid; abrupt, smooth boundary. 8 to 10 inches thick.

B1—10 to 15 inches, dark-brown (10YR 3/3) silty clay, dark yellowish brown (10YR 3/4) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; plentiful fine roots; many very fine, fine, and medium, tubular pores; continuous, thin coatings on ped faces; evidence of much worm activity; many, hard, earthy lumps; common, soft, strongly weathered pebbles distinctly yellower than matrix, and smeary; very strongly acid; clear, smooth boundary. 4 to 6 inches thick.

B21t—15 to 22 inches, dark-brown (10YR 3/3) silty clay, dark brown (10YR 4/3) when dry; strong, very fine to medium, blocky and subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many very fine, fine, and medium, tubular pores; continuous, thick clay films on ped faces and in pores; dark-brown (7.5YR 4/4 moist), continuous, thick clay films in root channels; many, hard, earthy lumps, compact in place; very strongly acid; clear, smooth boundary. 4 to 10 inches thick.

B22t—22 to 33 inches, dark-brown (10YR 3/3) silty clay, dark brown (10YR 4/3) when dry; strong, medium, subangular blocky structure and strong, very fine and fine, angular blocky; hard, friable, sticky and plastic; few fine roots; common, very fine and fine, tubular pores; continuous, thick clay films on ped faces and dark-brown (7.5YR 4/4 moist), continuous, thick clay films in root channels; many, hard, earthy lumps; very compact in place; few highly weathered rock fragments; extremely acid; clear, wavy boundary. 9 to 18 inches thick.

B23t—33 to 42 inches, dark-brown (10YR 3/3) silty clay, dark brown (10YR 4/3) when dry; strong, very fine and fine, blocky and subangular blocky structure; hard, friable, sticky and plastic; few fine roots; many, fine and very fine, tubular pores; reddish-brown (5YR 4/4 moist), continuous, thin clay films on ped faces and dark-brown (7.5YR 4/4 moist), continuous, thick clay films in root channels; compact in place; approximately 5 percent highly weathered, soft rock fragments that are yellower than the matrix and smeary when rubbed; extremely acid; clear, wavy boundary. 5 to 10 inches thick.

B24t—42 to 55 inches, dark yellowish-brown (10YR 4/4) loam, yellowish brown (10YR 5/4) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few fine roots; many, very fine and fine, tubular pores; reddish-brown (5YR 4/4 moist), continuous, thin, clay films on ped faces; dark-brown (7.5YR 4/4 moist), continuous, thick clay films in root channels; compact in place; few rock fragments; extremely acid; clear, smooth boundary. 13 to 15 inches thick.

B25t—55 to 62 inches, dark yellowish-brown (10YR 3/4) loam, yellowish brown (10YR 5/4) when moist; moderate to weak, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; many, very fine and fine, tubular pores; reddish-brown (5YR 4/4 moist), continuous, thin clay films on ped faces and in pores; 20 to 25 percent weathered rock fragments that are less weathered than those in the B24t horizon; extremely acid.

The depth to strongly weathered gravel and stones ranges from 40 to more than 60 inches. The strongly weathered, soft gravel and stones range from none to many throughout the solum. The A horizon ranges from 2 to 3 in value and chroma when moist. The Bt horizon ranges from 3 to 4 in value when moist and from 3 to 6 in chroma when moist. The texture of the B24t and B25t horizons ranges from loam to silty clay.

This soil is used for pasture, homesites, truck crops, bananas, and papaya. (Capability classification IIe, nonirrigated; pasture group 8; woodland group 7)

Lolekaa silty clay, 8 to 15 percent slopes (LoC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult because of the slope. Included in mapping were small, eroded spots and small, gravelly areas.

This soil is used for pasture, homesites, papaya, and bananas. (Capability classification IIIe, nonirrigated; pasture group 8; woodland group 7)

Lolekaa silty clay, 15 to 25 percent slopes (LoD).—This soil is on side slopes of terraces and along drainageways. Runoff is medium, and the erosion hazard is moderate. Workability is slightly difficult because of the slope. Included in mapping were small, eroded spots and small, gravelly areas.

This soil is used for pasture. (Capability classification IVe, nonirrigated; pasture group 8; woodland group 7)

Lolekaa silty clay, 25 to 40 percent slopes (LoE).—This soil occurs along drainageways and on fans adjacent to the Koolau Range. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult because of the slope. Included in mapping were small, eroded spots and small, gravelly areas.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Lolekaa silty clay, 40 to 70 percent slopes (LoF).—This soil occurs along drainageways and on fans adjacent to the Koolau Range. Runoff is rapid, and the erosion hazard is severe. It is impractical to cultivate this soil.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Lualualei Series

This series consists of well-drained soils on the coastal plains, alluvial fans, and on talus slopes on the islands of Kauai, Oahu, Molokai, and Lanai. These soils developed in alluvium and colluvium. They are nearly level and gently sloping. Elevations range from 10 to 125 feet. In most places the annual rainfall amounts to 18 to 30 inches, but it is as low as 10 inches on Lanai and as high as 50 inches on Kauai. Most of the rainfall occurs during storms in the period from November to April. There is a prolonged dry period in summer. The mean annual soil temperature is 75° F. Lualualei soils are geographically associated with Honouliuli, Jaucas, and Kekaha soils.

These soils are used for sugarcane, truck crops, pasture, wildlife habitat, urban development, and military installations. The natural vegetation consists of kiawe, koa haole, bristly foxtail, uhaloa, and fingergrass.

Lualualei clay, 0 to 2 percent slopes (LuA).—This soil is on alluvial fans. Included in mapping were small, stony areas and small areas of Ewa soils.

In a representative profile the surface layer, about 10 inches thick, is very dark grayish-brown, very sticky and very plastic clay that has prismatic structure. The next layer, 37 to more than 42 inches thick, is very dark grayish-brown, very sticky and very plastic clay that has prismatic structure. In addition, it has gypsum crystals. The soil is underlain by coral, gravel, sand, or clay at depths below 40 inches. This soil cracks widely upon drying. It is neutral in the surface layer and medium acid to moderately alkaline in the underlying layers.

Permeability is slow. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. The shrink-swell potential is high.

Representative profile: Island of Oahu, lat. 21°25′10″ N. and long. 158°09′00″ W.

A11—0 to 1 inch, very dark grayish-brown (10YR 3/2) clay, very dark gray (10YR 3/1) when moist; strong, fine and very fine, granular structure; very hard, firm, very sticky and very plastic; abundant fine roots; many, fine, interstitial pores; few light-colored sand grains; vertical cracks up to 2½ inches wide; strong effervescence with hydrogen peroxide; neutral; abrupt, smooth boundary. ½ inch to 1½ inches thick.

A12—1 inch to 10 inches, very dark grayish-brown (10YR 3/2) clay, very dark gray (10YR 3/1) when moist; moderate, coarse, prismatic structure breaking to moderate, medium, subangular blocky; very hard, firm, very sticky and very plastic; abundant fine roots; many, fine, tubular pores; some organic litter in the cracks; strong effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 8 to 12 inches thick.

AC—10 to 22 inches, very dark grayish-brown (10YR 3/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate, coarse, prismatic structure breaking to moderate, medium, subangular blocky; very hard, firm, very sticky and very plastic; abundant fine roots; many, fine, tubular pores; common slickensides; few black specks; few coral sand grains; strong effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 10 to 12 inches thick.

C1—22 to 30 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; moderate, medium and coarse, subangular blocky structure; hard, firm, very sticky and very plastic; plentiful fine and medium roots, mainly matted between cleavage planes; few, fine and very fine, tubular pores; many weakly grooved slickensides; common black stains in pores and in dendritic pattern on ped faces; few light-colored sand grains; common shiny specks; strong effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 7 to 10 inches thick.

C2cs—30 to 49 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; strong, medium and coarse, subangular blocky structure; hard, firm, very sticky and very plastic; few fine roots matted between faces; few, fine, tubular pores; many deeply grooved slickensides; many, fine and medium, gypsum crystals; common black stains in pores and on peds; common shiny specks; few light-colored sand grains; strong effervescence with hydrogen peroxide; medium acid; abrupt, smooth boundary. 17 to 20 inches thick.

C3cs—49 to 60 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; strong, coarse, subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots matted between peds; few, fine, tubular pores; many deeply grooved slickensides; common, medium and coarse, gypsum crystals; few shiny specks; strong effervescence with hydrogen peroxide; medium acid.

The A11 horizon is granular when dry but massive when wet. Because of the type of clay, there is considerable swelling and shrinking of the soil as a result of alternate wetting and drying. When the soil dries, it cracks and forms huge blocks 1 foot or more in diameter. When it is wet there is no evidence of the blocks. The A and C horizons range from 7.5YR to 10YR in hue and from 2 to 4 in value. Chroma is either 1 or 2. Gypsum crystals ⅛ inch to 3 inches in diameter are common in the profile, generally below a depth of 30 inches.

This soil is used for sugarcane, truck crops, pasture, wildlife habitat, urban development, and military installations. The very sticky and very plastic nature of the clay makes cultivation difficult and practical only within a narrow range of moisture content. Because of the high shrink-swell potential, considerable care is necessary when using this soil as a site for buildings or highways. (Capability classification IIIs if irrigated, VIs if nonirrigated; sugarcane group 4; pasture group 2; woodland group 4)

Lualualei clay, 2 to 6 percent slopes (LuB).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small, stony areas and small areas where the slope is as much as 12 percent.

This soil is used for sugarcane, truck crops, pasture, urban development, and military installations. (Capability classification IIIe if irrigated, VIs if nonirrigated; sugarcane group 4; pasture group 2; woodland group 4)

Lualualei stony clay, 0 to 2 percent slopes (LvA).—This soil occurs on Oahu on fans adjacent to drainageways. It is similar to Lualualei clay, 0 to 2 percent slopes, except that there are enough stones to hinder machine cultivation.

This soil is used for sugarcane, truck crops, pasture, and military installations. (Capability classification IIIs if irrigated, VIs if nonirrigated; sugarcane group 4; pasture group 2; woodland group 4)

Lualualei stony clay, 2 to 6 percent slopes (LvB).—This soil occurs on Oahu adjacent to drainageways. It is similar to Lualualei clay, 0 to 2 percent slopes, except that there are enough stones to hinder machine cultivation. Runoff is slow, and the erosion hazard is slight. Included in mapping were small areas where the slope is 6 to 12 percent.

This soil is used for urban development, military installations, pasture, truck crops, and sugarcane. (Capability classification IIIe if irrigated, VIs if nonirrigated; sugarcane group 4; pasture group 2; woodland group 4)

Lualualei extremely stony clay, 3 to 35 percent slopes (LPE).—This soil occurs on talus slopes on Oahu and Kauai. The slope range is 3 to 35 percent, but in most places the soil is moderately sloping to steep. This soil is similar to Lualualei clay, 0 to 2 percent slopes, except that there are many stones on the surface and in the profile. It is impractical to cultivate this soil unless the stones are removed. Runoff is medium to rapid, and the erosion hazard is moderate to severe.

This soil is used for pasture. (Capability classification VIIs, nonirrigated; pasture group 2; woodland group 4)

Mahana Series

This series consists of well-drained soils on uplands on the islands of Kauai and Oahu. These soils developed in volcanic ash. They are gently sloping to very steep. Elevations range from 1,000 to 3,000 feet. The annual rainfall amounts to 30 to 45 inches. The mean annual soil temperature is 67° F. Mahana soils are geographically associated with Oli and Puu Opae soils on Kauai and with Kolekole soils on Oahu.

These soils are used for pasture, woodland, wildlife habitat, irrigated sugarcane, and water supply. The natural vegetation consists of puakeawe, aalii, ricegrass, molassesgrass, silver oak, yellow foxtail, lantana, joee, Japanese tea, passion flower, and associated plants.

Mahana silt loam, 6 to 12 percent slopes (MaC).—This soil occurs on ridgetops and moderately sloping uplands.

Included in mapping were some areas where the slope is less than 6 percent.

In a representative profile the surface layer, about 7 inches thick, is dusky-red to dark reddish-brown silt loam that has subangular blocky structure. The subsoil, 41 inches thick, is dark-red to dusky-red silt loam and silty clay loam. The substratum is compact silty clay loam.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°01′30″ N. and long. 159°41′11″ W.

A1—0 to 7 inches, dusky-red (10R 3/4) silt loam, dark reddish brown (2.5YR 3/4) when dry; strong, fine and very fine, subangular blocky structure; very hard, friable, sticky and plastic; abundant roots; moderate effervescence with hydrogen peroxide; medium acid; clear, wavy boundary. 6 to 10 inches thick.

B21—7 to 11 inches, dark-red (2.5YR 3/6) silt loam, reddish brown (2.5YR 4/4) when dry; weak, coarse, prismatic structure; slightly hard, very friable, nonsticky and nonplastic; abundant roots; many fine pores; slightly acid; gradual, smooth boundary. 4 to 7 inches thick.

B22—11 to 20 inches, dark-red (2.5YR 3/6) silt loam, reddish brown (2.5YR 4/4) when dry; weak, coarse, prismatic structure; soft, very friable, slightly sticky and slightly plastic, and slightly smeary; abundant roots; many fine pores; medium acid; gradual, smooth boundary. 11 to 16 inches thick.

B23—20 to 35 inches, dark-red (2.5YR 3/6) silt loam, reddish brown (2.5YR 4/4) when dry; weak, coarse, prismatic structure; soft, very friable, slightly sticky and slightly plastic, and smeary; few roots; many fine pores; medium acid; gradual, smooth boundary. 11 to 16 inches thick.

IIB3—35 to 48 inches, dark-red (2.5YR 3/6) silty clay loam, reddish brown (2.5YR 5/4) when dry; weak, fine and medium, subangular blocky structure; slightly hard, friable, sticky and plastic, and slightly smeary; few roots; many fine pores; contains hard, earthy lumps; slightly acid; clear, smooth boundary. 12 to 15 inches thick.

IIC—48 to 61 inches, dark reddish-brown (5YR 3/3) silty clay loam; some coatings of dark red (10R 3/8), reddish brown (2.5YR 4/4) when dry; moderate, fine and medium, angular and subangular blocky structure; compact in place; hard, firm, sticky and plastic; few roots; many fine and very fine pores; continuous stress cutans; dark-red coatings that look like clay films; weak, patchy slickensides; medium acid.

The A horizon ranges from 10R to 2.5YR in hue, from 3 to 4 in chroma, and from 2 to 3 in value. The B horizon ranges from 7.5R to 2.5YR in hue and from 4 to 8 in chroma. The texture of the B horizon ranges from very fine sandy loam to silty clay loam.

This soil is used for pasture, woodland, wildlife habitat, pineapple, and sugarcane. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 5)

Mahana silt loam, 12 to 20 percent slopes (MaD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for pasture, woodland, wildlife habitat, and sugarcane. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 5)

Mahana silt loam, 12 to 20 percent slopes, severely eroded (MaD3).—This soil has a profile like that of Mahana silt loam, 6 to 12 percent slopes, except that most of the surface layer has been removed by erosion. Runoff is rapid, and the erosion hazard is severe. Included in mapping were some areas where all of the surface layer and part of the subsoil have been removed by erosion. Also included were small areas where the slope is less than 12 percent.

This soil is used for pasture, wildlife habitat, and woodland. (Capability classification IVe if irrigated, VIe if nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 5)

Mahana silt loam, 20 to 35 percent slopes (MaE).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Mahana silt loam, 20 to 35 percent slopes, severely eroded (MaE3).—This soil has a profile like that of Mahana silt loam, 6 to 12 percent slopes, except that the surface layer and part of the subsoil have been removed by erosion. There are a few gullies. Runoff is very rapid, and the erosion hazard is very severe.

This soil is used for pasture and woodland. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Mahana silty clay loam, 6 to 12 percent slopes, eroded (McC2).—Erosion has removed most of the surface layer of this soil, and the surface texture is now silty clay loam. Otherwise, the profile is like that of Mahana silt loam, 6 to 12 percent slopes. Included in mapping were small areas where the slope is less than 6 percent.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 5)

Mahana silty clay loam, 12 to 20 percent slopes, eroded (McD2).—This soil has a profile like that of Mahana silt loam, 6 to 12 percent slopes, except for the texture of the surface layer. Most of the surface layer has been removed by erosion. Runoff is rapid, and the erosion hazard is severe.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 5)

Mahana silty clay loam, 20 to 35 percent slopes, eroded (McE2).—This soil has a profile like that of Mahana silt loam, 6 to 12 percent slopes, except for the texture of the surface layer. Most of the surface layer has been removed by erosion. Runoff is very rapid, and the erosion hazard is very severe.

Included in mapping were areas where all of the surface layer and part of the subsoil have been removed by erosion. Also included were small, stony areas and reddish-colored upland soils that are underlain by a panlike layer at a depth of 15 to 50 inches.

This soil is used for pasture, pineapple, and irrigated sugarcane. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Mahana-Badland complex (MBL).—This complex consists of Mahana soils and Badland. Mahana soils make up 40 to 70 percent of the acreage, and Badland 30 to 60 percent. The Mahana soils are similar to Mahana silt loam, 6 to 12 percent slopes, except that the texture is silty clay loam and the soils are moderately steep to very steep. Runoff is medium to very rapid, and the erosion hazard is moderate to very severe.

This complex is used for pasture. (Mahana part is in capability classification IVe, nonirrigated; pasture group 6; woodland group 5. Badland part is in capability classification VIIIe, nonirrigated)

Makaalae Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are moderately sloping to steep. Elevations range from nearly sea level to 1,500 feet. The annual rainfall amounts to 60 to 90 inches. It is well distributed throughout the year. The mean annual soil temperature is 73° F. Makaalae soils are geographically associated with Hana, Honomanu, and Kaupo soils.

These soils are used for pasture, wildlife habitat, and water supply. The natural vegetation consists of guava, kaimiclover, kikuyugrass, rattailgrass, and yellow foxtail.

Makaalae silty clay, 7 to 25 percent slopes (MID).—This soil is on rough, low mountain slopes. Included in mapping were small areas of Hana and Honomanu soils. In a few places scattered stones are on the surface. Also included were a few cinder cones.

In a representative profile the surface layer is very dark brown silty clay about 10 inches thick. Below this is very dark grayish-brown silty clay, about 30 inches thick, that has subangular blocky structure. The substratum is fragmental Aa lava. The soil is strongly acid in the surface layer and medium to slightly acid in the subsoil.

Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. In places the roots penetrate to a depth of 4 feet.

Representative profile: Island of Maui, lat. 20°41′18″ N. and long. 156°03′06″ W.

Ap—0 to 10 inches, very dark brown (10YR 2/2) silty clay, very dark grayish brown (10YR 3/2) when dry; strong, very fine and fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant fine and very fine roots; common fine pores; common worm casts; 5 to 15 percent stones; few weathered pebbles; strongly acid; clear, wavy boundary. 8 to 12 inches thick.

C1—10 to 24 inches, very dark grayish-brown (10YR 3/2) silty clay, dark brown (10YR 3/3) when dry; moderate, very fine and fine, subangular blocky structure; hard, firm, very sticky and very plastic, and weakly smeary; plentiful fine roots; many fine pores; few worm casts; 30 to 50 percent stones; 5 to 10 percent gravel; few, red, weathered cinders; few pale-yellow mineral grains; medium acid; gradual, smooth boundary. 10 to 14 inches thick.

C2—24 to 40 inches, very dark grayish-brown (10YR 3/2) silty clay, dark brown (10YR 3/3) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, very sticky and plastic, and weakly smeary; plentiful fine and medium roots; many fine pores; many, red, weathered cinders; 50 to 70 percent hard gravel, cobblestones, and stones; slightly acid.

IIC3—40 inches, fragmental Aa lava.

The depth to Aa lava ranges from 24 to 48 inches. The C horizon ranges from 7.5YR to 10YR in hue and from 2 to 4 in chroma when moist. The content of gravel, cobblestones, and stones in the C2 horizon ranges from 50 to 70 percent. Smeariness in the C horizon increases with elevation.

This soil is used for pasture, wildlife habitat, and water supply. (Capability classification IVe, nonirrigated; pasture group 8; woodland group 7)

Makaalae extremely stony silty clay, 7 to 25 percent slopes (MJD).—This soil is similar to Makaalae silty clay, 7 to 25 percent slopes, except that stones cover 3 to 15 percent of the surface. Included in mapping were small areas that are less stony. In places outcrops of Aa lava along drainageways are common. Also included were a few cinder cones.

This soil is used for pasture, wildlife habitat, and water supply. (Capability classification VIIs, nonirrigated; pasture group 8; woodland group 7)

Makaalae clay, 7 to 40 percent slopes (MWE).—The slope range of this soil is 7 to 40 percent, but in most places the slope is 20 to 30 percent. The surface layer of this soil developed in a mixture of volcanic ash, and the subsoil in material derived from basic igneous rock. The surface layer is very sticky and very plastic. Included in mapping were small, stony areas.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Makalapa Series

This series consists of well-drained soils on uplands on the island of Oahu, near Salt Lake Crater, Diamond Head, and the Mokapu Peninsula. These soils formed in volcanic tuff. They are gently sloping to moderately steep. Elevations range from 20 to 200 feet. The annual rainfall amounts to 20 to 35 inches. A long dry period occurs in summer. The mean annual soil temperature is 74° F. Makalapa soils are geographically associated with Kokokahi and Mamala soils.

These soils are used for urban development and pasture. The natural vegetation consists of kiawe, koa haole, lantana, bermudagrass, and fingergrass.

Makalapa clay, 2 to 6 percent slopes (MdB).—This soil is gently sloping. Included in mapping were small areas of Mamala soils and small areas of saline soils within Salt Lake Crater and Diamond Head.

In a representative profile the surface layer is very dark grayish-brown clay about 8 inches thick. The next layer, 18 to 36 inches thick, is very dark grayish-brown clay to silty clay loam that has subangular blocky structure. It is underlain by light-gray to dark grayish-brown, weathered volcanic tuff. The clays are very sticky and very plastic, and they crack widely upon drying. The soil is mildly alkaline in the surface layer and mildly alkaline to moderately alkaline in the next layer.

Permeability is slow. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot of soil. Roots penetrate to the volcanic tuff. Workability is difficult because the clay is very sticky and very plastic. The shrink-swell potential is high.

Representative profile: Island of Oahu, lat. 21°21′52″ N. and long. 157°55′01″ W.

Ap1—0 to 2 inches, very dark grayish-brown (10YR 3/2) clay, very dark gray (10YR 3/1) when dry; strong, very fine and fine, granular structure; very hard, firm, very sticky and very plastic; abundant fine and very fine roots; few fine fragments of coral; strong effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; mildly alkaline; abrupt, smooth boundary. 1 to 3 inches thick.

Ap2—2 to 8 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; moderate, fine and very fine, granular structure and moderate, coarse, subangular blocky; hard, firm, very sticky and very plastic; abundant fine roots; common, fine and very fine, interstitial and tubular pores; few fine fragments of coral; strong effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; mildly alkaline; abrupt, smooth boundary. 6 to 10 inches thick.

AC—8 to 20 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; lozengelike peds (4 by 18 inches) that break to weak, medium, subangular blocky structure; very hard, firm, very sticky and very plastic; abundant fine and medium roots; few to common, fine and very fine, tubular and interstitial pores; common to many slickensides; common fine sand grains; few angular rock fragments; slight effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; mildly alkaline; gradual, smooth boundary. 8 to 12 inches thick.

C1—20 to 30 inches, very dark grayish-brown (10YR 3/2), moist and dry, clay; lozengelike peds (1 to 2 inches thick and 2 to 8 inches long); very hard, very firm, very sticky and very plastic; plentiful fine roots mainly matted on ped faces, few within peds; few, very fine, tubular pores; many distinct slickensides; few tuff fragments; slight effervescence with hydrogen peroxide; strong effervescence with hydrochloric acid; moderately alkaline; clear, wavy boundary. 8 to 12 inches thick.

C2—30 to 38 inches, very dark grayish-brown (10YR 3/2), moist and dry, silty clay loam; moderate, fine and medium, blocky and subangular blocky structure; slightly hard, firm, very sticky and very plastic; few fine roots; few, fine, tubular pores; many, very pale brown (10YR 7/3 dry), pebble-size tuff fragments; common distinct slickensides; slight effervescence with hydrogen peroxide; strong effervescence with hydrochloric acid; moderately alkaline; clear, smooth boundary. 4 to 12 inches thick.

C3—38 inches, highly decomposed, light-gray (10YR 7/2) to dark grayish-brown (10YR 4/2) volcanic tuff; strong effervescence with hydrochloric acid.

The thickness of the soil over volcanic tuff ranges from 27 to 49 inches. The amount of pebble-size fragments of tuff on the surface and in the profile ranges from 5 to 20 percent. When the soil is dry, there are cracks 2 inches or more wide and 20 to 30 inches deep. The profile ranges from 10YR to 7.5YR in hue and from 2 to 4 in chroma when moist. The texture of the upper part of the C horizon ranges from clay to silty clay loam.

This soil is used for urban development and pasture. (Capability classification IIIs, nonirrigated; sugarcane group 4; pasture group 3)

Makalapa clay, 6 to 12 percent slopes (MdC).—This soil is similar to Makalapa clay, 2 to 6 percent slopes, except that it occurs on fans. Runoff is slow to medium, and the erosion hazard is slight to moderate.

This soil is used for urban development and pasture. (Capability classification IVe, nonirrigated; sugarcane group 4; pasture group 3)

Makalapa clay, 12 to 20 percent slopes (MdD).—On this soil, runoff is medium and the erosion hazard is moderate. This soil is used for urban development and pasture. (Capability classification IVe, nonirrigated; sugarcane group 4; pasture group 3)

Makapili Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are nearly level to steep. Elevations range from 100 to 350 feet. The annual rainfall amounts to 70 to 80 inches. The mean annual soil temperature is 72° F. Makapili soils are geographically associated with Pooku soils.

These soils are used for pasture, irrigated sugarcane, and woodland. The natural vegetation consists of pangolagrass, kikuyugrass, kaimiclover, sensitiveplant, guava, and Java plum.

Makapili silty clay, 0 to 8 percent slopes (MeB).—This soil is on broad upland ridges.

In a representative profile the surface layer is brown silty clay about 12 inches thick. The subsoil, about 48 inches thick, is reddish-brown, dark reddish-brown, and yellowish-red clay loam and silty clay that has subangular blocky structure. The substratum is silty clay. The surface layer is strongly acid. The subsoil is very strongly acid.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°13′14″ N. and long. 159°28′46.9″ W.

Ap—0 to 12 inches, brown (10YR 4/3) silty clay, brown (10YR 4/3) when rubbed, brown (10YR 5/3) when dry; strong, fine, subangular blocky structure; very hard, friable, sticky and plastic; abundant micro, very fine, fine, and medium roots; many micro and very fine, tubular pores; many, very fine, interstitial pores; few pebbles (hard, weathered rock); strongly acid; abrupt, smooth boundary. 11 to 13 inches thick.

B1—12 to 14 inches, reddish-brown (5YR 4/3) clay loam, reddish brown (5YR 4/4) when rubbed, dark reddish brown (5YR 3/4) when dry; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and slightly plastic; abundant micro, very fine, fine, and medium roots; many, micro, very fine, tubular pores; common, fine and medium, tubular pores; thin, patchy pressure cutans; many higher chroma, sugarlike granules in pores; many worm channels and worm casts; strongly acid; clear, smooth boundary. 0 to 3 inches thick.

B21—14 to 22 inches, dark reddish-brown (5YR 3/3) clay loam, reddish brown (5YR 4/4) when rubbed, dark brown (7.5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; plentiful micro, very fine, and fine roots and few medium roots; many micro and very fine, tubular pores; many, very fine, interstitial pores; nearly continuous pressure cutans on peds; many higher chroma, sugarlike granules in pores; very strongly acid; clear, wavy boundary. 7 to 9 inches thick.

B22—22 to 28 inches, reddish-brown (5YR 4/4) clay loam, reddish brown (5YR 4/4) when rubbed; dark reddish brown (5YR 3/3) with sugary coatings of reddish brown (5YR 5/4) when dry; weak, fine and very fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; plentiful micro and very fine roots and few fine and medium roots; many micro and very fine tubular pores and common, fine, tubular pores; many, very fine, interstitial pores; continuous pressure cutans on peds; many higher chroma, sugarlike granules in pores; many, fine, black specks; very strongly acid; clear, wavy boundary. 4 to 8 inches thick.

B23—28 to 44 inches, dark reddish-brown (5YR 3/4) clay loam, yellowish red (5YR 4/6) when rubbed; dark reddish brown (5YR 3/4) with sugary coatings of reddish brown (5YR 5/4) when dry; moderate, fine and very fine, subangular blocky structure; very hard, firm, slightly sticky and slightly plastic; few micro and very fine roots; many micro and very fine, tubular pores and few, fine, tubular pores; many, very fine, interstitial pores; continuous pressure cutans on peds; many higher chroma, sugarlike granules in pores; about 40 percent of volume is weathered rock impregnated with white and yellowish-white secondary minerals; about 2 percent of the weathered rock is more than 1 inch in diameter; very strongly acid; gradual, wavy boundary. 14 to 18 inches thick.

B24—44 to 60 inches, dark reddish-brown (2.5YR 3/4) silty clay, reddish brown (5YR 4/4) when rubbed, reddish brown (5YR 4/4) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; few micro and very fine roots; many micro and very fine, tubular pores and common, fine, tubular pores; many, very fine, interstitial pores; continuous pressure cutans on peds; many higher chroma, sugarlike granules in pores; few, fine, black specks; weathered rock is impregnated with white and yellowish-white secondary minerals and makes up more than 50 percent of the volume; about 5 percent of the weathered rock is more than 1 inch in diameter; very strongly acid.

The A horizon ranges from 2.5Y to 10YR in hue, from 3 to 4 in value, and from 2 to 3 in chroma. The upper part of the B horizon ranges from 5YR to 7.5YR in hue and from 3 to 4 in value and chroma. It ranges from weak subangular blocky structure to massive. The B22 horizon ranges from clay loam to silty clay loam in texture.

This soil is used for pasture and sugarcane. (Capability classification IIe, irrigated or nonirrigated; pasture group 10; woodland group 9)

Makapili silty clay, 8 to 15 percent slopes (MeC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for pasture and sugarcane. (Capability classification IIIe, irrigated or nonirrigated; pasture group 10; woodland group 9)

Makapili silty clay, 15 to 25 percent slopes (MeD).—On this soil, runoff is medium and the erosion hazard is moderate to severe.

This soil is used for pasture. (Capability classification IVe, irrigated or nonirrigated; pasture group 10; woodland group 9)

Makapili silty clay, 25 to 40 percent slopes (MeE).—This soil has a profile like that of Makapili silty clay, 0 to 8 percent slopes, except that the surface layer is thinner. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture and woodland. (Capability classification VIe, nonirrigated; pasture group 10; woodland group 9)

Makawao Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash and in material weathered from basic igneous rock. They are gently sloping to moderately sloping. Elevations range from 1,200 to 2,500 feet. The annual rainfall amounts to 60 to 90 inches. The mean annual soil temperature is 69° F. Makawao soils are geographically associated with Haiku, Kailua, and Olinda soils.

These soils are used for pasture. Small acreages are used for pineapple, truck crops, and homesites. The natural vegetation consists of bermudagrass, eucalyptus, guava, hilograss, kaimiclover, and kikuyugrass.

Makawao silty clay, 3 to 7 percent slopes (MfB).—This soil is on smooth side slopes and intermediate slopes in the uplands. Included in mapping were small areas of Haiku and Kailua soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 9 inches thick. The subsoil, about 30 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is strongly acid to medium acid in the surface layer and slightly acid in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°51′02″ N. and long. 156°18′36″ W.

Ap1—0 to 4 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/4) when dry; strong, very fine, subangular blocky structure; hard, firm, sticky and plastic; abundant roots; many very fine pores; slight effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 3 to 6 inches thick.

Ap2—4 to 9 inches, dark reddish-brown (5YR 3/3) silty clay, yellowish red (5YR 4/6) when dry; strong, very fine, subangular blocky structure; hard, firm, sticky and plastic, and weakly smeary; abundant roots; common fine pores; slight effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 3 to 7 inches thick.

B21t—9 to 12 inches, dark reddish-brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) when dry; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic, and weakly smeary; few roots; many fine and very fine pores; thin, patchy clay films on peds; few weathered pebbles; slightly acid; clear, wavy boundary. 2 to 4 inches thick.

B22t—12 to 19 inches, dark reddish-brown (2.5YR 3/4) silty clay, reddish brown (2.5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic, and weakly smeary; few roots; many fine and very fine pores; thin, continuous clay films on peds; 10 to 15 percent weathered gravel; slightly acid; gradual, wavy boundary. 5 to 9 inches thick.

B3—19 to 37 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 5/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic, and moderately smeary; few roots; many fine and medium pores; continuous, gelatinlike coatings on peds; 10 to 15 percent weathered gravel; slightly acid; gradual, wavy boundary. 15 to 20 inches thick.

C—37 to 60 inches, gray, highly weathered rock with 15 to 20 percent dark-brown (10YR 3/3) silty clay, brown (10YR 5/3) when dry; weak, fine and medium, subangular blocky structure; hard, firm, sticky and plastic, and moderately smeary; very few roots; common fine and medium pores; slightly acid.

Smeariness ranges from weak at the lower elevations to moderate at the higher elevations. The A horizon ranges from 4 to 5 in value when dry and, in chroma, from 2 to 3 when moist and 4 to 6 when dry. The Bt horizon ranges from 5YR to 2.5YR in hue, from 3 to 4 in value when moist and 4 to 5 when dry, and from 3 to 4 in chroma when moist and 3 to 5 when dry. The texture is silty clay or clay.

This soil is used for pasture. Small acreages are used for pineapple, truck crops, and homesites. (Capability classification IIe, nonirrigated; pineapple group 5; pasture group 8; woodland group 7)

Makawao silty clay, 7 to 15 percent slopes (MfC).—This soil is similar to Makawao silty clay, 3 to 7 percent slopes, except that it is moderately sloping to strongly sloping. Runoff is slow to medium, and the erosion hazard is slight to moderate. Included in mapping were small, moderately steep areas and a few very steep cinder cones. In places there are small, eroded spots where soft, weathered rock fragments are in the surface layer.

This soil is used for pasture. Small acreages are used for homesites. (Capability classification IIIe, nonirrigated; pineapple group 6; pasture group 8; woodland group 7)

Makaweli Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are gently sloping to steep. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 20 to 35 inches. Three-fourths of it occurs from October through March. The mean annual soil temperature is 74° F. Makaweli soils are geographically associated with Niu soils.

These soils are used for irrigated sugarcane, pasture, and homesites. The natural vegetation consists of kiawe, lantana, fingergrass, klu, koa haole, and piligrass.

Makaweli silty clay loam, 0 to 6 percent slopes (MgB).—This soil is on the tops of broad interfluves in the uplands. Included in mapping were small areas that have a subsoil of silty clay and some areas that have strong structure in the subsoil.

In a representative profile the surface layer is dusky-red silty clay loam about 12 inches thick. The subsoil, 48 inches thick, is dusky-red, friable silt loam and silty clay loam that has prismatic and subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is slightly acid in the surface layer and slightly acid to neutral in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.6 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°53′45″ N. and long. 159°33′55″ W.

Ap1—0 to 7 inches, dusky-red (10R 3/2) silty clay loam, dark red (10R 3/6) when dry; cloddy breaking to weak, very fine to medium, granular structure; hard, friable, sticky and plastic; abundant very fine and fine roots; many very fine and fine pores; many very fine, black concretions; moderately magnetic; numerous fragments of charcoal from burning cane; violent effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 8 inches thick.

Ap2—7 to 12 inches, dusky-red (10R 3/3) silty clay loam, dusky-red (10R 3/2) material mixed by tillage, dusky red (10R 3/4) when dry; weak, medium and coarse, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant roots; common, very fine and fine, tubular pores; many black concretions; moderately magnetic; strong effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 4 to 6 inches thick.

B21—12 to 25 inches, dusky-red (10R 3/4) silt loam, red (10R 4/6) when dry; weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and plastic; plentiful roots; many, very fine and fine, medium pores; common black concretions; moderately magnetic; black manganese dioxide staining along root channels; strong effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 11 to 15 inches thick.

B22—25 to 36 inches, dusky-red (10R 3/4) silty clay loam, dark red (10R 3/6) when dry; weak, coarse, prismatic structure breaking to weak, fine to coarse, subangular blocky; pockets of moderate, very fine, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; plentiful roots; many very fine and fine pores and common medium pores; few black concretions; patchy, glazed surfaces on peds that look like pressure surfaces; root channels are lined with black manganese dioxide staining; moderately magnetic; slight effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 9 to 13 inches thick.

B23—36 to 60 inches, dusky-red (10R 3/3) silty clay loam, dark red (10R 3/6) when dry; weak, medium and fine, subangular blocky structure; pockets of moderate, medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; few fine and medium roots that tend to be confined between ped faces; many very fine and fine pores; few black manganese dioxide concretions; common, very fine, weathered mineral particles that tend to impart a gritty feel; few glazed coatings on ped surfaces that look like pressure faces; several large stones; slight effervescence with hydrogen peroxide; neutral.

In most places the A horizon is 10R in hue, but in some places it is 2.5YR. It ranges from 2 to 3 in chroma and from 2 to 3 in value. The B horizon ranges from 3 to 6 in chroma. The grade of structure of the B horizon ranges from weak to moderate.

This soil is used for irrigated sugarcane and pasture. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2)

Makaweli silty clay loam, 6 to 12 percent slopes (MgC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small, severely eroded areas.

This soil is used for sugarcane, pasture, and homesites. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Makaweli silty clay loam, 12 to 20 percent slopes (MgD).—On this soil, runoff is rapid and the erosion hazard is severe. Included in mapping were small, severely eroded areas.

This soil is used for sugarcane and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 2)

Makaweli silty clay loam, 20 to 35 percent slopes, eroded (MgE2).—This soil has a profile like that of Makaweli silty clay loam, 0 to 6 percent slopes, except that the surface layer is thinner. Runoff is rapid, and the erosion hazard is severe. Included in mapping were areas of less sloping soils and areas in the vicinity of Nomilo fishpond where the soils are underlain by cinders.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 2)

Makaweli stony silty clay loam, 0 to 6 percent slopes (MhB).—This soil is similar to Makaweli silty clay loam, 0 to 6 percent slopes, except that it is stony. Some of the stones are more than 27 inches in diameter. The stones hinder cultivation.

This soil is used for sugarcane and pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Makaweli stony silty clay loam, 6 to 12 percent slopes (MhC).—This soil is similar to Makaweli silty clay loam, 0 to 6 percent slopes, except that it is moderately sloping and is stony. The stones hinder cultivation. Runoff is medium, and the erosion hazard is moderate.

This soil is used for sugarcane and pasture. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2)

Makaweli stony silty clay loam, 12 to 20 percent slopes (MhD).—This soil is similar to Makaweli silty clay loam, 0 to 6 percent slopes, except that it is moderately steep and stony. The stones hinder cultivation. Runoff is rapid, and the erosion hazard is severe.

This soil is used for sugarcane and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 2)

Makaweli stony silty clay loam, 20 to 35 percent slopes (MhE).—This soil is similar to Makaweli silty clay loam, 0 to 6 percent slopes, except that it is steep and stony and the surface layer is thinner. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 2)

Makena Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently to moderately sloping. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 10 to 20 inches. Most of it occurs in winter. The mean annual soil temperature is 75° F. Makena soils are geographically associated with Keawakapu and Oanapuka soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of bristly foxtail, feather fingergrass, ilima, and kiawe.

Makena loam, stony complex, 3 to 15 percent slopes (MXC).—This complex is on the lower leeward slopes of Haleakala, between Makena and Kamaole. It consists of Makena loam and Stony land. Stony land occurs on low ridges and makes up 30 to 60 percent of the complex. Makena loam occurs as gently sloping areas between the low ridges of Stony land.

Included in mapping were small areas of Keawakapu and Oanapuka soils. Also included were areas where outcrops of Aa lava cover as much as 15 percent of the surface.

In a representative profile the surface layer, about 4 inches thick, is very dark brown loam that has platy structure. The subsoil, about 19 inches thick, is very dark grayish-brown and dark yellowish-brown silt loam that has prismatic structure. The substratum is dark yellowish-brown cobbly silt loam. The soil is mildly alkaline in the surface layer and subsoil.

On the Makena part of the complex, permeability is moderately rapid, runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.8 inches per foot of soil. On the Stony land part, permeability is very rapid and there is no erosion hazard.

Representative profile of Makena loam: Island of Maui, lat. 20°30′32″ N. and long. 156°26′14″ W.

A1—0 to 4 inches, very dark brown (10YR 2/2) loam, brown (10YR 4/3) when dry; weak, thin, platy structure; soft, very friable, nonsticky and nonplastic; few fine roots; few fine and very fine pores; mildly alkaline; abrupt, smooth boundary. 2 to 6 inches thick.

B21—4 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, brown (10YR 4/3) when dry; weak, coarse, prismatic structure; soft, very friable, nonsticky and nonplastic; plentiful fine roots; few fine pores; mildly alkaline; gradual, wavy boundary. 6 to 11 inches thick.

B22—12 to 23 inches, dark yellowish-brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) when dry; weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; plentiful fine roots; common fine pores; mildly alkaline; gradual, wavy boundary. 8 to 13 inches thick.

C1—23 to 34 inches, dark yellowish-brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) when dry; massive; soft, very friable, nonsticky and nonplastic; plentiful fine and medium roots; many fine pores; few Aa lava cobblestones; mildly alkaline; gradual, wavy boundary. 8 to 13 inches thick.

C2ca—34 to 44 inches, dark yellowish-brown (10YR 3/4) silt loam, yellowish brown (10YR 5/4) when dry; massive; soft, very friable, nonsticky and nonplastic; plentiful fine and medium roots; few fine pores; has gritty feel because of small cinders; 10 to 20 percent cobblestone-size Aa lava; strong effervescence with hydrochloric acid; moderately alkaline; clear, wavy boundary. 9 to 12 inches thick.

IIC3—44 inches, fragmental Aa lava that contains a little soil material in cracks; the Aa lava has carbonate encrustations on the surface.

The depth to Aa lava is more than 40 inches. Surface stoniness varies from nonstony to extremely stony near lava flows and drainageways. The B horizon ranges from 3 to 4 in value when moist and 4 to 5 when dry and from 2 to 4 in chroma when moist and 3 to 4 when dry. The texture is loam or silt loam.

This complex is used for pasture and wildlife habitat. (Makena part is in capability classification VIs, nonirrigated; pasture group 1. Stony land part is in capability classification VIIs, nonirrigated)

Makiki Series

This series consists of well-drained soils on alluvial fans and terraces in the city of Honolulu on the island of Oahu. These soils formed in alluvium mixed with volcanic ash and cinders. They are nearly level. Elevations range from 20 to 200 feet. The annual rainfall amounts to 30 to 60 inches. Most of it falls between November and April. The mean annual soil temperature is 73° F. Makiki soils are geographically associated with Kaena and Tantalus soils.

These soils are used almost entirely for urban purposes.

Makiki clay loam, 0 to 2 percent slopes (MkA).—This soil is on smooth fans and terraces. Included in mapping were small, stony areas and small areas of Kaena soils.

In a representative profile the surface layer is dark-brown clay loam about 20 inches thick. The subsoil, about 10 inches thick, is dark-brown clay loam that has subangular blocky structure. It contains cinders and rock fragments. The subsoil is underlain by similar material, about 24 inches thick, that is massive. Below this are volcanic cinders. The soil is strongly acid to medium acid.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°18'28" N. and long. 157°50'20" W.

Ap1—0 to 10 inches, dark-brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/2) when dry; moderate, very fine and fine, granular structure; very hard, firm, very sticky and very plastic; abundant fine and medium roots; common, very fine and fine, interstitial pores; common, fine, highly weathered basalt fragments; slight effervescence with hydrogen peroxide; strongly acid; gradual, smooth boundary. 8 to 12 inches thick.

Ap2—10 to 20 inches, dark-brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/4) when dry; moderate, coarse, subangular blocky structure; hard, firm, very sticky and very plastic; abundant fine and medium roots; common, very fine and fine, tubular pores and few, coarse, tubular pores; common, fine, highly weathered basalt and cinder fragments; slight effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 8 to 12 inches thick.

B2—20 to 30 inches, dark-brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/3) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, very sticky and very plastic; plentiful fine roots; common, very fine and fine, tubular pores and few, coarse, tubular pores; few, fine, distinct, reddish-brown stains that appear to be decomposed cinders; common, fine, gritty fragments of highly weathered basalt and cinders; medium acid; abrupt, smooth boundary. 8 to 15 inches thick.

IIC—30 to 54 inches, dark-brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/3) when dry; massive and stratified; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; common fine, medium, and coarse tubular pores; horizon consists of bands of unweathered, fine, pebble-size black cinders mixed with highly weathered, rounded pebbles and soil material similar in color, consistence, and texture to the B2 horizon. At a depth of about 60 inches, the soil material is underlain by gravelly, fine-textured alluvium mixed with cinders; medium acid.

The depth to unweathered cinders or stony or gravelly alluvium is variable within short distances and ranges from 30 to more than 60 inches. Layers of sandy loam or silt loam are common in the profile. The solum ranges from 10YR to 5YR in hue. When moist, the A horizon ranges from 2 to 3 in value and from 1 to 3 in chroma.

This soil is almost entirely in urban use. The headquarters of the Hawaii Sugar Planters Association Experiment Station is located on this soil. (Capability classification IIIc, nonirrigated)

Makiki stony clay loam, 0 to 3 percent slopes (MlA).—This soil is similar to Makiki clay loam, 0 to 2 percent slopes, except that there are enough stones to hinder cultivation. The stones are angular and make up about 15 percent of the soil by volume. The depth to basalt or cinders varies from 20 to 60 inches. Basalt outcrops are common. The soil is neutral to slightly acid.

This soil is almost entirely in urban use. The University of Hawaii uses a small area for truck crop experiments. (Capability classification IIIs, nonirrigated)

Mala Series

This series consists of well-drained soils on bottoms of drainageways and on alluvial fans on the coastal plains. These soils occur on the islands of Molokai and Lanai. They formed in recent alluvium. Elevations range from nearly sea level to 100 feet. The annual rainfall amounts to 10 to 25 inches. Most of it occurs between November and April. The summers are hot and dry; there is very little rain. The mean annual soil temperature is 75° F. Mala soils are geographically associated with Jaucas, Kealia, and Pulehu soils.

These soils are used for pasture, alfalfa, truck crops, orchards, and wildlife habitat. The natural vegetation consists of kiawe, bristly foxtail, feather fingergrass, ilima, and Australian saltbush.

Mala silty clay, 0 to 3 percent slopes (MmA).—This soil is on fans along the coastal plains.

In a representative profile the surface layer, about 7 inches thick, is dark reddish-brown silty clay that has platy structure. It is underlain by stratified layers of dark reddish-brown and very dark gray alluvium that is mostly silty clay. These layers are 47 to more than 59 inches thick. The soil is slightly acid to neutral in the surface layer and in the upper part of the subsoil and moderately alkaline in the lower part of the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

In low areas this soil is subject to flooding for short periods during heavy rains. Many shallow wells have been dug in this soil. The water is brackish, and care is required if it is used for irrigation purposes. The soil is easily compacted, and subsoiling may be necessary.

Representative profile: Island of Molokai, lat. 21°05'44" N. and long. 157°10'50" W.

A1—0 to 7 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; moderate, thin, platy structure breaking to weak, very fine, granular; lower 2 inches is massive; hard, friable, sticky and plastic; many roots; strong effervescence with hydrogen peroxide; slightly acid; abrupt, smooth boundary. 4 to 8 inches thick.

C1—7 to 13 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish gray (5YR 4/2) when dry; cloddy breaking to very weak, fine, granular structure; hard, friable, sticky and plastic; common roots; few very fine pores; many coral sand grains; few pebbles; strong effervescence with hydrogen peroxide; slightly acid; abrupt, smooth boundary. 5 to 7 inches thick.

C2—13 to 35 inches, dark reddish-brown (2.5YR 2/4 and 3/3), moist and dry, highly stratified layers of silty clay that has platy and granular structure; slightly hard, friable, sticky and plastic; common roots; few very fine pores; many coral sand grains; moderate effervescence with hydrogen peroxide; neutral; abrupt, smooth boundary. 18 to 24 inches thick.

C3—35 to 40 inches, very dark gray (5YR 3/1) silty clay, dark gray (10YR 4/1) when dry; massive; hard, very friable, very sticky and very plastic; many roots; few very fine pores; few coral sand grains; slight effervescence with hydrogen peroxide; mildly alkaline; abrupt, smooth boundary. 4 to 8 inches thick.

IIC4—40 to 60 inches, coral sand; the upper 4 inches is dark gray (10YR 4/1 moist), and the lower part light gray (10YR 7/1 moist); mildly alkaline.

The soil is underlain by coral sand or weathered rock at a depth of more than 40 inches. The profile is highly stratified. The thickness, texture, and consistence of the layers in the C horizon vary considerably. The stratified layers are silty clay, silty clay loam, and silt loam. There are few to common pebbles and stones in the profile. A few areas have surface cracking, but this is not common. The C1, C2, and C3 horizons range from 5YR to 2.5YR in hue. These soils are slightly saline where they grade to the Kealia soils.

This soil is used for pasture, alfalfa, truck crops, orchards, and wildlife habitat. (Capability classification I if irrigated, VIc if nonirrigated; pasture group 1)

Mala silty clay, 3 to 7 percent slopes (MmB).—On this soil, runoff is slow and the erosion hazard is slight to moderate. In many places the soil is slightly to moderately eroded. There are a few gullies formed by intermittent streams. In some places there are a few stones on the surface.

This soil is used for pasture. (Capability classification IIe if irrigated, VIc if nonirrigated; pasture group 1)

Malama Series

This series consists of excessively drained, extremely stony, very shallow, organic soils on uplands on the island of Maui. These soils developed in organic material. They are gently sloping to moderately steep. Elevations range from nearly sea level to 1,000 feet. The annual rainfall amounts to 60 to 90 inches. It is well distributed throughout the year. The mean annual soil temperature is 72° F. Malama soils are geographically associated with Hana and Opihikao soils.

These soils are used mostly for water supply. Small acreages are used for orchard crops and pasture. The natural vegetation consists of californiagrass, guava, hala, kukui, ohia, and treefern.

Malama extremely stony muck, 3 to 25 percent slopes (MYD).—This soil is on rough Aa lava flows. Included in mapping were small areas of outcrops of Aa lava near the edge and on the sides of small gulches.

In a representative profile the surface layer is black muck about 8 inches thick. The substratum is fragmental Aa lava. It contains a small amount of organic material in voids in the upper 24 inches. The amount of organic material decreases with depth.

Permeability is very rapid. Runoff is very slow, and the erosion hazard is no more than slight. In places roots penetrate to a depth of 2 feet.

Representative profile: Island of Maui, lat. 20°48′12″ N. and long. 156°02′44″ W.

1—0 to 8 inches, black (10YR 2/1) extremely stony muck, very dark gray (10YR 3/1) when dry; weak, very fine, granular structure when moist; strong, fine and very fine, subangular blocky structure when dry; very hard, friable, nonsticky and nonplastic, and moderately smeary; abundant roots; many pores; tendency to dehydrate irreversibly; low bulk density; 50 to 70 percent gravel, cobblestones, and stone-size fragments of Aa lava; medium acid; clear, irregular boundary. 3 to 8 inches thick.

IIC1—8 to 28 inches, aa lava; 5 to 15 percent of the material in voids is from the overlying horizon; abundant roots in the upper part.

IIC2—28 to 48 inches, fragmental Aa lava.

The muck layer ranges from 3 to 8 inches in thickness.

This soil is used mostly for water supply. Small acreages are used for orchard crops and pasture. (Capability classification VIs, nonirrigated; pasture group 9; woodland group 8)

Mamala Series

This series consists of shallow, well-drained soils along the coastal plains on the islands of Oahu and Kauai. These soils formed in alluvium deposited over coral limestone and consolidated calcareous sand. They are nearly level to moderately sloping. Elevations range from nearly sea level to 100 feet on Oahu but extend to 850 feet on Kauai. The annual rainfall amounts to 18 to 25 inches, most of which occurs between November and April. The mean annual soil temperature is 74° F. Mamala soils are geographically associated with Ewa, Honouliuli, and Lualualei soils on Oahu, and with Koloa and Nohili soils on Kauai.

These soils are used for sugarcane, truck crops, orchards, and pasture. The natural vegetation consists of kiawe, koa haole, bristly foxtail, and swollen fingergrass.

Mamala stony silty clay loam, 0 to 12 percent slopes (MnC).—The slope range of this soil is 0 to 12 percent, but in most places the slope does not exceed 6 percent. Stones, mostly coral rock fragments, are common in the surface layer and in the profile. Included in mapping were areas of Ewa soils. Also included were nonstony areas and areas where the slope is as much as 20 percent.

In a representative profile the surface layer is dark reddish-brown stony silty clay loam about 8 inches thick. The subsoil is dark reddish-brown silty clay loam about 11 inches thick. The soil is underlain by coral limestone and consolidated calcareous sand at depths of 8 to 20 inches. This soil is neutral to mildly alkaline.

Permeability is moderate. Runoff is very slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 2.2 inches per foot in the surface layer and 1.9 inches per foot in the subsoil. Roots are affected by the coral limestone and consolidated sand. The stones hinder, but do not prevent, cultivation.

Representative profile: Island of Oahu, lat. 21°20′20″ N. and long. 158°03′08″ W.

Ap—0 to 8 inches, dark reddish-brown (5YR 3/3) stony silty clay loam, dark reddish brown (5YR 3/4) when dry; moderate, fine and medium, subangular blocky structure; hard, firm, sticky and plastic; few fine, medium, and coarse roots; few, fine, tubular pores; compacted by recent cultivation; affected by mill waste from hydro-separator; about 20 percent coral rock fragments 1/16 inch to 4 inches in size; some mixing of lower horizon by cultivation; moderate effervescence with hydrogen peroxide; strong effervescence with hydrochloric acid; neutral; abrupt, smooth boundary. 6 to 8 inches thick.

B2—8 to 19 inches, dark reddish-brown (2.5YR 3/4) stony silty clay loam, dark red (2.5YR 3/6) when dry; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; common fine and medium roots; common very fine, fine, and medium, tubular pores; common worm casts and wormholes 1/16 to 1/4 inch in size, coated with organic stains; about 40 percent coral fragments and sand grains; strong effervescence with hydrochloric acid; mildly alkaline; abrupt, broken boundary. 4 to 11 inches thick.

IIR—19 inches, coral limestone.

The depth to coral limestone ranges from 8 to 20 inches but may extend to 40 inches in places on Kauai. The A horizon ranges from 5YR to 7.5YR in hue; in value, from

2 to 4 when moist and 3 to 4 when dry; and, in chroma, from 3 to 4 when moist and 4 to 6 when dry. The B horizon ranges from 5YR to 2.5YR in hue; in value, from 2 to 4 when moist and 3 to 4 when dry; and, in chroma, from 3 to 4 when moist and 4 to 6 when dry. On Kauai, this soil is generally redder; it has hues of 2.5YR to 5YR in the A horizon and 10R to 5YR in the B horizon.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIIs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 2)

Manana Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in material weathered from basic igneous rock. They are gently sloping to steep. Elevations range from 500 to 1,200 feet. The annual rainfall amounts to 40 to 60 inches. It is well distributed throughout the year. The mean annual soil temperature is 70° F. Manana soils are geographically associated with Leilehua, Paaloa, and Wahiawa soils.

These soils are used for sugarcane, pineapple, and pasture. The natural vegetation consists of bermudagrass, Christmas berry, false staghornfern, glenwoodgrass, guava, koa, ohia, and sedges.

Manana silty clay loam, 6 to 12 percent slopes (MoC).—This soil is on smooth slopes in the uplands. Included in mapping were small areas of Leilehua, Paaloa, and Wahiawa soils.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 8 inches thick. The subsoil, about 42 inches thick, is dusky-red, dark reddish-gray, and dark reddish-brown silty clay that has subangular blocky structure. A nonporous, panlike sheet, 1/8 inch to 1/4 inch thick, occurs in the subsoil at depths ranging from 15 to 50 inches. The substratum is soft, weathered basic igneous rock. The soil is very strongly acid in the surface layer and very strongly acid to extremely acid in the subsoil.

The depth to the panlike sheet is 15 to 30 inches. Permeability is moderately rapid above the pan and moderate below. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.2 inches per foot in the surface layer and 1.3 inches per foot in the subsoil. Roots penetrate to a depth of 15 to 30 inches, except that where there are cracks in the panlike sheet, they may extend to a depth of 4 feet.

Representative profile: Island of Oahu, lat. 21°27′50″ N. and long. 157°58′10″ W.

Ap—0 to 8 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay loam; moderate, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant very fine roots; many, very fine and fine, interstitial pores; common glistening specks; many firm aggregates when moist; high bulk density; some dusky-red (10R 3/4) material from B horizon mixed by tillage; moderately magnetic; very strongly acid; abrupt, smooth boundary. 6 to 9 inches thick.

B21—8 to 15 inches, dusky-red (10R 3/4) light silty clay, dark red (10R 3/6) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, sticky and plastic; abundant very fine roots; many, very fine and fine, tubular pores; few weak pressure cutans on ped faces; few worm casts; matted roots at lower boundary; moderately magnetic; very strongly acid; abrupt, smooth boundary. 6 to 8 inches thick.

B22t—15 to 27 inches, dark reddish-gray (5YR 4/2) gritty silty clay, reddish brown (5YR 4/3) when dry; strong, very fine, subangular blocky structure; very hard, firm, slightly sticky and plastic; few roots in vertical cracks; many, very fine and fine, tubular pores; many, patchy, dark-red (2.5YR 3/6) coatings with frostlike material on ped faces; many, moderately thick, discontinuous clay films on ped faces; nonporous, panlike sheet, 1/8- to 1/4-inch thick, caps this horizon; common highly weathered pebbles cemented by illuvial material; moderately magnetic; extremely acid; gradual, wavy boundary. 10 to 14 inches thick.

B23t—27 to 42 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; strong, very fine, subangular blocky structure; hard, firm, slightly sticky and plastic; few roots in vertical cracks; common, very fine, tubular pores; dark-red (2.5YR 3/6), continuous, moderately thick clay films on ped faces; compact in place; few fragments of highly weathered gravel; moderately magnetic; extremely acid; gradual, wavy boundary. 15 to 18 inches thick.

B24t—42 to 50 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few roots in vertical cracks; many, very fine and fine, tubular pores; dark-red (2.5YR 3/6), continuous, moderately thick clay films on ped faces; common highly weathered pebbles; moderately magnetic; extremely acid.

The size and number of highly weathered rock fragments vary considerably within short distances. The depth to the panlike sheet ranges from 15 to 50 inches, except that in small, eroded areas the pan may be less than 15 inches below the surface. The A horizon ranges from 2.5YR to 5YR in hue, from 2 to 3 in value when moist, and from 2 to 4 in chroma when moist or dry. The texture is silty clay or silty clay loam. Effervescence with hydrogen peroxide is none to slight, and reaction ranges from extremely acid to very strongly acid. The B horizon below the thin, panlike sheet ranges from 5YR to 10R in hue; the red hues are normally in the upper part. The texture is silty clay or clay.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Manana silty clay loam, 2 to 6 percent slopes (MoB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIe if irrigated, IIIe if nonirrigated; sugarcane group 1; pineapple group 5; pasture group 6; woodland group 6)

Manana silty clay loam, 12 to 25 percent slopes, eroded (MoD2).—This soil is similar to Manana silty clay loam, 6 to 12 percent slopes, except that it is moderately steep. The surface layer is 4 to 6 inches thick as a result of past erosion. Included in mapping were small spots where the subsoil is exposed. The depth to the panlike sheet is less than 15 inches. Runoff is rapid, and the erosion hazard is severe.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification VIe, irrigated or nonirrigated; sugarcane group 1; pasture group 6; woodland group 6)

Manana silty clay, 3 to 8 percent slopes (MpB).—On this soil, runoff is slow and the erosion hazard is slight. The depth to the panlike sheet is 30 to 50 inches.

This soil is used for sugarcane and pineapple. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 6; woodland group 6)

Manana silty clay, 8 to 15 percent slopes (MpC).—On this soil, the depth to the panlike sheet is 30 to 50 inches.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Manana silty clay, 15 to 25 percent slopes (MpD).—On this soil the depth to the panlike sheet is 30 to 50 inches. Runoff is medium, and the erosion hazard is moderate.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 6; woodland group 6)

Manana silty clay, 12 to 25 percent slopes, eroded (MpD2).—This soil is similar to Manana silty clay loam, 6 to 12 percent slopes, except that it is moderately steep, is eroded, and has a silty clay texture. In most areas nearly all of the original surface layer has been removed by erosion. Included in mapping were spots where the subsoil is exposed. Runoff is rapid, and the erosion hazard is severe.

This soil is used for sugarcane, pasture, and homesites. (Capability classification VIe, irrigated or nonirrigated, sugarcane group 1; pasture group 6; woodland group 6)

Manana silty clay, 25 to 40 percent slopes (MpE).—On this soil, runoff is medium to rapid and the erosion hazard is moderate to severe. The depth to the panlike sheet is 30 to 50 inches.

This soil is used for homesites and pasture. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 6)

Marsh

Marsh (MZ) consists of wet, periodically flooded areas covered dominantly with grasses and bulrushes or other herbaceous plants. It occurs as small, low-lying areas along the coastal plains. Water stands on the surface, but marsh vegetation thrives. The water is fresh or brackish, depending on proximity to the ocean. Included in mapping were small areas of mangrove swamp and small areas of open water. (Capability classification VIIIw, nonirrigated)

Mokuleia Series

This series consists of well-drained soils along the coastal plains on the islands of Oahu and Kauai. These soils formed in recent alluvium deposited over coral sand. They are shallow and nearly level. Elevations range from nearly sea level to 100 feet. The annual rainfall amounts to 15 to 40 inches on Oahu and 50 to 100 inches on Kauai. The mean annual soil temperature is 74° F. Mokuleia soils are geographically associated with Hanalei, Jaucas, and Keaau soils.

In this survey area a poorly drained variant of the Mokuleia series was mapped. This soil, Mokuleia clay loam, poorly drained variant, is described in alphabetical order, along with other mapping units of this series.

414-129—72——7

These soils are used for sugarcane, truck crops, and pasture. The natural vegetation consists of kiawe, klu, koa haole, and bermudagrass in the drier areas and napiergrass, guava, and joee in the wetter areas.

Mokuleia clay loam (Mt).—This soil occurs as small areas on the coastal plains. It is nearly level. Included in mapping were small areas of Jaucas soils; small areas of very deep, well-drained soils in drainageways; and small areas of poorly drained clay soils underlain by reef limestone.

In a representative profile the surface layer is very dark grayish-brown clay loam about 16 inches thick. The next layer, 34 to more than 48 inches thick, is dark-brown and light-gray, single-grain sand and loamy sand. The surface layer is neutral in reaction, and the underlying material is moderately alkaline.

Permeability is moderate in the surface layer and rapid in the subsoil. Runoff is very slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot in the surface layer and about 1.0 inch per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°34′49″ N. and long. 158°10′09″ W.

Ap—0 to 16 inches, very dark grayish-brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) when dry; moderate, very fine and fine, granular and subangular blocky structure; hard, firm, sticky and plastic; plentiful fine roots; many, very fine and fine, interstitial pores; few, fine and very fine, tubular pores; common wormholes and worm casts; horizon consists of about 25 percent coral sand; slight effervescence with hydrogen peroxide; violent effervescence with hydrochloric acid; neutral; abrupt, wavy boundary. 10 to 16 inches thick.

IIC1—16 to 22 inches, dark-brown (10YR 4/3) loamy sand, brown (10YR 5/3) when dry; massive; soft, slightly hard, nonsticky and nonplastic; plentiful fine roots; porous; few pieces of reef limestone; horizon consists of about 80 percent coral sand; violent effervescence with hydrochloric acid; moderately alkaline; abrupt, smooth boundary. 6 to 20 inches thick.

IIC2—22 to 50 inches, light-gray (10YR 7/2), moist and dry, coral sand; single grain; loose when moist or dry, nonsticky and nonplastic; few fine roots; porous; few pieces of coral; violent effervescence with hydrochloric acid; moderately alkaline.

The depth to coral sand ranges from 12 to 30 inches. The A horizon ranges from 10YR to 5YR in hue and from 1 to 3 in value when moist and 3 to 5 when dry. It ranges from 1 to 3 in chroma when moist and 1 to 3 when dry. The IIC1 horizon ranges from 10YR to 7.5YR in hue, from 3 to 6 in value when moist and 4 to 7 when dry, and from 1 to 3 in chroma.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 3)

Mokuleia clay (Mtb).—This soil has a profile like that of Mokuleia clay loam, except for the texture of the surface layer. It is nearly level. Permeability is slow in the surface layer. Workability is difficult because of the sticky, plastic clay.

This soil is used for sugarcane and pasture. (Capability classification IIIs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 3)

Mokuleia fine sandy loam (Mr).—This soil occurs on the eastern and northern coastal plains of Kauai. It is nearly level. This soil has a profile like that of Mokuleia clay loam, except for the texture of the surface layer.

Permeability is moderately rapid in the surface layer and rapid in the subsoil. Runoff is very slow, and the erosion hazard is slight. The available water capacity is about 1 inch per foot in the surface layer and 0.7 inch per foot in the subsoil. Included in mapping were small areas where the slope is as much as 8 percent.

This soil is used for pasture. (Capability classification IIIs if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 3)

Mokuleia loam (Ms).—This soil has a profile like that of Mokuleia clay loam, except that the surface layer is loam and in most places is about 8 inches thick. It is nearly level.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 3)

Mokuleia clay loam, poorly drained variant (Mta).—This soil occurs on Kauai. It is nearly level. The soil is poorly drained, and in this way, it differs from other soils of the Mokuleia series. The surface layer is dark brown to black and is mottled.

This soil is used for sugarcane, taro, and pasture. (Capability classification IIIw, irrigated or nonirrigated; sugarcane group 3; pasture group 3)

Molokai Series

This series consists of well-drained soils on uplands on the islands of Maui, Lanai, Molokai, and Oahu. These soils formed in material weathered from basic igneous rock. They are nearly level to moderately steep. Elevations range mainly from nearly sea level to 1,000 feet but are as much as 1,500 feet on Lanai. The annual rainfall amounts to 20 to 25 inches, most of which occurs between November and April. The summers are hot and dry. The mean annual soil temperature is 73° F. Molokai soils are geographically associated with Holomua, Keahua, Lahaina, and Uwala soils.

In this survey area a shallow variant of the Molokai series was mapped. This soil, Molokai silty clay loam, shallow variant, 15 to 25 percent slopes, severely eroded, is described in alphabetical order, along with other mapping units of this series.

These soils are used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. The natural vegetation consists of kiawe, ilima, uhaloa, feather fingergrass, and buffelgrass.

Molokai silty clay loam, 0 to 3 percent slopes (MuA).—This soil is on smooth slopes.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 15 inches thick. The subsoil, about 57 inches thick, is dark reddish-brown silty clay loam that has prismatic structure. The material at depths between 35 and 64 inches is moderately compact in place. The substratum is soft, weathered rock. The soil is slightly acid to neutral, except that areas used for pineapple are commonly very strongly acid or extremely acid in the surface layer.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Molokai, lat. 21°08′36″ N. and long. 157°03′05″ W.

Ap1—0 to 7 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; weak, very fine to medium, granular structure; slightly hard, friable, slightly sticky and plastic; many roots; many interstitial pores; many, very fine, black concretions that effervesce with hydrogen peroxide; strong effervescence with hydrogen peroxide; extremely acid; clear, wavy boundary. 6 to 7 inches thick.

Ap2—7 to 15 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; weak, medium and coarse, subangular blocky structure breaking to moderate, fine and very fine, granular; slightly hard, friable, sticky and plastic; common roots; common, very fine, tubular and interstitial pores; common, fine, black concretions; violent effervescence with hydrogen peroxide; very strongly acid; clear, smooth boundary. 8 to 9 inches thick.

B21—15 to 35 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, red (2.5YR 4/6) when dry; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky; slightly hard, friable, sticky and plastic; no roots; many, very fine and fine, tubular pores; few, shiny, patchy pressure cutans on prisms; common, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 14 to 22 inches thick.

B22—35 to 64 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, red (2.5YR 4/6) when dry; weak, coarse, prismatic structure breaking to strong, very fine and fine, subangular blocky; slightly hard, firm in place, sticky and plastic; no roots; many, very fine and fine, tubular pores and common, medium, tubular pores; common, patchy pressure cutans on peds; common, patchy illuviation cutans on ped surfaces; few, very fine, black concretions; moderately compact in place; moderate effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 27 to 30 inches thick.

B3—64 to 72 inches, dark reddish-brown (5YR 3/3) clay loam, dark reddish brown (5YR 3/4) when dry; moderate, fine and very fine, subangular and angular blocky structure; slightly hard, friable, slightly sticky and plastic; no roots; common, very fine and fine, tubular pores; thin, patchy illuviation cutans on peds; the walls of the larger pores are lined with red illuviation cutans; common, hard, earthy lumps; few, very fine, black concretions; slight effervescence with hydrogen peroxide; neutral.

The number and size of black concretions that effervesce with hydrogen peroxide decrease with depth. In places rock cores occur in the profile, but they are generally at a depth below 40 inches. The A horizon is 5YR, 2.5YR, or 10R in hue and ranges from 2 to 3 in value when moist, from 4 to 6 in chroma when dry, and from 4 to 5 when moist. The B2 horizon is 2.5YR or 10R in hue and ranges from 2 to 3 in value when moist and, in chroma, from 3 to 4 when moist and 4 to 6 when dry.

This soil is used entirely for sugarcane on Maui and Oahu. It is used for pineapple, pasture, and wildlife habitat on Molokai and Lanai. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 1; pasture group 2)

Molokai silty clay loam, 3 to 7 percent slopes (MuB).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were a few small areas that are eroded to soft, weathered rock. Also included in mapping on Oahu were small areas of dark reddish-brown silty clay loams that overlie fine-textured, gravelly alluvium and small areas of dark reddish-brown silty clay soils that have a mottled subsoil.

This soil is used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. (Capability classification

IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Molokai silty clay loam, 3 to 7 percent slopes, severely eroded (MuB3).—This soil occurs on Molokai. It has a profile like that of Molokai silty clay loam, 0 to 3 percent slopes, except that most of the surface layer and, in places, part of the subsoil have been removed by wind and water erosion. Runoff is medium, and the hazard of wind and water erosion is severe.

This soil is used entirely for pasture and wildlife habitat. Most of the vegetation is dormant in summer. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 2; pasture group 2)

Molokai silty clay loam, 7 to 15 percent slopes (MuC).—This soil occurs on knolls and sharp slope breaks. Runoff is medium, and the erosion hazard is moderate.

This soil is used for sugarcane, pineapple, pasture, wildlife habitat, and homesites. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pineapple group 3; pasture group 2)

Molokai silty clay loam, 7 to 15 percent slopes, severely eroded (MuC3).—This soil occurs on Molokai. It has a profile like that of Molokai silty clay loam, 0 to 3 percent slopes, except that most of the surface layer and part of the subsoil have been removed by wind and water erosion. Runoff is medium to rapid, and the hazard of wind and water erosion is severe. There are a few small gullies in areas not under cultivation. Pebble-size, weathered rock fragments are common in the plow layer in cultivated areas.

Most of this soil is used for pasture and wildlife habitat. Small areas are used for pineapple. (Capability classification IVe if irrigated, VIe if nonirrigated; pineapple group 3; pasture group 2)

Molokai silty clay loam, 15 to 25 percent slopes (MuD).—This soil occurs on Oahu. In most places the slope does not exceed 20 percent. Runoff is medium, and the erosion hazard is severe. Workability is slightly difficult because of the slope. Included in mapping were small areas where boulder cores are exposed.

This soil is used for sugarcane and pineapple. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 3; pasture group 2)

Molokai silty clay loam, shallow variant, 15 to 25 percent slopes, severely eroded (MvD3).—This soil occurs on the sides of drainageways. In most places all of the surface layer and part of the subsoil have been removed, and about 12 to 20 inches of dark reddish-brown soil overlies the soft, weathered rock. In some places the soil is eroded to soft, weathered rock and, as a result, is grayer or browner than is typical of the Molokai series. There are few to common stones and boulders on the surface. These are unweathered rock cores that have been exposed by erosion. Runoff is rapid, and the erosion hazard is severe. Workability is difficult.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, irrigated or nonirrigated; pasture group 2)

Naiwa Series

This series consists of well-drained soils on uplands on the islands of Lanai, Molokai, and Maui. These soils developed in volcanic ash and material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 250 to 3,250 feet. The annual rainfall amounts to 35 to 50 inches. The mean annual soil temperature is 70° F.

These soils are used for pasture, woodland, and wildlife habitat. Small acreages on the island of Molokai are used for pineapple. The natural vegetation consists of aalii, guava, kikuyugrass, lantana, and puakeawe.

Naiwa silty clay loam, 3 to 20 percent slopes (NAC).—This soil is on smooth side slopes and intermediate slopes in the uplands. Included in mapping were small areas of Olelo and Oli soils. Also included were small, eroded areas where the surface layer is very thin and where, in some places, the subsoil has been removed by erosion and weathered rock is exposed.

Naiwa soils are geographically associated with Kalae, Olelo, and Oli soils. In a representative profile the surface layer is dusky-red silty clay loam about 11 inches thick. The subsoil, about 30 inches thick, is dark-red, dark reddish-brown, and red silt loam and loam that has subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is strongly acid in the surface layer and strongly acid to very strongly acid in the subsoil.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate to severe. The available water capacity is about 1.2 inches per foot of soil. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°56′58″ N. and long. 156°31′20″ W.

Ap—0 to 4 inches, dusky-red (10R 3/3), moist and dry, silty clay loam; weak, fine, subangular blocky structure; slightly hard, firm, sticky and slightly plastic; many fine roots; many fine and medium pores; common worm casts and worm channels; moderately high bulk density; strongly acid; clear, smooth boundary. 3 to 6 inches thick.

A1—4 to 11 inches, dusky-red (10R 3/4), moist and dry, silty clay loam; moderate and strong, fine and very fine, subangular blocky structure; slightly hard, firm, sticky and plastic; many fine roots; many fine and medium pores; purplish cast when dry; high bulk density; strongly acid; abrupt, smooth boundary. 5 to 9 inches thick.

B1—11 to 14 inches, dark-red (10R 3/6), moist and dry, silt loam; weak, coarse and medium, subangular blocky structure; slightly hard, friable, slightly sticky and plastic; many fine roots; many fine pores; moderate bulk density; strongly acid; clear, wavy boundary. 1 to 5 inches thick.

B2—14 to 26 inches, red (10R 4/6), moist and dry, silt loam; weak, medium and coarse, subangular blocky structure; soft, very friable, nonsticky and slightly plastic, and weakly smeary; many fine roots; many fine pores; common, very fine, highly weathered rock fragments; strongly acid; gradual, wavy boundary. 9 to 15 inches thick.

B3—26 to 40 inches, dark reddish-brown (2.5YR 3/4) loam, reddish brown (2.5YR 4/4) when dry; weak, fine and very fine, subangular blocky structure; soft, friable, nonsticky and nonplastic, and weakly smeary; many fine roots that have a tendency to form horizontal layers; many fine pores; thin, patchy, translucent glaze; few pockets of decomposing rock fragments; very strongly acid; clear, wavy boundary. 11 to 18 inches thick.

C1—40 to 52 inches, dark reddish-brown (5YR 3/4), moist and dry, loam that has pockets of dark-red (10R 3/6), dark-brown (7.5YR 4/2), and very dark grayish-brown (10YR 3/2) decomposing rock particles; weak, medium, fine and very fine, subangular blocky structure; soft, friable, nonsticky and nonplastic; many fine roots; many fine and medium pores; 35 to 40 percent decomposing rock fragments; very strongly acid; gradual, wavy boundary. 8 to 15 inches thick.

C2—52 to 60 inches, soft, weathered basic igneous rock that encases a few hard cores; contains isolated roots matted in cracks of rocks.

The solum ranges from 30 to 60 inches in thickness. In some areas, especially where the soil is exposed to wetting and drying, the A horizon is massive. The A horizon ranges from 2.5YR to 10R in hue and, in value, from 2 to 3 when moist and from 3 to 4 when dry. The B horizon ranges from 2.5YR to 10R in hue, from 3 to 4 in value, and from 4 to 6 in chroma.

This soil is used for pasture, woodland, and wildlife habitat. Small acreages on Molokai below an elevation of 2,000 feet are used for pineapple. (Capability classification IVe, nonirrigated; pasture group 6; woodland group 5)

Naiwa silty clay loam, 7 to 15 percent slopes, severely eroded (NAC3).—This soil has a profile like that of Naiwa silty clay loam, 3 to 20 percent slopes, except that it is severely eroded. Shallow gullies are common, and about 75 percent of the original surface layer and, in places, part of the subsoil have been removed by erosion. The erosion hazard is severe.

This soil is used for pasture, woodland, and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Niu Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock, possibly mixed with volcanic ash. They are gently sloping to steep. Elevations range from 750 to 1,800 feet. The annual rainfall amounts to 22 to 35 inches, of which 70 percent falls in the period November to April. The mean annual soil temperature is 64° to 71° F. Niu soils are geographically associated with Mahana and Makaweli soils.

These soils are used for irrigated sugarcane, pasture, wildlife habitat, and woodland. The natural vegetation consists of kiawe, lantana, klu, koa haole, aalii, feather fingergrass, piligrass, guineagrass, and indigo.

Niu silty clay loam, 6 to 12 percent slopes (NcC).—This soil is on the tops of ridges in the uplands. Included in mapping were a few small areas where the slope is 2 to 6 percent.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 10 inches thick. The subsoil, about 50 inches thick, is dark-red silty clay loam over silty clay. It has subangular blocky structure. The substratum is soft, weathered rock. The surface layer is medium acid. The subsoil is neutral.

Permeability is moderate. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°02′6.7″ N. and long. 159°44′37.5″ W.

Ap—0 to 10 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark reddish brown (2.5YR 3/4) when rubbed and when dry; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; plentiful medium, fine, and very fine roots; strong to violent effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 8 to 14 inches thick.

B21—10 to 22 inches, dark-red (2.5YR 3/6) silty clay loam, red (2.5YR 4/6) when dry; weak, prismatic structure; hard, friable, sticky and plastic; plentiful medium, fine, and very fine roots; common medium pores; many fine, very fine, and micro pores; thin, patchy coatings on peds; coatings look like clay films; upper 2 inches compacted by tillage; slight to moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 8 to 14 inches thick.

B22—22 to 36 inches, dark-red (10R 3/6) light silty clay, dark red (10R 3/6) when dry; weak to moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few medium, plentiful fine and very fine roots; few medium, common fine, and many very fine and micro pores; nearly continuous, moderately thick coatings on some peds; coatings look like clay films; compact in place; slight to moderate effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 12 to 16 inches thick.

B23—36 to 60 inches, dark-red (10R 3/6) silty clay, dark red (10R 3/6) when rubbed, dark red (10R 3/6) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few medium, fine, and very fine roots; few medium, common fine and very fine pores; continuous, moderately thick coatings on some peds; coatings look like clay films; compact in place; no effervescence with hydrogen peroxide; neutral.

The A horizon ranges from 10R to 2.5YR in hue, from 2 to 3 in value, and from 3 to 4 in chroma. It ranges from silty clay loam to silty clay in texture. The B horizon ranges from 10R to 2.5YR in hue, from 2 to 3 in value, and from 5 to 7 in chroma. The upper part of the B horizon ranges from weak to moderate in structure, and the lower part from moderate to strong. In places small, black concretions occur throughout the profile.

This soil is used for irrigated sugarcane, pasture, wildlife habitat, and woodland. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Niu silty clay loam, 12 to 20 percent slopes (NcD).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for sugarcane, pasture, wildlife habitat, and woodland. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Niu silty clay loam, 6 to 20 percent slopes, eroded (NcD2).—This soil is similar to Niu silty clay loam, 6 to 12 percent slopes, except that the surface layer and part of the subsoil have been removed by erosion, and there are many gullies. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture, wildlife habitat, and woodland. (Capability classification IVe, nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Niu silty clay loam, 20 to 35 percent slopes, eroded (NcE2).—This soil is similar to Niu silty clay loam, 6 to 12 percent slopes, except that most of the original surface layer has been removed by erosion. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture, wildlife habitat, and woodland. (Capability classification VIe, nonirrigated; pasture group 3; woodland group 1)

Niulii Series

This series consists of well-drained soils on uplands on the island of Molokai. These soils formed in local alluvium and colluvium and were influenced by volcanic ash. They are sloping to hilly. On Molokai, elevations range from 1,250 to 2,000 feet. The annual rainfall amounts to 70 to 90 inches and is fairly well distributed throughout the year. Cloud and fog cover persist throughout most of the day. The mean annual soil temperature is 68° F. Niulii soils are geographically associated with Olokui soils and the medium-textured variant of Niulii soils.

In this survey area a medium-textured variant of the Niulii series was mapped. This soil, Niulii silty clay loam, medium textured variant, 7 to 30 percent slopes, is described in alphabetical order, along with other mapping units of this series.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of carpetgrass, glenwoodgrass, ohia, false staghornfern, treefern, creeping Chinese violets, and sedges.

Niulii silty clay loam, 7 to 30 percent slopes (NLE).—This soil occurs in areas where the topography is sloping to hilly.

In a representative profile the surface layer, about 11 inches thick, is dark-brown silty clay loam and silty clay that has subangular blocky structure. The subsoil, about 13 inches thick, is dark-brown silty clay that has subangular and angular blocky structure. The substratum is soft, highly weathered stones and gravel. The soil is very strongly acid throughout the profile.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. In places roots penetrate to a depth of 3 feet or more. Workability is slightly difficult because of the slope.

Representative profile: Island of Molokai, lat. 21°06′56″ N. and long. 156°47′23″ W.

A11—0 to 5 inches, dark-brown (10YR 3/3) silty clay loam, dark gray (10YR 4/1) when dry; strong and moderate, fine, subangular blocky structure; very hard, friable, sticky and plastic; many roots; many interstitial pores; very strongly acid; clear, wavy boundary. 4 to 6 inches thick.

A12—5 to 11 inches, dark-brown (10YR 3/3) silty clay, dark gray (10YR 4/1) when dry; moderate, fine, subangular blocky structure; very hard, friable, sticky and plastic; many roots; many, very fine, tubular pores and common, fine, tubular pores; very strongly acid; clear, wavy boundary. 5 to 8 inches thick.

B22—11 to 24 inches, dark-brown (10YR 3/3) silty clay, dark grayish brown (10YR 4/2) when dry; moderate, fine and medium, subangular and angular blocky structure; slightly hard, friable, sticky and plastic; few roots; many, very fine, tubular pores and common, fine, tubular pores; common oxide coatings on peds; gritty feeling because of few very fine rock fragments; very strongly acid; clear, wavy boundary. 11 to 22 inches.

C—24 to 40 inches, soft, highly weathered stones and pebbles, some of which break down to smeary silty clay loam.

IIR—40 inches, hard pahoehoe lava.

The A horizon is 10YR in hue. The B horizon ranges from 10YR to 7.5YR in hue. In places a few, fine, distinct, reddish-brown mottles occur in the A horizon and few to common, fine, reddish-brown mottles in the B horizon. This soil has a tendency to harden irreversibly upon drying.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 9; woodland group 8)

Niulii silty clay loam, medium textured variant, 7 to 30 percent slopes (NME).—This soil occurs on East Molokai, mainly on narrow ridges bordered by deep gulches. In most places the slope is 15 to 25 percent. Elevations range from 500 to 2,500 feet. The annual rainfall amounts to 40 to 60 inches. In a representative profile the texture of the subsoil is coarser than is typical of the Niulii series, and the structure is weaker.

This soil is dark brown throughout the profile. The surface layer is silty clay loam about 8 inches thick. The subsoil is very friable silt loam, 22 to 27 inches thick. The substratum is soft, weathered rock. The soil is strongly acid throughout the profile.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is moderate to severe. Workability is slightly difficult to difficult because of the slope. In many places this soil is slightly eroded.

This soil is used mostly for pasture and wildlife habitat. Small areas are used for woodland. (Capability classification VIe, nonirrigated; pasture group 9; woodland group 8)

Nohili Series

This series consists of poorly drained soils on coastal plains on the island of Kauai. These soils developed in alluvium that was deposited over marly lagoon deposits. They are nearly level. Elevations range from nearly sea level to a few feet above sea level. The annual rainfall amounts to 20 to 40 inches. The mean annual soil temperature is 75° F. Nohili soils are geographically associated with Kaloko soils.

These soils are used for irrigated sugarcane. They are all under cultivation.

Nohili clay (Nh).—This soil is on the coastal plains.

In a representative profile the surface layer is dark reddish-brown clay about 18 inches thick. The subsoil, about 15 inches thick, is mottled, dark-brown, very dark gray, and grayish-brown clay that has angular blocky structure. The substratum is marly clay that is underlain in places by dark-gray, noncalcareous clay. The surface layer is mildly alkaline and moderately alkaline.

Permeability is moderately slow. Runoff is slow, and there is no erosion hazard. This soil is subject to occasional flooding. Unless the soil is artificially drained, the water table is within 2 feet of the surface. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to the water table. Workability is difficult.

Representative profile: Island of Kauai, lat. 21°59′36.8″ N. and long. 159°44′28.8″ W.

Ap1—0 to 5 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/2) when dry; strong, fine and very fine, subangular blocky structure; extremely hard, firm, very sticky and very plastic; no roots; moderate effervescence with hydrogen peroxide; moderate effervescence with hydrochloric acid; mildly alkaline; abrupt, smooth boundary. 4 to 6 inches thick.

Ap2—5 to 18 inches, dark reddish-brown (5YR 3/3) clay, brown (7.5YR 4/2) when dry; moderate, medium, subangular blocky structure; extremely hard, firm, very sticky and very plastic; plentiful medium and fine roots; common medium and fine pores; moderate effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; mildly alkaline; abrupt, wavy boundary. 11 to 15 inches thick.

B21—18 to 23 inches, dark-brown (7.5YR 3/2) clay mottled with reddish brown (5YR 4/4) and dark gray (10YR 4/1), dark brown (7.5YR 3/2) when dry; moderate, fine to coarse, angular blocky structure; extremely hard, firm, very sticky and very plastic; plentiful medium roots and few fine and very fine roots; common medium pores and few fine pores; moderate effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid; few, soft, black concretions; mildly alkaline; abrupt, smooth boundary. 4 to 6 inches thick.

B22—23 to 29 inches, very dark gray (10YR 3/1) clay that contains blotches of light gray (10YR 6/1) and specks of dark reddish brown (2.5YR 3/4), very dark gray (10YR 3/1) when dry; moderate, coarse, angular blocky structure; extremely hard, firm, very sticky and very plastic; abundant fine roots, plentiful very fine roots, and few micro roots; many fine pores and common very fine pores; slight effervescence with hydrochloric acid; few pressure cutans and slickensides; moderately alkaline; gradual, smooth boundary. 5 to 7 inches thick.

B3—29 to 33 inches, grayish-brown (10YR 5/2) clay mottled with yellowish brown (10YR 5/4), dark yellowish brown (10YR 4/4), and black (10YR 2/1); gray (10YR 5/1) when dry; moderate, medium and coarse, angular blocky structure; extremely hard, firm, very sticky and very plastic; plentiful medium and fine roots; common medium and fine pores; slight effervescence with hydrogen peroxide; violent effervescence with hydrochloric acid; moderately alkaline; gradual, smooth boundary. 4 to 6 inches thick.

IIC1—33 to 43 inches, light brownish-gray (2.5Y 6/2) cemented layers that contain lenses of clay mottled with brown (7.5YR 5/4) and yellowish brown (10YR 5/4), dark gray (10YR 4/1) and light gray (N 7/0) when dry; laminated; clay in lenses is extremely hard, firm, very sticky and very plastic; few medium, fine, and very fine roots; few medium, fine, and very fine pores; slight effervescence with hydrogen peroxide; violent effervescence with hydrochloric acid; moderately alkaline; abrupt, smooth boundary. 8 to 12 inches thick.

IIIC2—43 to 120 inches, dark-gray (N 4/0) clay that has some coatings of olive brown (2.5Y 4/4), very dark gray (5Y 3/1) when dry; weak, coarse, angular blocky structure; extremely hard, firm, very sticky and very plastic; abundant fine, very fine, and micro roots; many fine, very fine, and micro pores; very slight effervescence with hydrogen peroxide; no effervescence with hydrochloric acid; yellow and white specks are visible under 10-power lens; many fine, white, elongated crystals form on outside of clods when they dry; very strongly acid.

The A horizon ranges from 2 to 3 in chroma. The B2 horizon ranges from 5YR to 10YR in hue, from 1 to 3 in chroma, and from 2 to 3 in value. The B horizon has few to many mottles. The depth to the marl ranges from 20 to 40 inches.

This soil is used for irrigated sugarcane. (Capability classification IIIw if irrigated, Vw if nonirrigated; sugarcane group 3; pasture group 7)

Nonopahu Series

This series consists of moderately well drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock relatively high in olivine. They are gently sloping to moderately sloping. Elevations range from nearly sea level to 800 feet. The annual rainfall amounts to 23 to 40 inches. The mean annual soil temperature is 74° F. Nonopahu soils are geographically associated with Makaweli and Waikomo soils.

These soils are used for irrigated sugarcane and pasture. The natural vegetation consists of koa haole, klu, and feather fingergrass.

Nonopahu clay, 2 to 10 percent slopes (NnC).—This soil is on low ridges on uplands. Included in mapping were small areas where the slope is less than 2 percent.

In a representative profile the surface layer is dark grayish-brown clay about 17 inches thick. The next layer, about 48 inches thick, is brown or grayish-brown clay and silty clay that has angular blocky and subangular blocky structure. This soil is underlain by soft, weathered rock. It is mildly alkaline throughout.

Permeability is moderately slow. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult.

Representative profile: Island of Kauai, lat. 21°54′57″ N. and long. 159°37′26.5″ W.

Ap—0 to 17 inches, dark grayish-brown (10YR 4/2) clay, brown (7.5YR 4/2) when dry; moderate, coarse, granular structure; very hard, firm, sticky and plastic; common fine roots; many, medium, interstitial pores and few, medium, tubular pores; common, black concretions 1 millimeter to 5 millimeters in size; pockets of dark yellowish-brown (10YR 4/4) and dark grayish-brown (2.5Y 4/2) clay; moderate effervescence with hydrogen peroxide; mildly alkaline; clear, wavy boundary. 15 to 20 inches thick.

C1—17 to 31 inches, brown (10YR 4/3) clay; pockets (about 40 percent) of mottled dark yellowish brown (10YR 4/4) and dark gray (10YR 4/1); light olive brown (2.5Y 5/4) when dry; weak, coarse, angular blocky structure; very hard, firm, sticky and plastic; many fine roots; few, medium, interstitial pores and many, medium, tubular pores; common concretions less than 2 millimeters in size; few slickensides; moderate effervescence with hydrogen peroxide; mildly alkaline; abrupt, wavy boundary. 12 to 16 inches thick.

C2—31 to 47 inches, grayish-brown (2.5Y 4/2) clay, light olive gray (5Y 6/2) when dry; weak, coarse, angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few, medium, tubular pores; common, fine, black, hard concretions; common slickensides; slight effervescence with hydrogen peroxide; mildly alkaline; clear, smooth boundary. 14 to 18 inches thick.

C3—47 to 65 inches, brown (10YR 4/3) silty clay, brown (10YR 5/3) when dry; strong, medium, subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; many interstitial pores; nearly continuous pressure cutans on ped faces; common slickensides; many, medium, black stains on peds; strong effervescence with hydrogen peroxide; mildly alkaline.

In places a few ironstone-gibbsite pebbles occur throughout the profile. The A horizon ranges from 2 to 4 in chroma and from 3 to 4 in value. The C horizon ranges from 10YR to 2.5Y in hue, from 2 to 4 in chroma, and from 4 to 5 in value. Mottles in the C horizon range from few to common. Unless the soil is irrigated, cracks more than 1 centimeter wide and 20 inches or more deep develop in most years.

This soil is used for sugarcane and pasture. (Capability classification IIIe if irrigated, VIe if nonirrigated; sugarcane group 4; pasture group 2)

Nonopahu stony clay, 2 to 12 percent slopes (NoC).—This soil is similar to Nonopahu clay, 2 to 10 percent slopes, except for the stones. The number of stones ranges from few to many. The stones interfere with farming operations. Included in mapping were small areas of rock outcrop.

This soil is used for sugarcane and pasture. (Capability classification IIIe if irrigated, VIe if nonirrigated; sugarcane group 4; pasture group 2)

Oanapuka Series

This series consists of well-drained, very stony soils on low uplands on the island of Maui. These soils developed in volcanic ash and material derived from cinders. They are moderately sloping to moderately steep. Elevations range from 100 to 800 feet. The annual rainfall amounts to 15 to 25 inches, most of which occurs in winter. The mean annual soil temperature is 73° F. Oanapuka soils are geographically associated with Io and Makena soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of feather fingergrass, ilima, kiawe, klu, koa haole, lantana, Natal redtop, and pitted beardgrass.

Oanapuka very stony silt loam, 7 to 25 percent slopes (OAD).—This soil is on the lower uplands. Included in mapping were small areas of Io and Makena soils.

In a representative profile the surface layer, about 6 inches thick, is very dark brown and very dark grayish-brown silt loam that has granular and subangular blocky structure. The subsoil, about 9 inches thick, is very dark grayish-brown silt loam that has prismatic structure. The substratum is dark yellowish-brown silt loam, loam, and stone-size Aa lava. The soil is medium acid to slightly acid in the surface layer, neutral in the subsoil, and neutral to mildly alkaline in the substratum.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight to moderate. The available water capacity is about 1.0 inch per foot of soil. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°39′44″ N. and long. 156°25′10″ W.

A11—0 to 2 inches, very dark brown (10YR 2/2) very stony silt loam, dark brown (10YR 3/3) when dry; weak, fine and medium, granular structure; soft, very friable, nonsticky and slightly plastic; abundant fine roots; common fine and very fine pores; 15 to 30 percent stones; slight effervescence with hydrogen peroxide; medium acid; abrupt, smooth boundary. 1 to 3 inches thick.

A12—2 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, brown (10YR 4/3) when dry; weak, medium and coarse, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant fine roots; many fine and very fine pores; few, fine, red, weathered cinders; slight effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 3 to 6 inches thick.

B2—6 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam, dark brown (7.5YR 3/2) when dry; moderate, medium, prismatic structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine roots; many fine pores; thin, patchy coatings on peds; coatings look like clay films; few, fine, red, weathered cinders; neutral; clear, wavy boundary. 8 to 14 inches thick.

C1—15 to 28 inches, dark yellowish-brown (10YR 3/4) silt loam, yellowish brown (10YR 5/6) when dry; massive; soft, very friable, slightly sticky and slightly plastic; plentiful fine roots; many fine pores; common, fine, red cinders; neutral; gradual, wavy boundary. 10 to 16 inches thick.

C2—28 to 43 inches, dark yellowish-brown (10YR 3/4) loam, yellowish brown (10YR 5/6) when dry; massive; soft, very friable, slightly sticky and nonplastic; plentiful fine roots; many fine and medium pores; common weathered cinders; few hard stones; mildly alkaline; gradual, wavy boundary. 10 to 20 inches thick.

C3—43 to 46 inches, dark yellowish-brown (10YR 3/4) very cobbly loam, yellowish brown (10YR 5/4) when dry; massive; soft, very friable, nonsticky and nonplastic; 50 to 60 percent gravel-size and cobblestone-size Aa lava fragments; common hard cinders; mildly alkaline; clear, wavy boundary. 2 to 4 inches thick.

IIC4—46 to 55 inches, Aa lava that contains very little soil material in voids; the soil material is dark yellowish-brown (10YR 3/4) loam, yellowish brown (10YR 5/4) when dry; massive; soft, very friable, nonsticky and nonplastic; slight effervescence with hydrochloric acid; mildly alkaline.

The depth of the soil ranges from 40 to more than 60 inches. The A horizon ranges from 7.5YR to 10YR in hue, from 2 to 3 in value when moist and from 3 to 4 when dry, and from 3 to 4 in chroma when dry. The B horizon ranges from 7.5YR to 10YR in hue; from 3 to 4 in value, moist or dry; and from 2 to 4 in chroma, moist or dry. The C horizon ranges from loam to silt loam in texture. The depth to free calcium carbonate ranges from 40 to 60 inches.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 2)

Oanapuka extremely stony silt loam, 7 to 25 percent slopes (OED).—This soil is similar to Oanapuka very stony silt loam, 7 to 25 percent slopes, except that stones cover 3 to 15 percent of the surface area. Included in mapping were small areas of rock outcrop.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 2)

Olelo Series

This series consists of well-drained soils on uplands on the islands of Molokai and Maui. These soils formed in material derived from basic igneous rock. They are gently sloping to moderately sloping. Elevations range from 2,000 to 3,500 feet. In most places rainfall amounts to 40 to 60 inches annually, but it is as much as 80 inches on Maui. The mean annual soil temperature is 63° F. Olelo soils are geographically associated with Kahanui and Naiwa soils.

These soils are used for woodland, pasture, and wildlife habitat. The natural vegetation consists of hilograss, guava, ohia, puakeawe, aalii, false staghornfern, and sweet vernalgrass.

Olelo silty clay, 3 to 15 percent slopes (OFC).—This soil occurs on narrow to broad ridgetops. Included in mapping were small areas on knolls where the slope is as much as 25 percent.

In a representative profile the surface layer, about 10 inches thick, is dark reddish-brown silty clay that has granular structure in the upper 4 inches but is massive below that depth. The subsoil, about 27 inches thick, is dark reddish-brown and dark-red silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is very strongly acid.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places, roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Molokai, lat. 21°08′32″ N. and long. 156°57′33″ W.

A1—0 to 4 inches, dark reddish-brown (5YR 3/2) silty clay, weak red (2.5YR 4/2) when dry; strong, fine to coarse, granular structure; hard, friable, sticky and plastic; many roots; many interstitial pores; high bulk density; many ironstone fragments as much as ½ inch long; very strongly acid; abrupt, smooth boundary. 3 to 6 inches thick.

A3—4 to 10 inches, dark reddish-brown (5YR 3/3) silty clay, weak red (2.5YR 4/2) when dry; massive (breaks to dense clods); very hard, firm, sticky and plastic; few roots; many, very fine, tubular pores; high bulk density; common pebble-size ironstone fragments; very strongly acid; clear, smooth boundary. 5 to 6 inches thick.

B21—10 to 14 inches, dark reddish-brown (2.5YR 3/5) silty clay, reddish brown (2.5YR 4/4) when dry; moderate, fine and medium, subangular blocky structure; hard, firm, very sticky and plastic; few roots; many, very fine, tubular pores; many wormholes and worm casts; very strongly acid; clear, smooth boundary. 3 to 4 inches thick.

B22t—14 to 19 inches, dark-red (2.5YR 3/6) silty clay, dark reddish brown (2.5YR 3/4) and red (2.5YR 4/6) when dry; moderate, medium and thick, platy structure breaking to moderate, fine and medium, subangular blocky; hard, friable, very sticky and very plastic; few roots; many, very fine, tubular pores and common, fine, tubular pores; common, thin, patchy clay films of slightly higher chroma; at the bottom of this horizon is a very thin (⅛-inch) layer of soft material that develops into an ironstone sheet; very strongly acid; abrupt, wavy boundary. 4 to 5 inches thick.

B23t—19 to 37 inches, dark-red (2.5YR 3/6) silty clay, dark reddish brown (2.5YR 3/4) when dry; strong, very fine and fine, subangular blocky structure; hard, friable, very sticky and very plastic; few roots; many, very fine and fine, tubular pores; continuous, moderate to thick clay films on peds; some very fine aggregates persist as hard, earthy lumps and break down after prolonged rubbing; very strongly acid; clear, wavy boundary. 17 to 19 inches thick.

C—37 to 60 inches, dark-gray (10YR 4/1) and dark-brown (7.5YR 3/3) saprolite; breaks down to smeary silty clay and silty clay loam; patchy, dark-red coatings; horizon contains some gray material that resembles halloysite.

Ironstone fragments in the A horizon normally range from few to many, but they do not occur in all places. The A3 horizon is lacking or discontinuous in some places. The A horizon ranges from 2.5YR to 5YR in hue, from 3 to 4 in value when dry, and from 2 to 4 in chroma when moist and 1 to 2 when dry. The B horizon ranges from 2.5YR to 10R in hue. The texture of the B horizon is generally silty clay but ranges to clay.

This soil is used for pasture and woodland. (Capability classification IIIe, nonirrigated; pasture group 8; woodland group 7)

Oli Series

This series consists of well-drained, moderately deep to deep soils on uplands on the islands of Molokai, Maui, and Kauai. These soils developed in volcanic ash deposited over basic igneous rock. They are gently sloping to very steep. Elevations range from 1,000 to 2,250 feet. The annual rainfall amounts to 30 to 40 inches, most of which occurs from November to April. The mean annual soil temperature is 70° F. Oli soils are geographically associated with Mahana and Naiwa soils.

These soils are used for sugarcane, pasture, woodland, and wildlife habitat. The natural vegetation consists of guava, lantana, molassesgrass, bermudagrass, Natal redtop, and aalii.

Oli silt loam, 10 to 30 percent slopes (OME).—This soil occupies uplands that are dissected by many small gulches.

Included in mapping were severely eroded areas and small areas of Naiwa soils, which make up as much as 15 percent of the acreage.

In a representative profile the surface layer, about 13 inches thick, is dark-brown silt loam and loam. The subsoil, about 17 inches thick, is dark-brown silt loam that has prismatic and subangular blocky structure. The substratum is slightly weathered hard rock. The soil is strongly acid to very strongly acid, except that on Maui it is slightly acid to medium acid.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate to severe. The available water capacity is about 1.5 inches per foot of soil. This soil is easily eroded because it is very friable and powdery. In places roots penetrate to the bedrock. Workability is slightly difficult to difficult.

Representative profile: Island of Molokai, lat. 21°08′37″ N. and long. 157°00′19″ W.

A1—0 to 5 inches, dark-brown (7.5YR 3/2) silt loam, brown (7.5YR 5/3) when dry; weak and moderate, very fine and fine, granular structure; slightly hard, very friable, nonsticky and nonplastic; many roots; many interstitial pores; strongly acid; clear, smooth boundary. 3 to 9 inches thick.

A3—5 to 13 inches, dark-brown (7.5YR 3/2) loam, yellowish brown (10YR 5/4) when dry; weak, fine and very fine, subangular blocky structure; soft, very friable, nonsticky and slightly plastic; many roots; many pores; few pebbles; strongly acid; abrupt, smooth boundary. 7 to 9 inches thick.

B21—13 to 18 inches, dark-brown (7.5YR 3/2) silt loam, brown (10YR 5/3) when dry; weak, coarse, prismatic structure breaking to weak, fine and medium, subangular blocky; soft, very friable, nonsticky and slightly plastic; many roots; many very fine and fine pores; few andesite pebbles; strongly acid; abrupt, smooth boundary. 5 to 6 inches thick.

B22—18 to 21 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; weak, medium, subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many roots; many fine and very fine pores; surface of peds, when dry, appears to be coated with a gray material, which disappears upon wetting; very strongly acid; abrupt, smooth boundary. 3 to 5 inches thick.

IIB23—21 to 30 inches, dark-brown (7.5YR 3/2) clay loam, brown (7.5YR 5/2) when dry; strong, fine and very fine, subangular blocky structure; soft, friable, slightly sticky and slightly plastic; roots are concentrated between peds; few very fine and fine pores; many, hard, earthy lumps; very strongly acid; abrupt, wavy boundary. 9 to 12 inches thick.

IIR—30 inches, hard, slightly weathered andesite bedrock.

The volcanic ash overlay is more than 20 inches thick, except that in eroded spots it may be as thin as 12 inches. The solum ranges from 4 to 5 in value and from 2 to 4 in chroma when dry. It is commonly 7.5YR and 10YR in hue. In places the B horizon is 5YR in hue. The texture of the A horizon is dominantly silt loam, but in some places it is loam or silty clay loam. The texture of the upper part of the B horizon is loam or silt loam.

This soil is used for pasture and wildlife habitat. In most places guava, lantana, and other shrubs are abundant. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Oli silt loam, 3 to 10 percent slopes (OMB).—This soil occupies smooth slopes on the uplands of West Maui. Runoff is medium, and the erosion hazard is moderate. The soil is slightly acid in the surface layer and medium acid in the subsoil. Included in mapping were small areas of Molokai and Naiwa soils.

This soil is used for pasture and wildlife habitat. (Capability classification IVe, nonirrigated; pasture group 6; woodland group 5)

Oli silt loam, 30 to 70 percent slopes (OMF).—This soil occurs on the sides of gulches. Runoff is very rapid, and the erosion hazard is very severe. The soil is less than 20 inches deep to soft, weathered rock. Rock outcrops are common. Cultivation is impractical.

This soil is used for pasture, woodland, and wildlife habitat. (Capability classification VIIe, nonirrigated; pasture group 6; woodland group 15)

Oli loam, 12 to 20 percent slopes (OID).—This soil occurs on ridges west of the Hanapepe River in the southern and western parts of Kauai. It has a profile like that of Oli silt loam, 10 to 30 percent slopes, except that the texture of the surface layer is loam in most places but ranges from fine sandy loam to clay loam. Included in mapping were small areas of Mahana soils. Runoff is medium, and the erosion hazard is severe.

This soil is mainly in brushy pasture. A small acreage is in sugarcane. (Capability classification IVe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Olinda Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are gently sloping to steep. Elevations range from 2,500 to 5,000 feet. The annual rainfall amounts to 40 to 60 inches and is well distributed throughout the year. The mean annual soil temperature is 57° F. Olinda soils are geographically associated with Kaipoioi and Pane soils.

These soils are used for pasture, woodland, and water supply. Small acreages are used for truck crops and orchards. The natural vegetation consists of bermudagrass, brackenfern, eucalyptus, Natal redtop, puakeawe, sweet vernalgrass, and Yorkshire foggrass.

Olinda loam, 12 to 20 percent slopes (OND).—This soil is on smooth, intermediate to high mountain slopes. Included in mapping were small areas of Kaipoioi and Pane soils. In a few places small, eroded spots were included.

In a representative profile the surface layer is dark reddish-brown loam about 6 inches thick. The subsoil, about 5 inches thick, is dark reddish-brown and yellowish-red silty clay loam that has subangular blocky structure. Below this is yellowish-red and reddish-brown silty clay loam and gravelly silty clay loam. This is underlain by slightly weathered basic igneous rock. The soil is slightly acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 2.4 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°48′30″ N. and long. 156°16′50″ W.

Ap—0 to 6 inches, dark reddish-brown (5YR 3/4) loam, reddish brown (5YR 4/4) when dry; moderate, very fine, granular structure; soft, friable, slightly sticky and nonplastic; abundant fine and very fine roots; many very fine pores; strongly magnetic; few, small, highly weathered, red cinders; slightly acid; abrupt, wavy boundary. 5 to 7 inches thick.

B21—6 to 9 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine roots; many very fine pores; thin, patchy, gelatinlike coatings on ped surfaces; very slightly magnetic; slightly acid; clear, wavy boundary. 3 to 6 inches thick.

B22—9 to 14 inches, dark reddish-brown (5YR 3/4) silty clay loam, reddish brown (5YR 4/4) when dry; moderate, medium and fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine roots; many fine pores; thin, patchy, gelatinlike coatings on ped surfaces; common sand-size aggregates that are resistant to crushing; has gritty feel after continued rubbing; slightly acid; clear, wavy boundary. 4 to 7 inches thick.

B23—14 to 21 inches, yellowish-red (5YR 4/6) silty clay loam, yellowish red (5YR 5/6) and light reddish brown (5YR 6/4) when dry; moderate, fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine and medium roots; many fine pores; thin, patchy, gelatinlike coatings on ped surfaces; many sand-size aggregates that are resistant to crushing; slightly acid; clear, wavy boundary. 6 to 9 inches thick.

IIC1—21 to 28 inches, yellowish-red (5YR 5/6) silty clay loam, pinkish gray (5YR 7/2) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic, and weakly smeary; plentiful fine roots; many fine pores; thin, patchy, gelatinlike coatings on ped surfaces; 5 to 10 percent slightly weathered gray rock fragments; slightly acid; gradual, wavy boundary. 5 to 10 inches thick.

IIC2—28 to 36 inches, reddish-brown (5YR 4/4) gravelly silty clay loam, pinkish white (5YR 8/2) when dry; moderate, very fine, subangular blocky structure; soft, very friable, slightly sticky and slightly plastic, and weakly smeary; few fine roots; common fine pores; 40 to 50 percent slightly weathered gray rock fragments; slightly acid.

IIIR—36 inches, slightly weathered andesite.

The depth to slightly weathered basic igneous rock ranges from 36 to more than 60 inches. A few stones are on the surface in some places. The B horizon ranges from 5YR to 2.5YR in hue, from 3 to 4 in value when moist and 4 to 6 when dry, and from 4 to 6 in chroma when moist or dry.

This soil is used for pasture, woodland, and water supply. (Capability classification IVe, nonirrigated; pasture group 12; woodland group 10)

Olinda loam, 4 to 12 percent slopes (ONC).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small, eroded spots.

This soil is used for truck crops and pasture. Small acreages are used for orchards. (Capability classification IIIe, nonirrigated; pasture group 12; woodland group 10)

Olinda loam, 20 to 40 percent slopes (ONE).—This soil is subject to frequent fog and cloud cover. Small gullies are common. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Included in mapping were small areas of rock outcrop and small, eroded spots.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 12; woodland group 10)

Olokui Series

This series consists of shallow, poorly drained soils on uplands near the summit of Molokai. These soils formed in material derived from basic igneous rock. They are gently sloping to hilly. Elevations range from 1,500 to 4,000 feet. The annual rainfall amounts to 75 to more than 150 inches and is fairly well distributed throughout the year. Fog and cloud cover occur throughout most of the day. The mean annual soil temperature is 58° F. Olokui soils are geographically associated with Amalu soils.

These soils are used for watershed and wildlife habitat. The natural vegetation consists of ohia, treefern, false staghornfern, hilograss, and clubmoss (fig. 7).

Olokui silty clay loam, 3 to 30 percent slopes (OOE).—This soil is shallow and poorly drained. The slope range is 3 to 30 percent, but in most places it is 5 to 20 percent.

Olokui soils have a high organic-matter content. In a representative profile they commonly have a mat of plant residue, about 4 inches thick, on the surface. The mineral soil below is mottled, very dark brown and very dark gray silty clay loam 6 to 17 inches thick. A thin ironstone sheet abruptly overlies soft, weathered rock at depths of 6 to 20 inches below the mineral surface. The soft, weathered rock is many feet thick and can be cut easily with a spade. The soil is extremely acid to very strongly acid.

Permeability above the ironstone sheet is moderately rapid, but the ironstone sheet is impervious except where it is fractured. Runoff is slow, but there is considerable seepage above the ironstone. The erosion hazard is slight to moderate. Roots are restricted by the ironstone sheet, and most trees have a flat rooting system. This soil is always wet.

Representative profile: Island of Molokai, lat. 21°07′09″ N. and long. 156°54′37″ W.

O1—4 inches to 0, dark reddish-brown (5YR 3/2) and very dark brown (10YR 2/2) mat of plant residue, mainly roots; little soil material; extremely acid; abrupt, smooth boundary. 1 to 5 inches thick.

A1g—0 to 4 inches, very dark brown (10YR 2/2) silty clay loam; common, fine, faint, dark reddish-brown and dark-gray mottles along cleavage planes and in pores; weak, medium and coarse, subangular blocky structure; friable, slightly sticky and slightly plastic; many roots; many, very fine and fine, tubular pores and common, medium, tubular pores; many glistening specks; extremely acid; abrupt, wavy boundary. 3 to 5 inches thick.

A2g—4 to 11 inches, very dark gray (10YR 3/1) silty clay

Figure 7.—Treefern and ohia on Olokui silty clay loam. These plants are dominant on this soil.

loam; many, distinct, medium and coarse, dark reddish-brown mottles along cleavage planes and in pores; moderate, medium and coarse, subangular blocky structure; friable, sticky and plastic; many roots; many very fine and fine pores; many glistening specks; very strongly acid; abrupt, wavy boundary. 3 to 12 inches thick.

Birm—11 to 11½ inches, horizontal ironstone sheet, dark reddish brown (5YR 2/2) when moist; very hard; discontinuous fine cracks; the ironstone sheet has a troweled surface and is laminar. ⅛ to 1 inch thick.

C—11½ to 60 inches, soft, variegated brown and dark reddish-brown saprolite; can be crushed to silt loam that is smeary when wet; common, discontinuous, ironstone sheets, ⅛ to ½ inch thick, oriented vertically as well as horizontally in this horizon. Many feet thick.

The depth to the ironstone sheet from the bottom of the organic horizon ranges from 6 to 20 inches. The ironstone sheet ranges from ⅛ inch to 2 inches in thickness. Commonly, it is weakly developed where the slope is more than 15 percent. The O1 horizon ranges from 10YR to 5YR in hue. The A1g and A2g horizons range from 10YR to 5Y in hue.

This soil supports a thick, rain forest type vegetation and is used primarily for watershed. It provides a habitat for wild pigs, deer, and goats. (Capability classification VIIw, nonirrigated; woodland group 16)

Opihikao Series

This series consists of well-drained, very shallow, organic soils on uplands on the island of Maui. These soils developed in vegetative material. They are gently sloping to moderately steep. Elevations range from nearly sea level to 200 feet. The annual rainfall amounts to 60 to 90 inches. It is well distributed throughout the year. The mean annual soil temperature is 72° F. Opihikao soils are geographically associated with Hana and Malama soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of guava, guineagrass, hala, hilograss, kikuyugrass, and ohia.

Opihikao extremely rocky muck, 3 to 25 percent slopes (OPD).—This soil is on smooth side slopes and toe slopes in the uplands. Rock outcrop covers 40 to 60 percent of the acreage. Included in mapping were small areas of Hana and Malama soils.

In a representative profile the surface layer is black muck about 5 inches thick. The substratum is black pahoehoe lava bedrock. The soil is medium acid to strongly acid in the surface layer.

Permeability is rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate.

Representative profile: Island of Maui, lat. 20°47′36″ N. and long. 156°01′12″ W.

1—0 to 5 inches, black (10YR 2/1) muck, very dark gray (10YR 3/1) when dry; moderate, very fine, granular structure when moist and strong, very fine, subangular blocky structure when dry; very hard, friable, nonsticky and nonplastic, and moderately smeary; abundant fine roots; porous; medium acid; abrupt, smooth boundary. 2 to 5 inches thick.

IIR—5 inches +, hard pahoehoe bedrock.

The muck ranges from 2 to 5 inches in thickness over the bedrock. The muck layer ranges from 7.5YR to 10YR in hue.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 9)

Paaiki Series

This series consists of well-drained soils on dissected uplands on the island of Kauai. These soils developed mainly in material weathered from basic igneous rock but partly in volcanic ash and ejecta. They are gently sloping to very steep. Elevations range from 2,900 to 3,500 feet. The annual rainfall amounts to 40 to 60 inches; clouds cover the area on many afternoons. The mean annual soil temperature is 60° F. Paaiki soils are geographically associated with Oli and Kokee soils.

These soils are used for woodland, wildlife habitat, and water supply. The natural vegetation consists of Formosa koa, koa, puakeawe, Boston fern, ohia, aalii, uki, molassesgrass, uki uki, and ricegrass.

Paaiki loam, 6 to 35 percent slopes (PGE).—This soil occurs on narrow ridges in the uplands.

In a representative profile the surface layer, about 9 inches thick, is dark reddish-brown loam and dark-brown silty clay loam. The subsoil, about 41 inches thick, is brown and dark-brown silty clay loam and silty clay that has subangular blocky structure. The substratum is hard saprolite.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. Roots penetrate readily to the hard, weathered rock.

Representative profile: Island of Kauai, lat. 22°06′28″ N. and long. 159°41′14″ W.

A11—0 to 3 inches, dark reddish-brown (5YR 3/3) heavy loam, dark reddish brown (5YR 3/4) when rubbed, yellowish red (5YR 3/6) when dry; moderate, very fine, granular structure; soft, friable, sticky and plastic; abundant roots; many pores; moderate effervescence with hydrogen peroxide; medium acid; clear, smooth boundary. 2 to 4 inches thick.

A12—3 to 6 inches, dark reddish-brown (5YR 3/3) loam, dark reddish brown (5YR 3/4) when rubbed, dark reddish brown (5YR 3/4) when dry; weak, very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic; abundant roots; many fine pores; slight effervescence with hydrogen peroxide; some small pieces of black charcoal; strongly acid; clear, smooth boundary. 3 to 5 inches thick.

A3—6 to 9 inches, dark-brown (7.5YR 3/4) silty clay loam, dark brown (7.5YR 3/4) when rubbed, brown (7.5YR 4/4) when dry; weak, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine pores; slight effervescence with hydrogen peroxide; medium acid; gradual, smooth boundary. 3 to 4 inches thick.

B21—9 to 18 inches, brown (7.5YR 4/4) heavy silty clay loam, reddish brown (5YR 4/4) when dry; weak, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; few roots; many fine pores; no effervescence with hydrogen peroxide; strongly acid; gradual, smooth boundary. 6 to 10 inches thick.

B22—18 to 35 inches, brown (7.5YR 4/4) light silty clay, reddish brown (5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; few roots; many pores; yellowish-red, sugarlike coatings in some pores; very strongly acid; gradual, wavy boundary. 10 to 18 inches thick.

B23—35 to 40 inches, brown (7.5YR 4/4) silty clay, strong brown (7.5YR 4/6) when dry; moderate, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; few roots; many pores; yellowish-red, sugarlike coatings in most pores and on ped faces; about 25 percent of this layer is weathered pebbles; very strongly acid; abrupt, wavy boundary. 5 to 15 inches thick.

B3&C—40 to 50 inches, hard, weathered rock; soil material in cracks and pores makes up 5 percent of horizon; soil is reddish-brown (5YR 4/4) silty clay loam, strong brown (7.5YR 5/6) when dry; massive; friable, sticky and plastic.

The A1 horizon ranges from 5YR to 7.5YR in hue, from 2 to 4 in chroma, and from 2 to 3 in value. The A1 horizon is loam or silt loam. The B horizon is generally 7.5YR in hue but ranges from 5YR to 10YR. It ranges from 2 to 4 in chroma and from 3 to 4 in value. The depth to hard, weathered rock ranges from 29 to more than 56 inches.

This soil is used for woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 12; woodland group 10)

Paaiki loam, 35 to 70 percent slopes (PGF).—This soil is similar to Paaiki loam, 6 to 35 percent slopes, except that it is very steep. Runoff is rapid, and the erosion hazard is severe.

This soil is used for woodland, wildlife habitat, and water supply. (Capability classification VIIe, nonirrigated; pasture group 12; woodland group 10)

Paaloa Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in old alluvium and residuum derived from basic igneous rock. They are gently to moderately sloping. Elevations range from 1,000 to 1,700 feet. The annual rainfall amounts to 70 to 90 inches and is fairly well distributed throughout the year. The mean annual soil temperature is 70° F. Paaloa soils are geographically associated with Kapaa, Leilehua, and Manana soils.

These soils are used primarily for pasture and sugarcane. Small areas are used for homesites and pineapple. The natural vegetation consists of guava, ohia, ferns, koa, and californiagrass.

Paaloa silty clay, 3 to 12 percent slopes (PaC).—This soil occurs as narrow areas bounded by steep gulches. The slope range is 3 to 12 percent, but in most places it is 3 to 8 percent. The slopes are smooth.

Included in mapping were small areas where the slope is 0 to 3 percent and small areas of Manana and Leilehua soils.

In a representative profile the surface layer, about 17 inches thick, is a mixture of dark-brown and dark reddish-brown silty clay and clay. The subsoil, about 43 inches thick, is dark reddish-brown silty clay and clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is strongly acid to very strongly acid.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.2 inches per foot in the surface layer and about 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more. Workability is slightly difficult because of the slope.

Representative profile: Island of Oahu, lat. 21°36′02″ N. and long. 158°01′30″ W.

Ap—0 to 17 inches, mixture of about equal parts of dark-brown (7.5YR 3/2) and dark reddish-brown (2.5YR 3/3) silty clay and clay, dark brown (7.5YR 4/4) and dark reddish brown (2.5YR 3/4) when dry; strong, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; abundant roots; few, fine and very fine, tubular and interstitial pores; strongly acid; abrupt, smooth boundary. 15 to 17 inches thick.

B21t—17 to 25 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; root mat caps this horizon; common, fine, tubular pores; dusky-red clay films in pores and moderately thick, nearly continuous clay films on ped faces; strongly acid; clear, wavy boundary. 6 to 9 inches thick.

B22t—25 to 36 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few very fine roots; many, fine and medium, tubular pores; thin, nearly continuous, dark-red clay films in pores and thin, patchy films on ped faces; 30 to 50 percent of this horizon consists of dark reddish-brown saprolite gravel coated with clay films; very strongly acid; clear, wavy boundary. 10 to 12 inches thick.

B23t—36 to 45 inches, dark reddish-brown (2.5YR 3/4) clay, dark red (2.5YR 3/6) when dry; moderate, medium to very fine, subangular blocky structure; hard, firm, sticky and very plastic; few very fine roots; few, very fine and fine, tubular pores; thin, continuous, dark-red clay films in pores and thin, patchy films on ped faces; very strongly acid; clear, smooth boundary. 9 to 11 inches thick.

B24t—45 to 60 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and very plastic; few very fine roots; common, tubular pores; thin, continuous, dark-red clay films in pores and thin, patchy films on ped faces; very strongly acid.

The amount of saprolite gravel in the Bt horizon ranges from 5 to 50 percent. Chunks of soil, high in content of titanium oxide and 1 to 4 inches in diameter, are common in the A horizon. The A horizon ranges from 2 to 3 in chroma when moist and from 1 to 4 when dry. In cultivated areas it ranges from 7.5YR to 10YR in hue, and chromas are 2 when moist or dry. The B horizon ranges from 2.5YR to 10R in hue, from 3 to 4 in value, and from 3 to 6 in chroma when moist or dry. The Bt horizon ranges from silty clay to clay in texture.

This soil is used primarily for pasture and sugarcane. Small areas are used for pineapple and urban development. Larger areas were formerly used for pineapple, but, because of cool temperatures and high rainfall, most of these areas are now used for other purposes. (Capability classification IIIe, nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Paaloa clay, 2 to 12 percent slopes (PbC).—This soil is similar to Paaloa silty clay, 3 to 12 percent slopes, except that the texture is clay throughout the solum. It is grayer than is typical; hues range from 2.5Y to 10YR, particularly at the higher elevations. Included in mapping were small areas where the texture of the surface layer is silty clay.

This soil is used for sugarcane and pasture. (Capability classification IIIe, nonirrigated; sugarcane group 2; pasture group 8; woodland group 7)

Paia Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently to moderately sloping. Elevations range from nearly sea level to 1,000 feet. The annual rainfall amounts to 25 to 40 inches. The mean annual soil temperature is 73° F.

Paia soils are geographically associated with Haliimaile, Keahua, and Molokai soils.

These soils are used for sugarcane. Small acreages are used for homesites. The natural vegetation consists of ilima, kiawe, lantana, Natal redtop, uhaloa, and yellow foxtail.

Paia silty clay, 3 to 7 percent slopes (PcB).—This soil is on uplands. Included in mapping were small areas of Haliimaile and Molokai soils. Also included were small, nearly level areas.

In a representative profile the surface layer is dark reddish-brown silty clay and clay about 19 inches thick. The subsoil, about 41 inches thick, is dark reddish-brown clay that has angular and subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is mildly alkaline in the surface layer and subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 4 feet or more.

Representative profile: Island of Maui, lat. 20°55′10″ N. and long. 156°21′10″ W.

Ap1—0 to 11 inches, dark reddish-brown (5YR 3/2) silty clay, dark reddish brown (5YR 3/3) when dry; weak, fine, granular structure; hard, friable, sticky and plastic; abundant fine roots; many fine pores; many coral fragments, ¼ millimeter to 2 millimeters in diameter; few, fine, black concretions; violent effervescence with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 8 to 15 inches thick.

Ap2—11 to 19 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; weak, fine, subangular blocky structure; hard, firm, very sticky and very plastic; abundant roots; many fine and very fine pores; many coral fragments, ¼ millimeter to 2 millimeters in diameter; few, fine, black concretions; violent effervescence with hydrogen peroxide; mildly alkaline; clear, smooth boundary. 6 to 10 inches thick.

B1—19 to 30 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/4) when dry; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant roots that tend to follow the boundary at bottom of horizon; many fine and very fine pores; few to common, fine, black stains; dusky-red and black stains that effervesce violently with hydrogen peroxide; dark reddish-brown stains that effervesce slightly with hydrogen peroxide; mildly alkaline; clear, smooth boundary. 8 to 12 inches thick.

B21—30 to 41 inches, dark reddish-brown (5YR 3/2) clay, dark reddish brown (5YR 3/3) when dry; moderate, fine, angular and subangular blocky structure; hard, friable, sticky and plastic; few fine roots at the top of horizon and none at the bottom; many fine pores; continuous pressure cutans; compact in place; common sand-size aggregates that are resistant to crushing; few to common, black stains; slight effervescence with hydrogen peroxide in matrix and violent effervescence with hydrogen peroxide on black stains; mildly alkaline; clear, smooth boundary. 8 to 14 inches thick.

B22—41 to 53 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/4) when dry; moderate, fine, angular and subangular blocky structure; hard, friable, sticky and plastic; many fine pores; continuous pressure cutans; 30 to 40 percent of matrix has black stains that effervesce violently with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 11 to 15 inches thick.

B23—53 to 60 inches, dark reddish-brown (5YR 3/3) clay, dark reddish brown (5YR 3/4) when dry; moderate, fine, angular and subangular blocky structure; hard, friable, sticky and plastic; many fine pores; mildly alkaline.

The thickness of the solum is more than 40 inches. The A horizon ranges from 5YR to 7.5YR in hue and, when moist, from 2 to 3 in value and from 2 to 3 in chroma. The texture is silty clay or clay. The B horizon ranges from 2 to 3 in value when moist and 3 to 4 when dry, and from 2 to 3 in chroma when moist. The texture ranges from silty clay to clay.

This soil is used for sugarcane. Small acreages are used for homesites. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3)

Paia silty clay, 7 to 15 percent slopes (PcC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Included in mapping were small, moderately steep areas.

This soil is used for sugarcane. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3)

Paia silty clay, 7 to 15 percent slopes, eroded (PcC2).—This soil is similar to Paia silty clay, 3 to 7 percent slopes, except that it is eroded. In most of the area, about 50 percent of the original surface layer has been lost. Runoff is medium, and the erosion hazard is moderate to severe. In places roots penetrate to a depth of 3 or 4 feet.

This soil is used for sugarcane. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pasture group 3)

Pakala Series

This series consists of well-drained soils on alluvial fans and bottom lands on the island of Kauai. These soils developed in alluvium. They are nearly level to moderately sloping. Elevations range from nearly sea level to 400 feet. The annual rainfall amounts to 25 to 40 inches. The mean annual soil temperature is 73° to 75° F. Pakala soils are geographically associated with Makaweli soils.

These soils are used for irrigated sugarcane, pasture, truck crops, and homesites. The natural vegetation consists of koa haole, kiawe, bermudagrass, mango, and associated plants.

Pakala clay loam, 0 to 2 percent slopes (PdA).—This soil is on bottom lands and alluvial fans. Included in mapping were small areas where the surface layer is sandy loam.

In a representative profile the surface layer is dark reddish-brown clay loam about 16 inches thick. The next layer, about 6 inches thick, is dark reddish-brown very fine sandy loam that is massive. Below this is stratified alluvium that ranges from sandy loam to clay loam in texture. The surface layer is very strongly acid. Below the surface layer, the soil is medium acid.

Permeability is moderate. Runoff is very slow, and the erosion hazard is no more than slight. This soil is subject to infrequent nondamaging overflow. The available water capacity is about 1.7 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 21°56′20.6″ N. and long. 159°38′28.0′ W.

Ap—0 to 16 inches, dark reddish-brown (2.5YR 3/3) clay loam, dark red (2.5YR 3/6) when dry; moist rubbed color is dark reddish brown (5YR 3/3); weak, fine, subangular blocky structure; slightly hard, firm, sticky and plastic; compacted by tillage; plentiful medium, fine, and very fine roots; slight effervescence with hydrogen peroxide; very strongly acid; abrupt, smooth boundary. 15 to 17 inches thick.

AC—16 to 22 inches, dark reddish-brown (2.5YR 3/3) very fine sandy loam, dark reddish brown (5YR 3/4) when dry; massive; slightly hard, very friable, slightly sticky and plastic; plentiful medium and fine roots; common fine pores; slight effervescence with hydrogen peroxide; under hand lens, material appears to be made up of very fine, sand-size particles; medium acid; abrupt, smooth boundary. 5 to 7 inches thick.

C1—22 to 27 inches, very dusky red (10R 2/3) silt loam, dark reddish brown (5YR 3/4) when dry; massive; soft, very friable, nonsticky and slightly plastic, and weakly smeary; plentiful medium and fine roots; common fine pores; very slight effervescence with hydrogen peroxide; many small pieces of charcoal that are very smeary; medium acid; abrupt, smooth boundary. 4 to 6 inches thick.

C2—27 to 60 inches, dusky-red (10R 3/3) silty clay loam, reddish brown (2.5YR 4/4) when dry; massive; slightly hard, very friable, sticky and plastic; few medium and fine roots; many fine pores; slight effervescence with hydrogen peroxide; horizon stratified with a layer of highly weathered gravel and sand at a depth of 44 to 46 inches and, at a depth of 54 inches, with a ½-inch layer of very dusky red (2.5YR 2/2), smeary material; under hand lens, material has appearance of being made up of very fine sand; medium acid.

The A and C horizons range from 10R to 5YR in hue, from 2 to 4 in value, and from 2 to 4 in chroma. The texture of the C horizon ranges from sandy loam to clay loam. Because of stratification, the thickness and texture of the horizons vary greatly within short distances.

This soil is used for sugarcane and pasture. A small acreage is used for truck crops. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2; woodland group 4)

Pakala clay loam, 2 to 10 percent slopes (PdC).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane and pasture. (Capability classification IIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 2; woodland group 4)

Pakala extremely stony sandy clay loam, 0 to 12 percent slopes (PHXC).—This soil is similar to Pakala clay loam, 0 to 2 percent slopes, except that it is extremely stony and includes areas where the soil is gently and moderately sloping. Stones make up about 30 percent, by volume, of the subsoil. Runoff is slow, and the erosion hazard is slight.

This soil is used for pasture and woodland. (Capability classification VIIs, nonirrigated; pasture group 2; woodland group 4)

Pamoa Series

This series consists of well-drained soils on uplands on the islands of Molokai, Lanai, and Oahu. These soils formed in fine-textured old alluvium. They are gently sloping to moderately steep. Elevations range from 100 to 1,500 feet. The annual rainfall amounts to 15 to 30 inches, most of which occurs from November to April. The mean annual soil temperature is 72° F. Pamoa soils are geographically associated with Lahaina soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of kiawe, ilima, uhaloa, pitted beardgrass, and fuzzy top.

Pamoa silty clay, 5 to 20 percent slopes (PlD).—This soil is gently sloping to moderately steep. Included in mapping were small, eroded areas and small, stony areas.

In a representative profile the surface layer, about 7 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The subsoil, about 55 inches thick, is dark reddish-brown clay and silty clay that has subangular blocky structure. The clay is very sticky and very plastic when wet but friable when moist. The substratum is soft, weathered rock. The soil is neutral in the surface layer and in the upper part of the subsoil and slightly acid to very strongly acid in the lower part.

Permeability is moderately slow. Runoff is medium, and the erosion hazard is moderate to severe. This soil is susceptible to gullying and piping. The available water capacity is about 1.2 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult because of the very sticky and very plastic clay.

Representative profile: Island of Molokai, lat. 21°08′06″ N. and long. 157°10′11″ W.

A1—0 to 7 inches, dark reddish-brown (5YR 3/3), moist and dry, silty clay; dark reddish brown (5YR 3/4) when crushed, moist; moderate, very fine to medium, subangular blocky structure breaking to moderate, fine and medium, granular; hard, friable, sticky and very plastic; many roots; few, thin, patchy coatings on peds; many manganese concretions; violent effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 6 to 8 inches thick.

B1—7 to 15 inches, dark reddish-brown (5YR 3/4), moist and dry, clay; moderate, very fine and fine, subangular blocky structure; pockets of loose material that has very fine, subangular blocky structure; slightly hard, friable, very sticky and very plastic; many roots; many, very fine and fine, tubular pores; few, thin, patchy coatings on peds; many, fine, black concretions; strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 5 to 8 inches thick.

B21—15 to 32 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay; moderate, very fine to medium, subangular blocky structure; hard, friable, very sticky and very plastic; many roots; many, very fine, tubular pores and common, fine, tubular pores; common organic stains in root channels; many patchy stress cutans; strong effervescence with hydrogen peroxide; firm in place; slightly acid; clear, wavy boundary. 15 to 18 inches thick.

B22—32 to 40 inches, dark reddish-brown (5YR 3/4), moist and dry, clay; strong, very fine and fine, angular and subangular blocky structure; hard, friable, very sticky and very plastic; many roots; many, very fine, tubular pores and common, fine, tubular pores; continuous, weakly grooved stress cutans; firm in place; common organic stains in root channels; strong effervescence with hydrogen peroxide; strongly acid; gradual, wavy boundary. 7 to 9 inches thick.

B23—40 to 62 inches, dark reddish-brown (5YR 3/4), moist and dry, clay; few, fine, distinct, dark-brown mottles along some major root channels; moderate, coarse, subangular blocky structure breaking to moderate and strong, very fine and fine, angular and subangular blocky; hard, friable, very sticky and very plastic; many roots; many, very fine, tubular pores; continuous stress cutans and coatings on peds; many black stains; strong effervescence with hydrogen peroxide; very strongly acid.

Few to many, vertical tubular holes, a few inches to 5 feet in diameter and 2 to 10 feet deep, occur throughout this soil. A strong, granular surface mulch, ½ inch to 2 inches thick, forms upon drying. Cracks, ½ inch to 2 inches wide and several feet deep, occur when the soil is dry. The texture of the solum ranges from clay to silty clay. The profile ranges from 5YR to 2.5YR in hue. The A horizon ranges from 2 to 3 in chroma when moist. The B horizon ranges from 2 to 3 in value when moist and from 3 to 6 in chroma when moist or dry.

This soil is used for pasture and wildlife habitat. It can be used for cultivated crops, but in most places it occurs in association with soils that are poorly suited to cultivation. (Capability classification IVe, nonirrigated; pasture group 3)

Pamoa silty clay, 5 to 20 percent slopes, eroded (PID2).—On this soil, runoff is medium and the erosion hazard is severe. Both sheet and gully erosion are active. In most places about 75 percent of the surface layer has been removed. There are common shallow and moderately deep gullies that have cut into and channeled away part of the subsoil. Workability is difficult. Included in mapping were a few small, stony areas.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 3)

Pamoa stony silty clay, 5 to 20 percent slopes, eroded (PJD2).—This soil has a profile like that of Pamoa silty clay, 5 to 20 percent slopes, except for erosion and stoniness. Runoff is medium, and the erosion hazard is severe. Both sheet erosion and gully erosion are active. Most of the surface layer has been removed, and gullies are common. The gullies are steep sided, and many extend to the bedrock. The gullies and stones make workability difficult.

This soil is used for pasture and wildlife habitat. (Capability classification VIe, nonirrigated; pasture group 3)

Pane Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash. They are moderately sloping to moderately steep. Elevations range from 2,000 to 3,500 feet. The annual rainfall amounts to 30 to 50 inches; it is well distributed throughout the year. The mean annual soil temperature is 66° F. Pane soils are geographically associated with Haliimaile, Kaipoioi, and Kula soils.

These soils are used for pasture and wildlife habitat. Small acreages are used for truck crops, pineapple, and homesites. The natural vegetation consists of burclover, dallisgrass, plantain, rattailgrass, vetch, and white clover.

Pane silt loam, 7 to 25 percent slopes (PXD).—This soil is on rough side slopes and intermediate slopes in the uplands. Included in mapping were small areas of Haliimaile and Kaipoioi soils. Also included were small areas of moderately shallow soils and soils that have a gravelly surface layer. In addition, small areas where the topography is undulating were included.

In a representative profile the surface layer is dark reddish-brown silt loam about 8 inches thick. The subsoil, about 49 inches thick, is dark reddish-brown, reddish-brown, and dark-brown silt loam and loam that has prismatic and subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is slightly acid in the surface layer and neutral in the subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.8 inches per foot in the surface layer and subsoil.

Representative profile: Island of Maui, lat. 20°49′30″ N. and long. 156°18′40″ W.

Ap—0 to 8 inches, dark reddish-brown (5YR 3/3) silt loam, reddish brown (5YR 4/3) when dry; strong, fine and very fine, granular structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine and very fine roots; many fine pores; slight effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 9 inches thick.

B21—8 to 16 inches, dark reddish-brown (5YR 3/4) silt loam, reddish brown (5YR 4/4) when dry; weak, coarse, prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine roots; many fine pores; neutral; clear, smooth boundary. 6 to 9 inches thick.

B22—16 to 29 inches, dark reddish-brown (5YR 3/4) loam, reddish brown (5YR 4/4) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; abundant fine and medium roots; many fine pores; many sand-size aggregates that are resistant to crushing; 2 to 3 percent gravel; neutral; gradual, irregular boundary. 10 to 15 inches thick.

B23—29 to 39 inches, reddish-brown (5YR 4/4) silt loam, reddish brown (5YR 5/4) when dry; weak, fine and very fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; plentiful fine and medium roots; many fine pores; neutral; clear, wavy boundary. 8 to 11 inches thick.

B3—39 to 57 inches, dark-brown (7.5YR 3/2) gravelly loam, brown (7.5YR 5/4) when dry; weak, fine and very fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; few fine roots; many fine and medium pores; 20 to 30 percent gray, highly weathered, pebble-size rock fragments; neutral; abrupt, wavy boundary. 17 to 19 inches thick.

IIC—57 to 65 inches, brown (10YR 4/3) very gravelly loam, pale brown (10YR 6/3) when dry; weak, fine, subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic, and weakly smeary; few fine roots; many fine pores; 50 to 70 percent strongly weathered, pebble-size and cobblestone-size rock fragments; neutral.

The solum is more than 40 inches thick. A few pebbles, cobblestones, and stones occur on the surface in some areas. The A horizon ranges from 5YR to 10YR in hue and from 2 to 3 in value and chroma when moist. The B horizon ranges from 5YR to 7.5YR in hue; from 3 to 4 in value when moist and 4 to 5 when dry; and from 2 to 4 in chroma, moist or dry. The texture of the B horizon ranges from loam to silty clay loam.

This soil is used for pasture and wildlife habitat. Small acreages are used for truck crops, pineapple, and homesites. (Capability classification IVe, nonirrigated; pasture group 5; woodland group 3)

Papaa Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils formed in colluvium and residuum derived from basalt. They are moderately sloping to very steep. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 30 to 45 inches, most of which occurs between November and April. The mean annual soil temperature is 73° F. Papaa soils are geographically associated with Alaeloa and Kokokahi soils, near Kailua.

These soils are used for pasture. The natural vegetation consists of guava, Java plum, klu, koa haole, Christmas berry, lantana, sourgrass, and ricegrass.

Papaa clay, 35 to 70 percent slopes (PYF).—This soil has convex, very steep slopes. Included in mapping were small areas of Alaeloa soils and small, eroded spots. Also included were small, stony areas and basalt outcrops near the ridgetops.

In a representative profile the surface layer is very dark brown clay about 12 inches thick. The next layers are dark reddish-brown and dark reddish-gray clay that has prismatic structure. They extend to a depth of about 24 inches. Below this is clay to silty clay loam that has a variegated color pattern of grays, browns, and yellows. Soft, weathered rock is at a depth of about 40 inches. The clays in this soil are very sticky and very plastic, and they crack widely when dry. The soil is slightly acid throughout the profile.

Permeability is slow. Runoff is rapid, and the erosion hazard is severe. The available water capacity is about 1.4 inches per foot of soil. Roots penetrate to a depth of 40 inches or more.

Representative profile: Island of Oahu, lat. 21°22′04″ N. and long. 157°44′11″ W.

Ap—0 to 12 inches, very dark brown (10YR 2/2) clay, some dark-brown (7.5YR 4/2) material mixed by churning, very dark gray (10YR 3/1) when dry; moderate, very fine and fine, granular mulch in upper ½ inch to 1 inch and strong, fine, subangular blocky structure below; hard, firm, very sticky and very plastic; abundant fine and medium roots; common, fine and very fine, tubular and interstitial pores; few wormholes and worm casts; common, fine, dark-gray, highly weathered rock fragments; common shiny specks; slight effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 14 inches thick.

AC—12 to 19 inches, dark reddish-brown (5YR 3/2), moist and dry, clay; moderate, coarse, prismatic structure; hard, firm, very sticky and very plastic; abundant fine and medium roots; many, very fine, tubular pores and few, fine, tubular pores; common wormholes and worm casts that are thickly coated with very dark gray gelatinous material; few, fine, angular rock fragments; slight effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 9 inches thick.

C1—19 to 24 inches, dark reddish-gray (5YR 4/2), moist and dry, clay; weak, coarse, prismatic structure; hard, very firm, very sticky and very plastic; abundant fine and medium roots; common, very fine and fine, tubular pores; root channels lined with very dark gray material; common prominent slickensides; few fine rock fragments; slight effervescence with hydrogen peroxide; slightly acid; abrupt, wavy boundary. 4 to 8 inches thick.

C2—24 to 28 inches, variegated color pattern of grayish-brown (10YR 5/2) and dark grayish-brown (10YR 4/2) clay; strong, coarse, prismatic structure; extremely hard, firm, very sticky and very plastic; abundant fine and medium roots; common fine and medium pores; peds coated with shiny specks; many thick, deeply grooved slickensides; slightly acid; abrupt, wavy boundary. 2 to 10 inches thick.

C3—28 to 40 inches, mixture of brown (10YR 5/3), dark yellowish-brown (10YR 4/4), and dark grayish-brown (10YR 4/2) silty clay loam; massive; slightly hard, friable, slightly sticky and slightly plastic; plentiful fine and medium roots; common, fine, tubular pores; few, fine, highly weathered rock fragments; slightly acid.

C4—40 inches, slightly to moderately weathered basalt.

The depth to bedrock is more than 40 inches. The amount of stones in the profile ranges from 5 to 40 percent. The A horizon ranges from 5YR to 10YR in hue and from 2 to 3 in value when moist. The AC and C horizons range from 10YR to 5YR in hue.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 3; woodland group 1)

Papaa clay, 6 to 20 percent slopes (PYD).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is difficult.

This soil is used for pasture. (Capability classification IVe, nonirrigated; pasture group 3; woodland group 1)

Papaa clay, 20 to 35 percent slopes (PYE).—On this soil, runoff is medium to rapid and the erosion hazard is moderate to severe. Workability is difficult.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 3; woodland group 1)

Paumalu Series

This series consists of well-drained silty clay soils on uplands in the northern part of Oahu. These soils developed in old alluvium and colluvium derived from basic igneous rock. They are gently sloping to very steep. Elevations range from 700 to 1,000 feet. The annual rainfall amounts to 50 to 70 inches and is well distributed throughout the year. The mean annual soil temperature is 71° F. Paumalu soils are geographically associated with Kemoo soils, near Kahuku.

These soils are used for pasture and sugarcane. The natural vegetation consists of guava, waiwe, Christmas berry, ricegrass, and carpetgrass.

Paumalu silty clay, 15 to 25 percent slopes (PeD).—This soil occurs as small, irregularly shaped areas. Included in mapping were small, eroded areas.

In a representative profile the surface layer and the subsoil are dark reddish-brown silty clay that has subangular and angular blocky structure. The surface layer is about 9 inches thick, and the subsoil is 30 to more than 60 inches thick. The substratum is highly weathered gravel. The soil is very strongly acid in the surface layer and strongly acid to medium acid in the subsoil.

Permeability is moderately rapid. Runoff is medium, and the erosion hazard is moderate. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult because of the slope.

Representative profile: Island of Oahu, lat. 21°40′18″ N. and long. 158°01′02″ W.

A1—0 to 9 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; strong, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant fine and medium roots; many, very fine and fine, interstitial and tubular pores; few highly weathered pebbles; very strongly acid; abrupt, smooth boundary. 8 to 12 inches thick.

B21—9 to 17 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant fine roots; common, fine and very fine, tubular pores; few highly weathered pebbles; common black stains; strongly acid; clear, smooth boundary. 5 to 9 inches thick.

B22t—17 to 33 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; moderate, very fine and fine, angular and subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; common, very fine, tubular pores; common black stains; thin, continuous clay films on peds and in pores; few highly weathered pebbles; medium acid; gradual, smooth boundary. 10 to 16 inches thick.

B31t—33 to 48 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; strong, fine, blocky structure; few fine roots; few, fine, tubular pores; thin, continuous, dark-red (2.5YR 3/6) clay films on peds and in pores; common highly weathered pebbles; medium acid; clear, wavy boundary. 12 to 15 inches thick.

B32—48 to 70 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/4) when dry; strong, fine, blocky structure; few, fine, tubular pores; thin, continuous, dark-red (2.5YR 3/6) clay films on peds and in pores; 40 to 50 percent highly weathered gravel; medium acid; clear, wavy boundary.

The depth to highly weathered gravel ranges from 30 to more than 60 inches. The B horizon ranges from 3 to 4 in value when moist and from 4 to 6 in chroma, moist or dry. Effervescence with hydrogen peroxide ranges from none to moderate in the A horizon.

This soil is used for pasture and sugarcane. (Capability classification IVe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Paumalu silty clay, 3 to 8 percent slopes (PeB).—On this soil, runoff is slow and the erosion hazard is slight. Workability is easy.

This soil is used for sugarcane and pasture. (Capability classification IIe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Paumalu silty clay, 8 to 15 percent slopes (PeC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult.

This soil is used for sugarcane and pasture. (Capability classification IIIe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Paumalu silty clay, 25 to 40 percent slopes (PeE).—On this soil, runoff is medium to rapid and the erosion hazard is moderate to severe.

This soil is used for pasture and sugarcane. (Capability classification VIe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Paumalu silty clay, 40 to 70 percent slopes (PeF).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for pasture. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Paumalu-Badland complex (PZ).—In this complex Paumalu soils make up 40 to 80 percent of the acreage. The slope is 10 to 70 percent.

The Paumalu soils are similar to Paumalu silty clay, 15 to 25 percent slopes, except for the slope. Runoff is medium to rapid, and the erosion hazard is moderate to severe.

Badland consists of nearly barren land that has remained after the Paumalu soils were removed by wind and water erosion. Runoff is rapid, and the erosion hazard is very severe. About 80 percent of the Badland part occurs in the direction of the trade winds. Rock outcrop, Stony land, Stony steep land, and Rock land were included in mapping, and they make up as much as 25 percent of the area.

This complex is used for pasture and military purposes. (Paumalu part is in capability classification VIIe, nonirrigated; pasture group 8; woodland group 7. Badland part is in capability classification VIIIe, nonirrigated)

Pauwela Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They are gently sloping to moderately steep. Elevations range from 150 to 1,500 feet. The annual rainfall amounts to 70 to 120 inches; it is well distributed throughout the year. The mean annual soil temperature is 70° F. Pauwela soils are geographically associated with Haiku and Kailua soils.

These soils are used for pasture and water supply. Small acreages are used for pineapple and woodland. The natural vegetation consists of californiagrass, guava, and ricegrass.

Pauwela clay, 3 to 7 percent slopes (PfB).—This soil is on smooth uplands. Included in mapping were small areas of Haiku and Kailua soils.

In a representative profile the surface layer is dark grayish-brown clay about 12 inches thick. The subsoil, about 21 inches thick, is dark reddish-brown clay that has angular blocky and subangular blocky structure. The substratum is soft, weathered basic igneous rock. The soil is very strongly acid to extremely acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°55′26″ N. and long. 156°16′24″ W.

Ap1—0 to 6 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine and fine roots; many fine pores; common sand-size aggregates that are resistant to crushing; many, very fine, glistening specks; high bulk density; few yellowish-red (5YR 4/6) particles from the upper part of the B horizon mixed in by plowing; slight effervescence with hydrogen peroxide; very strongly acid; clear, wavy boundary. 4 to 7 inches thick.

Ap2—6 to 12 inches, dark grayish-brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) when dry; moderate, fine, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine and fine roots; many fine pores; common sand-size aggregates that are resistant to crushing; many, very fine, glistening specks; high bulk density; few yellowish-red (5YR 4/6) particles from the upper part of the B horizon mixed in by plowing; slight effervescence with hydrogen peroxide; few small pockets of very dark brown (10YR 2/2) and black (10YR 2/1), massive, heavy mineral concentration; extremely acid; abrupt, wavy boundary. 5 to 7 inches thick.

B21t—12 to 17 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/4) when dry; moderate, very fine and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine roots; many, very fine and fine, tubular pores; many sand-size aggregates that are resistant to crushing; moderately thick, patchy clay films; slight effervescence with hydrogen peroxide; extremely acid; gradual, wavy boundary. 4 to 6 inches thick.

B22t—17 to 25 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 4/4) when dry; strong, fine and very fine, angular blocky structure; hard, firm, sticky and plastic; few very fine roots; common, fine, tubular pores and few, medium, tubular pores; nearly continuous, moderately thick clay films; common, very fine, yellowish-red (5YR 4/6) and brown (7.5YR 4/4) crumbs on some peds; common sand-size aggregates that are resistant to crushing; more compact than the B21t horizon; contains a few yellowish-red sheets, 2 to 10 millimeters thick; slight effervescence with hydrogen peroxide; very strongly acid; clear, wavy boundary. 6 to 10 inches thick.

B23t—25 to 33 inches, dark reddish-brown (5YR 3/4) clay, reddish brown (5YR 4/4) when dry; strong, very fine and fine, angular blocky structure; hard, firm, sticky and plastic; few very fine roots; common, very fine and fine, tubular pores; nearly continuous, moderately thick clay films; common, very fine, yellowish-red (5YR 4/6) and brown (7.5YR 4/4) crumbs on some peds; common sand-size aggregates that are resistant to crushing; few, fine, very dark brown (10YR 2/2), weathered basic igneous pebbles; a few yellowish-red (5YR 4/6) silty clay sheets (1/4 inch to 1 1/4 inches thick) that have weak, subangular blocky structure and a few roots matted on the surface; slight effervescence with hydrogen peroxide; very strongly acid; gradual, wavy boundary. 6 to 9 inches thick.

C1—33 to 42 inches, strong-brown (7.5YR 5/6) and yellowish-red (5YR 4/6) silty clay, reddish yellow (7.5YR 6/6) and yellowish red (5YR 5/6) when dry; moderate, fine and very fine, subangular and angular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; 70 to 90 percent of horizon consists of very dark brown (10YR 2/2), highly weathered basic igneous rock; few veins and sheets of soft gibbsite, 1/16 to 1/4 inch thick; slight effervescence with hydrogen peroxide; very strongly acid; gradual, wavy boundary. 7 to 12 inches thick.

C2—42 to 54 inches, strong-brown (7.5YR 5/6) silty clay, reddish yellow (7.5YR 6/6) when dry; weak, fine and very fine, subangular blocky structure; soft, friable, slightly sticky and slightly plastic; many, very fine, tubular pores; 80 to 95 percent of horizon consists of highly weathered basic igneous rock; common veins of soft gibbsite, 1/16 to 1/4 inch thick; very strongly acid.

The depth to soft, weathered rock ranges from 30 to more than 60 inches. The A horizon ranges from 10YR to 2.5Y in hue, from 3 to 4 in value when moist, and from 2 to 4 in chroma when dry. The B horizon ranges from 5YR to 7.5YR in hue, from 3 to 4 in value when moist and 4 to 6 when dry, and from 3 to 5 in chroma when moist and 4 to 6 when dry. The texture is silty clay or clay.

This soil is used for pasture and water supply. Small acreages are used for pineapple and woodland. (Capability classification IIe, nonirrigated; pineapple group 7; pasture group 8; woodland group 7)

Pauwela clay, 7 to 15 percent slopes (PfC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for pasture and water supply. Small acreages are used for woodland. (Capability classification IIIe, nonirrigated; pineapple group 8; pasture group 8; woodland group 7)

Pauwela clay, 15 to 25 percent slopes (PfD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were areas that are steep and moderately eroded. This soil is used for pasture and woodland. (Capability classification IVe, nonirrigated; pineapple group 8; pasture group 8; woodland group 7)

Pearl Harbor Series

This series consists of very poorly drained soils on nearly level coastal plains on the island of Oahu. These soils developed in alluvium overlying organic material. Elevations range from nearly sea level to 5 feet. The annual rainfall amounts to 18 to 40 inches. The mean annual soil temperature is 74° F. Pearl Harbor soils are geographically associated with Hanalei, Kaloko, and Keaau soils.

These soils are used for taro, sugarcane, and pasture. The natural vegetation consists of cattails, mangrove trees, californiagrass, and sedges.

Pearl Harbor clay (Ph).—This soil is on low coastal plains adjacent to the ocean. It is level or nearly level. Included in mapping were small areas of Kaloko and Keaau soils.

In a representative profile the surface layer is very dark gray, mottled clay about 12 inches thick. The subsoil, about 19 inches thick, is very dark gray and very dark grayish-brown, mottled clay that has angular and subangular blocky structure. The substratum is muck or peat. The soil is neutral in the surface layer and mildly to moderately alkaline in the subsoil.

Permeability is very slow. Runoff is very slow to ponded, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 2 to 4 feet. Workability is very difficult.

Representative profile: Island of Oahu, lat. 21°22′19″ N. and long. 158°01′47″ W.

Ap—0 to 12 inches, very dark gray (10YR 3/1) clay; many, fine, strong-brown (7.5YR 5/6), prominent mottles on peds and in pores; dark gray (10YR 4/1) when dry; strong, fine and medium, granular structure and fine, subangular blocky; very hard, firm, very sticky and very plastic; abundant very fine and fine roots; common, very fine and fine, tubular pores and few, medium, tubular pores; common wormholes and worm casts; moderate effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 8 to 12 inches thick.

B21g—12 to 20 inches, very dark gray (10YR 3/1) clay; many strong-brown (7.5YR 5/6) mottles in all pores and a few on ped faces; strong, fine and medium, subangular blocky and angular blocky structure; very hard, firm, very sticky and very plastic; abundant very fine and fine roots; common, very fine and fine, tubular pores and few, medium, tubular pores; thin, intermittent, horizontal layers of ironstone; moderate effervescence with hydrogen peroxide; mildly alkaline; gradual, smooth boundary. 6 to 8 inches thick.

B22g—20 to 25 inches, very dark gray (10YR 3/1) clay; fine pores are lined with strong-brown (7.5YR 5/6) mottles; moderate, fine and medium, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine roots; many, very fine, tubular pores and common, fine, tubular pores; slight effervescence with hydrogen peroxide; few fine shells that effervesce with hydrochloric acid; moderately alkaline; gradual, smooth boundary. 3 to 7 inches thick.

B23g—25 to 31 inches, very dark grayish-brown (10YR 3/2) clay; many, fine, strong-brown (7.5YR 5/6) mottles in pores and on ped surfaces, grayish brown (10YR 5/2) when dry; moderate, fine and medium, subangular blocky structure; hard, firm, very sticky and very plastic; few very fine roots; many, very fine, tubular pores; few, fine and coarse, tubular pores; wormholes and worm casts; many small shells; strong effervescence with hydrogen peroxide; moderate effervescence with hydrochloric acid on soil mass; violent effervescence on shells; moderately alkaline; abrupt, smooth boundary. 3 to 6 inches thick.

1b—31 to 37 inches, very dark grayish-brown muck; few, fine, strong-brown (7.5YR 5/6) mottles; massive; very hard, friable, slightly sticky and slightly plastic; plentiful roots; common, fine, tubular pores; few shells; few, fine, black fragments of tuff; thin, discontinuous, vertical bands of ironstone; moderate effervescence with hydrogen peroxide; strong effervescence with hydrochloric acid; mildly alkaline; clear, smooth boundary. 4 to 6 inches thick.

2b—37 to 48 inches, very dark gray (10YR 3/1) muck, gray (10YR 6/1) when dry; massive; hard, friable, sticky and plastic; few roots; few, very fine, tubular pores; brackish water table at a depth of 40 inches; few rounded pebbles; mildly alkaline.

The depth to the buried muck or peat ranges from 20 to 33 inches. The brackish water table is at approximately the same depth. In places as much as 5 percent of the buried horizons is coral sand or shells. The solum ranges from 7.5YR to 10YR in hue and from 2 to 4 in value when moist. When dry, the A and B horizons range from 4 to 6 in value and from 0 to 1 in chroma.

This soil is used for sugarcane, taro, bananas, and pasture. (Capability classification IVw, irrigated or nonirrigated; pasture group 7; woodland group 4)

Pohakupu Series

This series consists of well-drained soils on terraces and alluvial fans on the islands of Oahu and Kauai. These soils formed in old alluvium derived from basic igneous material. They are nearly level to moderately sloping. Elevations range from 50 to 250 feet. The annual rainfall amounts to 40 to 60 inches. The mean annual soil temperature is 73° F. Pohakupu soils are geographically associated with Alaeloa, Papaa, and Lihue soils.

These soils are used for sugarcane, pineapple, truck crops, pasture, and homesites. The natural vegetation consists of guava, Christmas berry, Japanese tea, koa haole, and kikuyugrass.

Pohakupu silty clay loam, 0 to 8 percent slopes (PkB).—This soil has smooth slopes and occurs on terraces and alluvial fans. The slopes are mainly 3 to 8 percent. Included in mapping were small areas of Alaeloa and Waialua soils and small areas where the slope is as much as 15 percent. Also included on Kauai were small areas where the texture is silty clay and small areas that have a hue of 2.5YR in the subsoil.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 13 inches thick. The subsoil, 40 to more than 60 inches thick, is dark reddish-brown and dark-brown silty clay loam that has angular and subangular blocky structure. The substratum is strongly weathered gravel. The soil is slightly acid to medium acid.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°22′53″ N. and long. 157°45′16″ W.

Ap—0 to 13 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; common wormholes and worm casts; moderate effervescence with hydrogen peroxide; slightly acid; abrupt, smooth boundary. 8 to 13 inches thick.

B21—13 to 21 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/4) when dry; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and plastic; abundant roots; many, very fine and fine, tubular pores; common, patchy pressure cutans; slight effervescence with hydrogen peroxide; slightly acid; abrupt, smooth boundary. 4 to 9 inches thick.

B22—21 to 38 inches, dark-brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) when dry; strong, very fine, blocky and subangular blocky structure; hard, friable, sticky and plastic; plentiful roots; many, very fine and fine, tubular pores; continuous pressure cutans on ped surfaces; few highly weathered pebbles; many black stains in pores and on peds; stains show strong effervescence with hydrogen peroxide; slightly acid; clear, irregular boundary. 4 to 17 inches thick.

B23—38 to 50 inches, dark-brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) when dry; strong, very fine, angular and subangular blocky structure; hard, friable, sticky and plastic; few roots; many, very fine and fine, tubular pores; strong, continuous pressure cutans; few highly weathered pebbles; common black stains that effervesce with hydrogen peroxide; slightly acid; clear, irregular boundary. 12 to 20 inches thick.

B3—50 to 76 inches, dark-brown (7.5YR 3/4) silty clay loam, brown (7.5YR 4/4) when dry; strong, very fine, angular and subangular blocky structure; hard, friable, slightly sticky and plastic; few roots; many, very fine and fine. tubular pores; nearly continuous pressure cutans; few highly weathered pebbles; few, fine, black stains that effervesce with hydrogen peroxide; slightly acid.

Effervescence with hydrogen peroxide ranges from slight to moderate in the upper part of the profile and from slight to none below. The structure in the B horizon ranges from moderate to strong. In places a few boulder cores occur within the lower part of the profile. The A horizon ranges from 2 to 3 in chroma and value when moist. The B horizon ranges from 7.5YR to 5YR in hue and from 3 to 4 in chroma and value when moist.

This soil is used for pasture, truck crops, and homesites on Oahu and for sugarcane and pineapple on Kauai. (Capability classification IIe if irrigated, IIIe if nonirrigated; sugarcane group 1; pasture group 6; woodland group 5)

Pohakupu silty clay loam, 8 to 15 percent slopes (PkC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult because of the slope.

Included in mapping were small areas where the surface layer and part of the subsoil have been removed. Also included, near the drainageways, were areas where the slope ranges from 15 to 25 percent.

This soil is used for pasture. (Capability classification IIIe, nonirrigated; sugarcane group 1; pasture group 6; woodland group 5)

Pooku Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are nearly level to steep. Elevations range from 250 to 1,000 feet. The annual rainfall amounts to 80 to 150 inches. The mean annual soil temperature is 72° F. Pooku soils are geographically associated with Makapili soils.

These soils are used for pasture, sugarcane, wildlife habitat, and water supply. The natural vegetation consists of kikuyugrass, pangolagrass, guava, joee, sensitiveplant, ricegrass, yellow foxtail, Java plum, and associated plants.

Pooku silty clay, 0 to 8 percent slopes (PmB).—This soil is on the tops of broad interfluves in the uplands. Included in mapping were about 60 acres east of Anini Stream. The included soil has a yellowish-brown subsoil.

In a representative profile the surface layer is dark-brown silty clay about 14 inches thick. The subsoil, about 48 inches thick, is dark-red and dark reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The soil is strongly acid to extremely acid throughout the profile.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°12′23.1″ N. and long. 159°29′53″ W.

Ap1—0 to 11 inches, dark-brown (10YR 4/3) silty clay, yellowish brown (10YR 5/4) when dry; strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; many ironstone-gibbsite pebbles that have a dense outer shell and a softer, yellowish center; extremely acid; clear, smooth boundary. 10 to 15 inches thick.

Ap2—11 to 14 inches, dark-brown (10YR 4/3) silty clay, dark reddish brown (2.5YR 3/4) when mixed by cultivation, yellowish brown (10YR 5/4) and dark reddish brown (2.5YR 3/4) when dry; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; medium acid; abrupt, wavy boundary. 3 to 5 inches thick.

B21—14 to 28 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, dark red (2.5YR 3/6) when dry; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant fine roots; many very fine and fine pores; nearly continuous pressure cutans; few cutans that look like illuviated sesquioxides; few nonmagnetic, very firm particles that appear to be segregated iron; strongly acid; abrupt, smooth boundary. 10 to 15 inches thick.

B22—28 to 33 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; moderate, very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; nearly continuous pressure cutans; patchy, glazed coatings that appear to be sesquioxides; a few pebble-size pieces of saprolite; this horizon is capped by a thin, discontinuous ironstone seam 1 millimeter to 2 millimeters thick; a root mat has built up in places on this ironstone seam; strongly acid; clear, smooth boundary. 5 to 12 inches thick.

B23—33 to 43 inches, dark-red (2.5YR 3/6) silty clay, yellowish red (5YR 5/6) when dry; moderate, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many very fine and fine pores; pebble-size pieces of saprolite; pores filled with white material; patchy surfaces that look like pressure cutans; this horizon is capped by a very thin, discontinuous ironstone seam in which there is a buildup of roots; very strongly acid; gradual, wavy boundary. 0 to 10 inches thick.

B24—43 to 62 inches, variegated dark-red (2.5YR 3/6), yellowish-red (5YR 4/6), reddish-yellow (7.5YR 6/8), and very dusky red (2.5YR 2/2) silty clay; yellowish red (5YR 4/6) when dry; weak, medium and coarse, subangular blocky structure; hard, friable, sticky and plastic; few roots; many very fine and fine pores; few fragments of saprolite; few, thick, patchy cutans that look like clay flows; thin, platy material (probably gibbsite) gives some areas a platy appearance; very strongly acid.

The A horizon ranges from 7.5YR to 10YR in hue, from 3 to 4 in chroma, and from 3 to 4 in value. The B2 horizon ranges from 4 to 6 in chroma.

This soil is used for pasture, sugarcane, wildlife habitat, woodland, and water supply. (Capability classification IIIs, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Pooku silty clay, 8 to 15 percent slopes (PmC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for pasture, sugarcane, wildlife habitat, woodland, and water supply. (Capability classification IIIe, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Pooku silty clay, 15 to 25 percent slopes (PmD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for pasture, wildlife habitat, woodland, water supply, and sugarcane. (Capability classification IVe, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Pooku silty clay, 25 to 40 percent slopes (PmE).—This soil is similar to Pooku silty clay, 0 to 8 percent slopes, except that it is steep and the surface layer is thinner. Runoff is rapid, and the erosion hazard is severe. Included in mapping were small, eroded areas.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 10; woodland group 9)

Pooku silty clay loam, 3 to 8 percent slopes (PlB).—This soil is generally similar to Pooku silty clay, 0 to 8 percent slopes, except that the texture of the surface layer is silty clay loam and the soil has more ironstone sheets than is typical. Also, the lower part of the subsoil is yellower, has weaker structure, and has a texture of silty clay loam. Runoff is slow, and the erosion hazard is slight.

This soil is used for sugarcane, wildlife habitat, water supply, and woodland. (Capability classification IIIs, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Pooku silty clay loam, 8 to 25 percent slopes (PlD).—This soil is similar to Pooku silty clay, 0 to 8 percent slopes, except that the texture of the surface layer is silty clay loam and the soil has more ironstone sheets than is typical. Also, the lower part of the subsoil is yellower, has weaker structure, and has a texture of silty clay loam. Runoff is slow to medium, and the erosion hazard is slight to moderate.

This soil is used for sugarcane, pasture, wildlife habitat, water supply, and woodland. (Capability classification IVe, nonirrigated; sugarcane group 2; pasture group 10; woodland group 9)

Puhi Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material derived from basic igneous rock. They are nearly level to steep. Elevations range from 175 to 500 feet. The annual rainfall amounts to 60 to 80 inches. The mean annual soil temperature is 73° F. Puhi soils are geographically associated with Lihue and Kapaa soils.

These soils are used for sugarcane, pineapple, truck crops, orchards, pasture, woodland, wildlife habitat, water supply, and homesites. The natural vegetation consists of guava, Java plum, pangolagrass, kikuyugrass, elephantopus, joee, yellow foxtail, and rhodomyrtus.

Puhi silty clay loam, 0 to 3 percent slopes (PnA).—This soil is on broad interfluves on the uplands.

In a representative profile the surface layer is brown silty clay loam about 12 inches thick. The subsoil, about 48 inches thick, is reddish-brown and dark reddish-brown silty clay loam and silty clay that has subangular blocky structure. The substratum is silty clay. The surface layer is very strongly acid. The subsoil is slightly acid to medium acid.

Permeability is moderately rapid. Runoff is very slow, and there is no erosion hazard. The available water capacity is about 1.3 inches per foot of soil. In places, roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°01′14″ N. and long. 159°23′8.1″ W.

Ap—0 to 12 inches, brown (10YR 4/3) silty clay loam, brown (10YR 4/3) when rubbed, yellowish brown (10YR 5/4) when dry; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant roots; many, very fine and fine, tubular pores and common interstitial pores; many gritty particles that are hard to break down; delayed effervescence with hydrogen peroxide; very strongly acid; abrupt, wavy boundary. 11 to 14 inches thick.

B21—12 to 21 inches, reddish-brown (5YR 4/4) silty clay loam, yellowish red (5YR 4/6) when dry; weak, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; plentiful fine and very fine roots; many very fine pores and common fine pores; nearly continuous, shiny glaze on peds; patchy coatings that look like clay films on some peds; medium acid; gradual, smooth boundary. 7 to 11 inches thick.

B22—21 to 33 inches, dark reddish-brown (5YR 3/4) silty clay loam, yellowish red (5YR 4/6) when dry; common black specks; moderate, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; plentiful fine and very fine roots; many very fine pores and common fine pores; nearly continuous, shiny glaze on peds; patchy coatings that look like clay films on some peds; stringy coatings of stronger chroma; slightly acid; gradual, smooth boundary. 10 to 14 inches thick.

B23—33 to 41 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, yellowish red (5YR 4/6) when dry; moderate, very fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few very fine roots; many very fine pores and common medium pores; continuous, shiny glaze on peds; patchy coatings that look like clay films on peds; many shiny particles; many, very fine, black specks; medium acid; gradual, smooth boundary. 6 to 9 inches thick.

B24—41 to 60 inches, dark reddish-brown (5YR 3/3) silty clay, yellowish red (5YR 4/8) when dry; strong, very fine and fine, subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; many very fine and fine pores and common medium pores; continuous, shiny glaze on peds; many, very fine, black specks and shiny particles; medium acid.

The A horizon ranges from 7.5YR to 10YR in hue, from 2 to 4 in value, and from 2 to 4 in chroma. The B horizon ranges from 2.5YR to 7.5YR in hue, from 3 to 4 in value, and from 3 to 4 in chroma.

This soil is used for sugarcane, pineapple, orchards, truck crops, pasture, and homesites. (Capability classification IIs, irrigated or nonirrigated; sugarcane group 1; pineapple group 4; pasture group 8; woodland group 7)

Puhi silty clay loam, 3 to 8 percent slopes (PnB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, orchards, pasture, truck crops, and homesites. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 8; woodland group 7)

Puhi silty clay loam, 8 to 15 percent slopes (PnC).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, pineapple, pasture, and orchards. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 8; woodland group 7)

Puhi silty clay loam, 15 to 25 percent slopes (PnD).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small, eroded areas.

This soil is used for sugarcane, pineapple, orchards, pasture, woodland, wildlife habitat, and water supply. (Capability classification IVe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 8; woodland group 7)

Puhi silty clay loam, 25 to 40 percent slopes (PnE).—On this soil, runoff is rapid and the erosion hazard is severe.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Pulehu Series

This series consists of well-drained soils on alluvial fans and stream terraces and in basins. These soils occur on the islands of Lanai, Maui, Molokai, and Oahu. They developed in alluvium washed from basic igneous rock. The soils are nearly level to moderately sloping. Elevations range from nearly sea level to 300 feet. The annual rainfall amounts to 10 to 35 inches. The mean annual soil temperature is 74° F. Pulehu soils are geographically associated with Ewa, Jaucas, Kealia, Lualualei, Waialua, and Mala soils.

These soils are used for sugarcane, truck crops, pasture, homesites, and wildlife habitat. The natural vegetation consists of bermudagrass, bristly foxtail, fingergrass, kiawe, klu, lantana, koa haole, and sandbur.

Pulehu clay loam, 0 to 3 percent slopes (PsA).—This soil is on alluvial fans and stream terraces and in basins. Included in mapping were small areas of Ewa, Mala, and Waialua soils. Also included were small areas of gravelly, stony, and gently sloping soils.

In a representative profile the surface layer is dark-brown clay loam about 21 inches thick. This is underlain by dark-brown, dark grayish-brown, and brown, massive and single grain, stratified loam, loamy sand, fine sandy loam, and silt loam about 39 inches thick. Below this is coarse, gravelly or sandy alluvium. The soil is neutral in the surface layer and neutral to mildly alkaline below the surface layer.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.4 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 5 feet or more. Low areas are subject to flooding.

Representative profile: Island of Oahu, lat. 21°34′38″ N. and long. 158°09′51″ W.

Ap1—0 to 7 inches, very dark brown (10YR 2/2) clay loam, dark brown (10YR 3/3) when dry; weak, fine and medium, granular structure; hard, friable, sticky and plastic; abundant very fine and fine roots; common, fine and very fine, interstitial pores; few rounded pebbles; slight effervescence with hydrogen peroxide; neutral; gradual, smooth boundary. 5 to 8 inches thick.

Ap2—7 to 21 inches, very dark brown (10YR 2/2) clay loam, dark brown (10YR 3/3) when dry; weak, fine and medium, subangular blocky structure; hard, friable, sticky and plastic; abundant very fine and fine roots; common, fine and very fine, interstitial pores and common, fine, tubular pores; slight effervescence with hydrogen peroxide; neutral; abrupt, wavy boundary. 9 to 14 inches thick.

IIC1—21 to 33 inches, dark-brown (10YR 3/3) loam, dark brown (10YR 4/3) when dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; plentiful fine roots; common, very fine and fine, tubular pores; neutral; abrupt, wavy boundary. 8 to 12 inches thick.

IIIC2—33 to 37 inches, very dark grayish-brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) when dry; single grain; loose when dry or moist, nonsticky and nonplastic; few fine roots; porous; mildly alkaline; abrupt, wavy boundary. 0 to 6 inches thick.

IVC3—37 to 47 inches, dark-brown (10YR 3/3) fine sandy loam, dark brown (10YR 4/3) when dry; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common, fine, tubular pores; mildly alkaline; abrupt, wavy boundary. 8 to 10 inches thick.

VC4—47 to 60 inches, dark-brown (10YR 3/3) silt loam, brown (10YR 5/3) when dry; massive; slightly hard, friable, sticky and plastic; few fine roots; common, fine, tubular pores; mildly alkaline.

The main variation is in the range in thickness and texture of the layers in the C horizon. The thickness of the layers ranges from less than 1 inch to more than 12 inches. The texture ranges from sand to silty clay loam. Throughout the profile, the soil ranges from 10YR to 7.5YR in hue, from 2 to 3 in value when moist and 3 to 5 when dry, and from 1 to 3 in chroma when moist or dry. Gravel is common on the surface and is scattered throughout the profile.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu cobbly clay loam, 0 to 3 percent slopes (PtA).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that it is cobbly.

This soil is used for sugarcane. Small acreages are used for pasture. (Capability classification IIs if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu cobbly clay loam, 3 to 7 percent slopes (PtB).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small areas that have thin, stratified layers of sand and gravel at a depth of 20 to 36 inches.

This soil is used for sugarcane. Small acreages are used for pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu stony clay loam, 2 to 6 percent slopes (PuB).—On this soil, there are sufficient stones to hinder tillage but not enough to make intertilled crops impracticable. Runoff is slow, and the erosion hazard is slight.

This soil is used for sugarcane, truck crops, and pasture. Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu very stony clay loam, 0 to 12 percent slopes (PvC).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that as much as 3 percent of the surface is covered with stones. Runoff is slow to medium, and the erosion hazard is slight to moderate. Workability is difficult because of the stones.

This soil is used for pasture and wildlife habitat. (Capability classification IVs, nonirrigated; sugarcane group 1; pasture group 2)

Pulehu silt loam, 0 to 3 percent slopes (PpA).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is silt loam. This soil is used for sugarcane. Small acreages are used for homesites. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu silt loam, 3 to 7 percent slopes (PpB).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is silt loam. Runoff is slow, and the erosion hazard is slight. Included in mapping were small areas underlain by coral sand at a depth of 20 to 36 inches.

This soil is used for sugarcane. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu cobbly silt loam, 0 to 3 percent slopes (PrA).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is silt loam and there are many cobblestones on the surface. In a few places cobblestones are common throughout the profile. Included in mapping were small areas underlain by coral sand at a depth of 20 to 36 inches.

This soil is used for sugarcane and pasture. (Capability classification IIs if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu cobbly silt loam, 3 to 7 percent slopes (PrB).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is silt loam, and the surface layer is cobbly. Runoff is slow, and the erosion hazard is slight. Included in mapping were small areas underlain by coral sand at a depth of 20 to 36 inches.

This soil is used for sugarcane. Small areas are used for pasture. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu sandy loam, 2 to 6 percent slopes (PoB).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is sandy loam. Runoff is slow, and the erosion hazard is slight.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 2)

Pulehu stony sandy loam, 0 to 7 percent slopes (PoaB).—This soil is similar to Pulehu clay loam, 0 to 3 percent slopes, except that the texture is sandy loam. There are sufficient stones to hinder tillage but not enough to make intertilled crops impractical.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 2)

Puuone Series

This series consists of somewhat excessively drained soils on low uplands on the island of Maui. These soils developed in material derived from coral and seashells. They are moderately sloping to moderately steep. Elevations range from 50 to 350 feet. The annual rainfall amounts to 20 to 30 inches, most of which occurs in winter. The mean annual soil temperature is 75° F. Puuone soils are geographically associated with Iao and Jaucas soils.

These soils are used for pasture and homesites. The natural vegetation consists of bermudagrass, kiawe, and lantana.

Puuone sand, 7 to 30 percent slopes (PZUE).—This soil is on sandhills near the ocean. Included in mapping were small areas of Iao and Jaucas soils. Also included were small areas where the cemented layer is less than 20 inches below the surface.

In a representative profile the surface layer is grayish-brown, calcareous sand about 20 inches thick. This is underlain by grayish-brown, cemented sand. The soil is moderately alkaline in the surface layer.

Permeability is rapid above the cemented layer. Runoff is slow, and the hazard of wind erosion is moderate to severe. The available water capacity is about 0.7 inches per foot in the surface layer and subsoil. In places roots penetrate to the cemented layer.

Representative profile: Island of Maui, lat. 20°54′40″ N. and long. 156°29′30″ W.

C1—0 to 20 inches, grayish-brown (10YR 5/2) sand, light brownish gray (10YR 6/2) when dry; single grain; loose, nonsticky and nonplastic; abundant fine roots; porous; violent effervescence with hydrochloric acid; moderately alkaline; abrupt, wavy boundary. 20 to 40 inches thick.

C2cam—20 to 40 inches, grayish-brown (10YR 5/2), strongly cemented sand, light brownish gray (10YR 6/2) when dry; massive; very hard, very firm, nonsticky and nonplastic; few fine roots in cracks; breaks down under treatment with dilute hydrochloric acid, but not with water; violent effervescence with hydrochloric acid; strongly alkaline.

The depth to the lime hardpan ranges from 20 to 40 inches. It is common to find old root channels filled with a hard, white material that effervesces violently with hydrochloric acid.

The soil is used for pasture and homesites. (Capability classification VIIe, nonirrigated; pasture group 1)

Puu Opae Series

This series consists of well-drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are moderately sloping to steep. Elevations range from 500 to 2,500 feet. The annual rainfall amounts to 30 to 50 inches. The mean annual soil temperature is 70° F. Puu Opae soils are geographically associated with Mahana soils.

These soils are used for pasture, woodland, and wildlife habitat. A small acreage is in sugarcane. The natural vegetation consists of molassesgrass, silver oak, passion flower, puakeawe, yellow foxtail, lantana, uluhe, ti, and aalii.

Puu Opae silty clay loam, 8 to 15 percent slopes (PwC).—This soil is on the tops of ridges in the uplands.

In a representative profile the surface layer, about 10 inches thick, is dusky-red silty clay loam that has subangular blocky structure. The subsoil, more than 41 inches thick, is reddish-brown and dark reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered rock. The surface layer is medium acid to strongly acid. The subsoil is strongly acid to very strongly acid.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Kauai, lat. 22°02′16.6″ N. and long. 159°41′52″ W.

A11—0 to 7 inches, dusky-red (2.5YR 3/2) silty clay loam, weak red (2.5YR 4/2) when dry; moderate, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; abundant roots; many fine pores; strong effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 6 to 8 inches thick.

A12—7 to 10 inches, dusky-red (2.5YR 3/2) loam, dark reddish brown (2.5YR 3/3) when dry; weak, fine, subangular blocky structure; weakly coherent, very friable, slightly sticky and slightly plastic; abundant roots; many fine pores; strong effervescence with hydrogen peroxide; medium acid; clear, smooth boundary. 3 to 5 inches thick.

B1—10 to 14 inches, dark reddish-brown (2.5YR 3/3) light silty clay, reddish brown (2.5YR 4/3) when dry; moderate, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many fine pores; very few, thin clay films on ped faces; moderate effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 3 to 5 inches thick.

B21t—14 to 29 inches, reddish-brown (2.5YR 4/4) silty clay, reddish brown (2.5YR 4/4) when dry; weak, fine and very fine, subangular blocky structure; hard, firm, very sticky and plastic; plentiful roots; common fine and very fine pores; thin, patchy clay films on ped faces; no effervescence with hydrogen peroxide; strongly acid; gradual, smooth boundary. 12 to 18 inches thick.

B22t—29 to 61 inches, reddish-brown (2.5YR 4/3) silty clay, reddish brown (2.5YR 4/3) when dry; moderate, fine and very fine, angular blocky structure; hard, firm, very sticky and plastic; few roots; few fine and very fine pores; nearly continuous, moderately thick clay films on ped faces; sugarlike coatings of higher chroma in pores; strongly acid; gradual, smooth boundary. 26 to 38 inches thick.

B23t—61 inches, dark reddish-brown (2.5YR 3/4) silty clay, weak red (2.5YR 4/2) when dry; strong, fine and very fine, angular and subangular blocky structure; hard, firm, sticky and plastic; very few roots; few fine pores; glazed appearance; continuous, moderately thick clay films on ped faces; sugarlike coatings of higher chroma in pores; very strongly acid.

The profile ranges from 10R to 2.5YR in hue. The B horizon ranges from 3 to 4 in chroma and from 2 to 6 in value.

This soil is used for pasture, woodland, and wildlife habitat. A small acreage is in irrigated sugarcane. (Capability classification IIIe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Puu Opae silty clay loam, 15 to 25 percent slopes (PwD).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification IVe, irrigated or nonirrigated; pasture group 6; woodland group 5)

Puu Opae silty clay loam, 25 to 40 percent slopes (PwE).—This soil is similar to Puu Opae silty clay loam, 8 to 15 percent slopes, except that the A horizon is thinner. Runoff is rapid, and the erosion hazard is severe.

This soil is used for pasture, woodland, wildlife habitat, and water supply. (Capability classification VIe, nonirrigated; pasture group 6; woodland group 5)

Puu Pa Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in volcanic ash overlying fragmental Aa lava. They are moderately sloping to steep. Elevations range from 1,000 to 2,200 feet. The annual rainfall amounts to 20 to 35 inches. The mean annual soil temperature is 70° F. Puu Pa soils are geographically associated with Uma and Waiakoa soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of bermudagrass, indigo, lantana, and Natal redtop.

Puu Pa very stony silt loam, 7 to 40 percent slopes (PZVE).—This soil is on the southern intermediate slopes of Haleakala. The landscape is dissected by many small gulches. Included in mapping were small areas of Uma and Waiakoa soils. Also included were small, very steep areas.

In a representative profile the surface layer, about 10 inches thick, is very dark brown silt loam that has subangular blocky structure. The next layer, about 37 inches thick, is very dark brown and very dark grayish-brown silt loam that is massive. Below this is fragmental Aa lava. The soil is medium acid to slightly acid in the surface layer and neutral below the surface layer.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.7 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°39′15″ N. and long. 156°12′52″ W.

A11—0 to 5 inches, very dark brown (10YR 2/2) very stony silt loam, dark brown (10YR 3/3) when dry; weak, fine and medium, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; abundant fine roots; many fine and very fine pores; common, very fine, gritty particles that break down slowly under continued rubbing; on top of this horizon is an intermittent ash deposit as much as ¼ inch thick; very weak effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 3 to 6 inches thick.

A12—5 to 10 inches, very dark brown (10YR 2/2) gravelly and cobbly silt loam, dark brown (10YR 3/3) when dry; weak, medium, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; abundant fine roots; many fine and very fine pores; 30 to 40 percent gravel and cobblestones; slightly acid; clear, wavy boundary. 4 to 6 inches thick.

AC—10 to 15 inches, very dark brown (10YR 2/2) gravelly and cobbly silt loam, dark brown (10YR 4/3) when dry; massive; slightly hard, very friable, slightly sticky and nonplastic; abundant fine roots; many fine pores; few, fine, hard, earthy lumps; 30 to 40 percent gravel and cobblestones; a few pebbles and cobblestones are slightly weathered; neutral; clear, wavy boundary. 4 to 6 inches thick.

C1—15 to 19 inches, very dark grayish-brown (10YR 3/2) gravelly and cobbly silt loam, dark yellowish brown (10YR 4/4) when dry; massive; slightly hard, very friable, slightly sticky and nonplastic; plentiful fine roots; common fine pores; common, hard, earthy lumps; 40 to 50 percent gravel and cobblestones; a few highly weathered rock fragments; neutral; clear, wavy boundary. 3 to 6 inches thick.

C2—19 to 31 inches, very dark grayish-brown (10YR 3/2) very gravelly and cobbly silt loam, dark yellowish brown (10YR 4/4) when dry; massive; slightly hard, very friable, slightly sticky and nonplastic; plentiful fine roots; many fine pores; few, hard, earthy lumps; 60 to 70 percent gravel and cobblestones; few highly weathered rock fragments; neutral; gradual, wavy boundary. 10 to 15 inches thick.

C3—31 to 47 inches, dark-brown (10YR 3/3) very gravelly and cobbly silt loam, brown (10YR 4/3) when dry; massive; soft, very friable, slightly sticky and nonplastic; many fine pores; 70 to 80 percent gravel and cobblestones; common weathered gravel and cobblestones; neutral.

IIC4—47 inches, Aa lava and very little soil material.

The depth to Aa lava ranges from 20 to 50 inches. The A horizon ranges from 7.5YR to 10YR in hue, from 2 to 3 in value when moist, and from 2 to 3 in chroma when moist or dry. The texture is loam or silt loam. The C horizon ranges from 2 to 3 in value when moist and 3 to 4 when dry, and from 2 to 3 in chroma when moist.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 2)

Riverwash

Riverwash (rRH) consists of nearly level bars of sand, gravel, and stones along perennial and intermittent streams on the island of Kauai. In places it consists mainly of large stones and boulders. It is nearly bare of vegetation and is subject to overflow and shifting during normally high water.

Accessible areas of Riverwash are sources of material for roadbuilding and other kinds of construction. This land type, however, is used mainly for wildlife habitat. (Capability classification VIIIw, nonirrigated)

Rock Land

Rock land (rRK) is made up of areas where exposed rock covers 25 to 90 percent of the surface. It occurs on all five islands. The rock outcrops and very shallow soils are the main characteristics. The rock outcrops are mainly basalt and andesite. This land type is nearly level to very steep. Elevations range from nearly sea level to more than 6,000 feet. The annual rainfall amounts to 15 to 60 inches.

Rock land is used for pasture, wildlife habitat, and water supply. The natural vegetation at the lower elevations consists mainly of kiawe, klu, piligrass, Japanese tea, and koa haole. Lantana, guava, Natal redtop, and molassesgrass are dominant at the higher elevations. This land type is also used for urban development. In many areas, especially on the island of Oahu, the soil material associated with the rock outcrops is very sticky and very plastic. It also has high shrink-swell potential. Buildings on the steep slopes are susceptible to sliding when the soil is saturated. Foundations and retaining walls are susceptible to cracking. (Capability classification VIIs, nonirrigated)

Rock Outcrop

Rock outcrop (rRO) consists of areas where exposed bedrock covers more than 90 percent of the surface. It occurs on all five islands. The rock outcrops are mainly basalt and andesite. This land type is gently sloping to precipitous. Elevations range from nearly sea level to 10,000 feet. Included in mapping were a small area of lithified coral sand on Molokai and small areas of coral outcrop along the coasts of other islands.

This land type is not suited to farming. It is used for water supply, wildlife habitat, and recreation. (Capability classification VIIIs, nonirrigated)

Rough Broken Land

Rough broken land (rRR) consists of very steep land broken by numerous intermittent drainage channels. In most places it is not stony. It occurs in gulches and on mountainsides on all the islands except Oahu. The slope is 40 to 70 percent. Elevations range from nearly sea level to about 8,000 feet. The local relief is generally between 25 and 500 feet. Runoff is rapid, and geologic erosion is active. The annual rainfall amounts to 25 to more than 200 inches.

These soils are variable. They are 20 to more than 60 inches deep over soft, weathered rock. In most places some weathered rock fragments are mixed with the soil material. Small areas of rock outcrop, stones, and soil slips are common. Included in mapping were areas of colluvium and alluvium along gulch bottoms.

This land type is used primarily for watershed and wildlife habitat. In places it is used also for pasture and woodland. The dominant natural vegetation in the drier areas consists of guava, lantana, Natal redtop, bermudagrass, koa haole, and molassesgrass. Ohia, kukui, koa, and ferns are dominant in the wetter areas. Puakeawe, aalii, and sweet vernalgrass are common at the higher elevations. (Capability classification VIIe, nonirrigated)

Rough Broken and Stony Land

Rough broken and stony land (rRS) consists of very steep, stony gulches. The local relief is generally between 25 and 500 feet. Runoff is rapid, and geologic erosion is active. Elevations range from nearly sea level to 3,000 feet. The annual rainfall amounts to 20 to 40 inches.

The soil material is generally less than 20 inches deep over saprolite or bedrock. About 3 to 25 percent of the surface is covered with stones, and there are a few rock outcrops. Included in mapping were small areas of colluvium and alluvium along the bottoms of gulches.

This land type is used for pasture, wildlife habitat, and watershed. The dominant natural vegetation consists of lantana, koa, haole, klu, feather fingergrass, bermudagrass, and ilima. (Capability classification VIIs, nonirrigated)

Rough Mountainous Land

Rough mountainous land (rRT) occurs in mountainous areas on all islands in the survey area. Is consists of very steep land broken by numerous intermittent drainage channels. In most places it is not stony. Elevations range from nearly sea level to more than 6,000 feet. The annual rainfall amounts to 70 to more than 400 inches. Over much of the area, the soil mantle is very thin. It ranges from 1 inch to 10 inches in thickness over saprolite. In most places the saprolite is relatively soft and permeable to roots and water.

The land surface is dominated by deep, V-shaped valleys that have extremely steep side slopes and narrow ridges between the valleys. In most places the local relief exceeds 500 feet. The soil material on the narrow ridgetops is similar to that of the Amalu and Olokui series. Rock land, rock outcrop, soil slips, and eroded spots make up 20 to 40 percent of the acreage.

This land type is used for water supply, wildlife habitat, and recreation. The natural vegetation consists of ohia, false staghornfern, treefern, yellow foxtail, lantana, kukui, and puakeawe. (Capability classification VIIIe, nonirrigated)

Rubble Land

Rubble land (rRU) consists of areas where 90 percent of the surface is covered by stones or boulders. It occurs at the base of very steep to precipitous slopes in the western and southern parts of the island of Kauai. Elevations range from sea level to about 500 feet. The annual rainfall amounts to 22 to 50 inches.

This land type is used for wildlife habitat. The natural vegetation is mainly koa haole. (Capability classification VIIIs, nonirrigated)

Sandy Alluvial Land

Sandy alluvial land (rSL) occurs along the narrow coastal flats in the northern and northeastern parts of Lanai. It consists of recent stream deposits that vary widely in texture. Most areas are sandy and have few pebbles and stones. This land type is subject to flooding during the rainy season. In most places the slope is 0 to 5 percent, but in places it is as much as 15 percent. In areas exposed to strong trade winds, the sand has been blown to form a hummocky topography. Elevations range from sea level to 25 feet. The annual rainfall amounts to about 10 inches.

This land type is used for wildlife habitat. The natural vegetation consists of kiawe, bristly foxtail, and fingergrass. Some areas are bare. (Capability classification VIIw, nonirrigated)

Stony Alluvial Land

Stony alluvial land (rSM) consists of stones, boulders, and soil deposited by streams along the bottoms of gulches and on alluvial fans. In most places the slope is 3 to 15 percent. Elevations range from nearly sea level to 1,000 feet. The annual rainfall amounts to 15 to 200 inches.

This land type is suited to pasture in the dry areas and to pasture and woodland in the wet areas. The natural vegetation consists of kiawe, klu, ilima, piligrass, and lantana in the dry areas and guava, kukui, hilograss, and Christmas berry in the wet areas. Improvement of this land is difficult because of the stones and boulders. (Capability classification VIIs, nonirrigated)

Stony Blown-out Land

Stony blown-out land (rSN) occurs on knolls and gulches, mainly in the northern part of Lanai. In most places the slope is 7 to 30 percent, but gulch sides as steep as 70 percent are included. Elevations range from 1,000 to 2,000 feet. The annual rainfall amounts to 15 to 25 inches.

On this land type (fig. 8), stones, boulders, and rock outcrop are common as a result of severe erosion by wind and water. The stones and boulders overlie soft, weathered rock. Included in mapping were small areas of windblown and alluvial material similar to that of Koele soils.

This land type produces a small amount of forage that is used by deer and antelope. The natural vegetation is sparse, but there is some molassesgrass, dallisgrass, lantana, and Natal redtop. (Capability classification VIIs, nonirrigated)

Stony Colluvial Land

Stony colluvial land (rSO) occurs on talus slopes at the base of the Kalaupapa cliffs on the island of Molokai. It consists of a mixture of stones and boulders and a small amount of soil material. The slope ranges from 25 to 40 percent. Elevations range from nearly sea level to 400 feet. The annual rainfall amounts to 30 to 60 inches.

Most of this land type is idle. The very stony condition and steep slopes make pasture improvement very difficult. The natural vegetation consists of Christmas berry, koa haole, kukui, false mallow, and Java plum. (Capability classification VIIs, nonirrigated)

Stony Land

Stony land (rST) occurs in valleys and on side slopes of drainageways on the island of Oahu. It is mainly between Barbers Point and Kaena Point. It consists of a mass of boulders and stones deposited by water and gravity. The slope ranges from 5 to 40 percent. Elevations range from nearly sea level to 500 feet. The annual rainfall amounts to 18 to 60 inches. Stony land is geographically associated with Lualualei and Ewa soils.

Stones and boulders cover 15 to 90 percent of the surface. The soil among the stones consists of reddish

Figure 8.—Typical landscape of Stony blown-out land.

silty clay loam that is similar to Ewa soils and very dark grayish-brown clay that is similar to Lualualei soils. In most places there is enough soil among the stones to provide a foothold for plants.

This land type is used for wildlife habitat and recreation. The natural vegetation consists of kiawe, lantana, koa haole, bermudagrass, and annuals. (Capability classification VIIs, nonirrigated)

Stony Steep Land

Stony steep land (rSY) consists of a mass of boulders and stones deposited by water and gravity on side slopes of drainageways. It occurs on the island of Oahu. The slope ranges from 40 to 70 percent. Elevations range from 100 to 1,500 feet. The annual rainfall amounts to 20 to 80 inches.

Stones and boulders cover 50 to 90 percent of the surface. There is a small amount of soil among the stones that provides a foothold for plants. Rock outcrops occur in many places.

This land type is used for wildlife habitat and recreation. The natural vegetation consists of kiawe, koa haole, and grasses. (Capability classification VIIs, nonirrigated)

Tantalus Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in volcanic ash and material weathered from cinders. They are moderately sloping to very steep. Elevations range from 100 to 2,200 feet. The annual rainfall amounts to 50 to 150 inches. It is well distributed throughout the year. The mean annual soil temperature is 70° F. Tantalus soils are geographically associated with Makiki soils.

These soils are used for homesites, water supply, and recreation. The natural vegetation consists of ferns, Formosa koa, koa haole, kukui, and eucalyptus.

Tantalus silt loam, 40 to 70 percent slopes (TAF).—This soil is on volcanic spurs and cinder cones in the uplands.

Included in mapping were small areas of Makiki soils. Also included were small cinder deposits and stony soils within the drainageways.

In a representative profile the surface layer, about 18 inches thick, is very dark brown silt loam that has subangular blocky structure. The subsoil, about 11 inches thick, is dark reddish-brown, massive very fine sandy loam. The substratum is black, unweathered, gravel-size cinders. The soil is neutral in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is medium to rapid, and the erosion hazard is severe. In places roots penetrate to a depth of 3 feet.

Representative profile: Island of Oahu, lat. 21°19′48″ N. and long. 157°49′38″ W.

A1—0 to 18 inches, very dark brown (10YR 2/2) silt loam, dark brown (10YR 3/3) when dry; moderate, very fine and fine, subangular blocky structure; hard, friable, slightly sticky and slightly plastic; abundant very fine and fine roots; common, very fine, interstitial pores; common, fine and very fine, sharp cinders; neutral; clear, wavy boundary. 10 to 18 inches thick.

B2—18 to 29 inches, dark reddish-brown (5YR 3/4) very fine sandy loam, reddish brown (5YR 4/4) when dry; massive; soft, very friable, slightly sticky and slightly plastic, and weakly smeary; abundant very fine and fine roots and few medium and coarse roots; many, very fine and fine, tubular pores; abundant, very fine, sharp cinders; neutral; clear, wavy boundary. 6 to 12 inches thick.

IIC—29 inches, black, unweathered, fine, gravel-size cinders.

The solum ranges from 16 to 30 inches in thickness. The A horizon ranges from silt loam to silty clay loam in texture. It ranges from 5YR to 10YR in hue and from 2 to 3 in value and chroma. The texture of the B horizon is very fine sandy loam, silt loam, or silty clay loam. The B horizon ranges from 5YR to 10YR in hue and from 2 to 4 in chroma.

This soil is used for water supply and recreation. (Capability classification VIIe, nonirrigated; pasture group 9; woodland group 8)

Tantalus silt loam, 15 to 40 percent slopes (TAE).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for water supply and recreation. (Capability classification VIe, nonirrigated; pasture group 9; woodland group 8)

Tantalus silty clay loam, 8 to 15 percent slopes (TCC).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small areas of stony soils in the drainageways.

This soil is used for homesites, water supply, and recreation. (Capability classification IIIe, nonirrigated; pasture group 9; woodland group 8)

Tantalus silty clay loam, 15 to 40 percent slopes (TCE).—On this soil, runoff is medium and the erosion hazard is moderate.

This soil is used for homesites, water supply, and recreation. (Capability classification VIe, nonirrigated; pasture group 9; woodland group 8)

Tropaquepts

Tropaquepts (TR) are poorly drained soils that are periodically flooded by irrigation in order to grow crops that thrive in water. They occur as nearly level flood plains on the islands of Oahu and Maui. Elevations range from sea level to 200 feet. The annual rainfall amounts to 20 to 150 inches.

These soils have been flooded for varying lengths of time, and soil development differs in degree from place to place. Generally, the surface layer, about 10 inches thick, consists of dark-gray, soft, mucky silt loam. This layer overlies firm to compact silty clay loam, 5 to 10 inches thick, that is mottled with gray, yellow, and brown. The mottled layer overlies friable alluvium.

Tropaquepts are used for production of taro, rice, and watercress on flooded paddies. (Capability classification IVw, irrigated or nonirrigated)

Tropaquods

Areas mapped as Tropaquods (rTO) consist of steep-walled gulches and mountainsides on uplands on the island of Molokai. There are many intermittent streams in these areas. The slope ranges from 30 to 70 percent. Elevations range from 1,800 to 5,000 feet. Rainfall amounts to 80 to 150 inches or more annually. Fog and clouds cover the areas most of the time. The slope and dense vegetation make most areas inaccessible.

The soil material resembles that of Amalu and Olokui soils. It is generally shallow over soft weathered rock, but in places it ranges from shallow to deep. In the less sloping areas, thin sheets of ironstone are common at a depth of 10 to 20 inches.

These areas serve as watersheds, and they provide habitat for wildlife. The vegetation consists of ohia, treefern, false staghornfern, sedges, and various kinds of rain forest vegetation. (Capability classification VIIw, nonirrigated)

Tropohumults-Dystrandepts Association

Areas mapped as Tropohumults-Dystrandepts association (rTP) consist of mountainous areas in the Waianae Range on the island of Oahu. The areas are dominated by deep, V-shaped drainageways and narrow ridges. The slope ranges from 30 to 90 percent. Elevations range from 1,000 to 4,000 feet. Rainfall amounts to 30 to 75 inches annually.

The soils in this association consist mainly of Tropohumults and Dystrandepts. Histosols make up a smaller part of the association. Areas of Rock land and Rock outcrop occur in the drainageways.

Tropohumults occur on narrow ridgetops at the higher elevations. These are well-drained, strongly acid to extremely acid soils that are similar to those of the Halawa series. The surface layer consists of reddish-brown silty clay that has strong structure and high bulk density. The subsoil has strong subangular blocky structure; it is underlain by an ironstone pan or by saprolite. A hard crust that has a purplish cast forms on these soils in some places where the vegetation has been depleted.

Dystrandepts are dark-colored, friable soils on steep side slopes and narrow ridgetops at the lower elevations. In most places the surface layer is silty clay. The subsoil is generally massive, but areas were included where the subsoil is fine textured. These soils formed mainly in volcanic ash, but partly in colluvium. They are well drained and medium to strongly acid. Except for color, they are similar to the reddish soils of the Mahana series.

Histosols occupy small, wet positions near mountain peaks. They are poorly drained and have accumulations of organic material as much as 3 feet thick. These soils are similar to those of the Alakai series.

Most of this association is very steep and inaccessible. It serves mainly as a watershed. At the lower elevations the natural vegetation consists of lantana, molassesgrass, and yellow foxtail. At the higher elevations the vegetation is mainly ohia, puakeawe, koa, aalii, and ferns. (Capability classification VIIe, nonirrigated)

Ulupalakua Series

This series consists of well-drained soils on intermediate mountain slopes on the island of Maui. These soils developed in volcanic ash and material weathered from cinders. They are moderately sloping to moderately steep. Elevations range from 2,400 to 4,500 feet. The annual rainfall amounts to 30 to 40 inches. Afternoon cloud cover and fog are common. The mean annual soil temperature is 65° F. Ulupalakua soils are geographically associated with Io and Kaipoioi soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of brackenfern, dallisgrass, plantain, rattailgrass, Spanish clover, and white clover.

Ulupalakua silt loam, 7 to 25 percent slopes (UlD).—This soil is on smooth intermediate mountain slopes. Included in mapping were small areas of Io and Kaipoioi soils. Also included were small, very steep areas.

In a representative profile the surface layer is very dark brown silt loam about 9 inches thick. The subsoil, about 24 inches thick, is dark reddish-brown silt loam and clay loam that has subangular blocky structure. The substratum is black, unweathered cinders. The soil is slightly acid in the surface layer and neutral to mildly alkaline in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is slight. In places roots penetrate to a depth of 3 feet or more.

Representative profile: Island of Maui, lat. 20°48′28″ N. and long. 156°22′58″ W.

Ap—0 to 9 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) when dry; strong, medium and fine, granular structure; slightly hard, very friable, slightly sticky and nonplastic; abundant fine roots; many fine and medium pores; 15 to 20 percent very fine cinders, which causes a gritty feel; slightly acid; clear, wavy boundary. 8 to 11 inches thick.

B21—9 to 19 inches, dark reddish-brown (5YR 2/2) silt loam, dark reddish brown (5YR 3/3) when dry; strong, fine and very fine, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; abundant fine roots; many fine and very fine pores; patchy, gelatinlike coatings on peds; few, fine, black cinders; common sand-size aggregates that are resistant to crushing; neutral; clear, wavy boundary. 8 to 12 inches thick.

B22—19 to 28 inches, dark reddish-brown (5YR 2/2) silt loam, dark brown (7.5YR 3/2) when dry; strong, very fine, subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; plentiful fine roots; many fine pores; patchy, gelatinlike coatings on peds; few pockets of slightly weathered cinders; mildly alkaline; clear, smooth boundary. 8 to 11 inches thick.

B23—28 to 33 inches, dark reddish-brown (5YR 2/2) clay loam, dark reddish brown (5YR 3/2) when dry; strong, medium and fine, subangular blocky structure; slightly hard, friable, sticky and slightly plastic; plentiful fine roots; many fine pores; patchy, gelatinlike coatings on peds; mildly alkaline; abrupt, wavy boundary. 4 to 6 inches thick.

IIC—33 inches, black, unweathered cinders and a few yellowish-red, weathered cinders; slight effervescence with hydrochloric acid.

The solum is 28 to 40 inches thick over black, unweathered cinders. At the higher elevations, the soil is weakly smeary. The B horizon ranges from 5YR to 7.5YR in hue. The texture ranges from silt loam to clay loam. Gelatinous coatings on peds are more numerous where rainfall is higher.

This soil is used for pasture and wildlife habitat. (Capability classification IVe, nonirrigated; pasture group 5; woodland group 3)

Uma Series

This series consists of excessively drained, sandy soils on intermediate mountain slopes on the island of Maui.

These soils developed in volcanic ash and material weathered from cinders. They are on moderately sloping to very steep intermediate mountain slopes. Elevations range from 2,500 to 6,000 feet. The annual rainfall amounts to 30 to 40 inches. Afternoon fog and cloud cover are common. The mean annual soil temperature is 56° F. Uma soils are geographically associated with Puu Pa and Ulupalakua soils.

These soils are used for pasture and wildlife habitat. The natural vegetation consists of kikuyugrass, rattailgrass, and sweet vernalgrass.

Uma loamy coarse sand, 15 to 40 percent slopes (UME).—This soil is on smooth, intermediate mountain slopes. Included in mapping were small areas of Puu Pa and Ulupalakua soils. Also included were a few cinder cones and small areas of rock outcrop.

In a representative profile the surface layer, about 6 inches thick, is black loamy coarse sand that has granular structure. The substratum is black, unweathered cinders, 3 to 10 millimeters in size. The soil is mildly alkaline in the surface layer.

Permeability is very rapid. Runoff is slow, and the erosion hazard is slight to moderate. In places, roots penetrate to a depth of about 1 foot.

Representative profile: Island of Maui, lat. 20°39′00″ N. and long. 156°24′50″ W.

A1—0 to 6 inches, black (5YR 2/1) loamy coarse sand, dark brown (7.5YR 3/2) when dry; weak, very fine, granular structure; soft, very friable, nonsticky and nonplastic; abundant fine and very fine roots; many, very fine, interstitial pores; 5 to 10 percent cinders, 3 to 10 millimeters in size; mildly alkaline; abrupt, smooth boundary. 4 to 10 inches thick.

IIC—6 to 55 inches, black, unweathered cinders, 3 to 10 millimeters in size; single grain; loose; few roots.

The depth to cinders ranges from 4 to 10 inches. Intermittent layers of volcanic ash occur in the substratum near cinder cones. The A horizon ranges from 5YR to 10YR in hue and from 1 to 2 in chroma when moist.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 4; woodland group 11)

Uma loamy coarse sand, 40 to 70 percent slopes (UMF).—This soil is similar to Uma loamy coarse sand, 15 to 40 percent slopes, except for the slope. The erosion hazard is severe. Included in mapping were small areas of rock outcrop and cinder cones.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 4; woodland group 11)

Uma rocky loamy coarse sand, 7 to 25 percent slopes (URD).—This soil is similar to Uma loamy coarse sand, 15 to 40 percent slopes, except that rock outcrops cover 5 to 10 percent of the surface. Runoff is medium, and the erosion hazard is moderate. Included in mapping were small areas where there are few to many stones on the surface and in the profile.

This soil is used for pasture and wildlife habitat. (Capability classification VIs, nonirrigated; pasture group 4; woodland group 11)

Uwala Series

This series consists of well-drained soils on uplands on the island of Lanai. These soils formed in material derived from basalt. They are gently sloping to moderately sloping. Elevations range from 500 to 1,500 feet. The annual rainfall amounts to 15 to 25 inches, most of which occurs between November and April. There is little rain in summer. The mean annual soil temperature is 70° F. Uwala soils are geographically associated with Molokai soils, along the southern edge of the central plateau.

These soils are used for pineapple and wildlife habitat. The natural vegetation consists of klu, lantana, feather fingergrass, uhaloa, ilima, and piligrass.

Uwala silty clay loam, 2 to 7 percent slopes (UwB).—This soil has smooth slopes. Included in mapping were small, severely eroded areas.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 18 inches thick. The subsoil, about 39 inches thick, is dark reddish-brown silty clay loam that has subangular and angular blocky structure. Below this is very dark grayish-brown silty clay loam and soft, weathered rock. The soil is very strongly acid in the surface layer and medium acid in the subsoil.

Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Lanai, lat. 20°46′26″ N. and long. 156°58′02″ W.

Ap1—0 to 5 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; weak, medium and fine, subangular blocky structure breaking to weak, fine, granular; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; few, fine, interstitial pores; common, fine, black concretions; strong effervescence with hydrogen peroxide; very strongly acid; clear, wavy boundary. 3 to 6 inches thick.

Ap2—5 to 18 inches, dark reddish-brown (5YR 3/3) silty clay loam, reddish brown (5YR 4/3) when dry; weak, fine and medium, subangular blocky structure breaking to moderate, fine, granular; slightly hard, friable, slightly sticky and plastic; many very fine and fine roots; common, very fine, tubular and interstitial pores; few, fine, black concretions; common fragments of organic matter; moderate effervescence with hydrogen peroxide; very strongly acid; abrupt, smooth boundary. 12 to 14 inches thick.

B21—18 to 26 inches, dark reddish-brown (5YR 3/4) silty clay loam, yellowish red (5YR 3/6) when dry; moderate, fine, subangular blocky structure; slightly hard, firm, slightly sticky and plastic; few fine roots; many, fine, tubular pores; moderately thick, patchy coatings on all ped faces; common, fine, black concretions; strong effervescence with hydrogen peroxide; medium acid; clear, smooth boundary. 7 to 9 inches thick.

B22—26 to 32 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay loam; strong, fine, blocky structure; hard, firm, sticky and plastic; common, fine, tubular pores; moderately thick, patchy coatings on ped faces; few black concretions; few, very firm, earthy lumps; very weak effervescence with hydrogen peroxide; medium acid; clear, smooth boundary. 5 to 7 inches thick.

B23—32 to 44 inches, dark reddish-brown (5YR 3/4), moist and dry, silty clay loam; strong, fine and very fine, subangular blocky and angular blocky structure; hard, firm, sticky and plastic; many, fine and very fine, tubular pores; nearly continuous coatings on ped surfaces, many of which look like pressure surfaces; common, fine, earthy lumps; few, fine, black concretions; many very fine particles of weathered rock; effervescence with hydrogen peroxide limited to the black concretions; medium acid; gradual, wavy boundary. 10 to 15 inches thick.

B3—44 to 57 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, very fine, angular and subangular blocky structure; hard, firm, slightly sticky and plastic; many fine, very fine and medium, tubular pores; thin, patchy pressure cutans on ped faces; many very fine particles of weathered rock; no effervescence with hydrogen peroxide; medium acid; clear, smooth boundary. 11 to 14 inches thick.

C—57 to 60 inches, very dark grayish-brown (10YR 3/2) light silty clay loam, dark brown (10YR 3/3) when dry; weak, very fine, subangular blocky structure; hard, friable, slightly sticky and plastic; few, fine, tubular pores; common, fine, earthy lumps; numerous fragments of saprolite that increase with depth.

The solum ranges from 48 to 65 inches in thickness. The lower boundary is commonly diffuse. The depth to weathered basalt ranges from 3 to 7 feet. The A horizon ranges from 5YR to 7.5YR in hue, and the B horizon 5YR to 7.5YR. The structural grade of the B2 horizon ranges from moderate to strong.

All of this soil is used for pineapple. (Capability classification IIe if irrigated, IVc if nonirrigated; pineapple group 2; pasture group 2)

Uwala silty clay loam, 7 to 15 percent slopes (UwC).—On this soil, runoff is medium and the erosion hazard is moderate. Workability is slightly difficult because of the slope. Included in mapping were a few small, severely eroded areas. These areas have common pebble-size fragments of weathered rock in the surface layer.

This soil is used primarily for pineapple. Small areas are used for wildlife habitat. (Capability classification IIIe if irrigated, IVe if nonirrigated; pineapple group 3; pasture group 2)

Uwala silty clay loam, 7 to 15 percent slopes, severely eroded (UwC3).—On this soil, runoff is medium to rapid and the erosion hazard is severe. In cultivated areas there are many pebble-size fragments of weathered rock in the plow layer. In areas not cultivated, 10 to 25 percent of the surface is covered by erosion scars and there are a few small gullies.

This soil is used for wildlife habitat and pineapple. Most of the area is in grasses and shrubs. In recent years, however, pineapple acreage on Lanai has been expanding, mainly on this soil. (Capability classification IVe, irrigated or nonirrigated; pineapple group 3; pasture group 2)

Very Stony Land

This land type consists of areas where 50 to 90 percent of the surface is covered with stones and boulders. It is mapped on the islands of Maui, Molokai, and Lanai.

Very stony land (rVS).—This land type occurs on Maui, Molokai, and Lanai. The slope ranges from 7 to 30 percent. Included in mapping were very steep gulches.

On Maui, this land type consists of young Aa lava that has a thin covering of volcanic ash that locally extends deep into cracks and depressions. It occurs as large areas, mainly on the upper slopes of Mt. Haleakala at elevations between 4,000 and 9,000 feet. The annual rainfall amounts to 30 to 40 inches. The ash-covered areas support a stand of shrubs and grasses. Puakeawe, Yorkshire foggrass, and orchardgrass are common at the higher elevations. Lantana, kiawe, Natal redtop, and pitted beardgrass are common at the lower elevations.

On Molokai and Lanai, this land type consists of stones and boulders underlain by soft, weathered rock and bedrock. In a few places there is a shallow, clayey soil among the stones and boulders. Elevations range from sea level to 1,500 feet. The annual rainfall amounts to 10 to 25 inches. The natural vegetation consists of kiawe, klu, piligrass, and Japanese tea.

This land type is used for pasture and wildlife habitat. Pasture improvement is very difficult because of the many stones. (Capability classification VIIs, nonirrigated)

Very stony land, eroded (rVT2).—This land type consists of large areas of severely eroded soils on Molokai and Lanai. About 50 to 75 percent of the surface is covered with stones and boulders. There are common shallow gullies and a few deep gullies. The soil material is like that of the Holomua, Molokai, Pamoa, and Waikapu soils. In most places it is less than 24 inches deep to bedrock, but it is deeper in a few low-lying areas. Slopes are mainly 7 to 30 percent, but they range from 3 to 40 percent.

This land type occurs in the same general area as Very stony land, but it is mostly upslope from those areas. Elevations range from sea level to 1,000 feet. The annual rainfall amounts to 10 to 25 inches. This land type supports a thicker stand of vegetation than Very stony land because it has more soil material. The dominant vegetation is kiawe, ilima, piligrass, and fingergrass.

These areas are used for pasture and wildlife habitat. Improvement of pasture is difficult because of the many stones and gullies, and in unimproved areas the carrying capacity is low. The habitat is excellent for axis deer. With a little improvement, excellent habitat for game birds can be established. (Capability classification VIIs, nonirrigated)

Wahiawa Series

This series consists of well-drained soils on uplands on the island of Oahu. These soils developed in residuum and old alluvium derived from basic igneous rock. They are nearly level to moderately steep. Elevations range from 500 to 1,200 feet. Rainfall amounts to 40 to 60 inches annually; most of it occurs between November and April. The mean annual soil temperature is 71° F. Wahiawa soils are geographically associated with Kunia, Lahaina, Leilehua, and Manana soils.

These soils are used for sugarcane, pineapple, pasture, and homesites. The natural vegetation consists of bermudagrass, guava, honohono, koa haole, and lantana.

Wahiawa silty clay, 0 to 3 percent slopes (WaA).—This soil occurs on smooth, broad interfluves. Included in mapping were small areas of Kunia, Lahaina, and Leilehua soils.

In a representative profile the surface layer is very dusky red and dusky red silty clay about 12 inches thick. The subsoil, about 48 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The underlying material is weathered basic igneous rock. The soil is medium acid in the surface layer and medium acid to neutral in the subsoil.

Permeability is moderately rapid. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.3 inches per foot in the surface layer and about 1.4 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°26′16″ N. and long. 158°00′16″ W.

Ap1—0 to 6 inches, very dusky red (2.5Y 2/2) silty clay, dusky red (2.5YR 3/2) when dry; moderate, medium, fine and very fine, granular structure; very hard, friable, sticky and plastic; abundant roots; many medium, fine and very fine, interstitial pores; many black concretions 1/8 inch to 1/4 inch in diameter; violent effervescence with hydrogen peroxide; medium acid; abrupt, smooth boundary. 2 to 6 inches thick.

Ap2—6 to 12 inches, dusky-red (2.5YR 3/2), moist and dry, silty clay; commonly, dark reddish-brown (2.5YR 3/4) material from the B horizon of cultivated soil; moderate, coarse, subangular blocky structure; hard, firm, sticky and plastic; abundant roots; few, fine and very fine, tubular pores; compact in place; many black concretions; violent effervescence with hydrogen peroxide; medium acid; abrupt, wavy boundary. 5 to 8 inches thick.

B21—12 to 16 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; plentiful roots; common, fine and very fine, tubular pores and few, coarse, tubular pores; many black concretions; strong effervescence with hydrogen peroxide; medium acid; gradual, wavy boundary. 4 to 8 inches thick.

B22—16 to 33 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate and strong, fine and very fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; common, fine and very fine, tubular pores; nearly continuous pressure cutans; many, fine, distinct, black stains; few black concretions; strong effervescence with hydrogen peroxide; slightly acid; diffuse, wavy boundary. 14 to 20 inches thick.

B23—33 to 45 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate and strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; common, fine and very fine, tubular pores; nearly continuous pressure cutans; many, fine, distinct, black stains; few black concretions; moderate effervescence with hydrogen peroxide; neutral; diffuse, wavy boundary. 10 to 14 inches thick.

B24—45 to 60 inches, dark reddish-brown (2.5YR 2/4) silty clay, dark reddish brown (2.5YR 3/4) when dry; moderate and strong, very fine, subangular blocky structure; hard, friable, sticky and plastic; common, fine and very fine, tubular pores; few, fine, black stains; thin, patchy clay films; continuous pressure cutans; many distinct slickensides as much as 2 inches long; very few black concretions; slight effervescence with hydrogen peroxide; neutral.

Black concretions, 2 to 5 millimeters in size, occur on the surface and to a depth of 5 feet or more. The depth to highly weathered basalt ranges from 5 feet to more than 10 feet. A few boulder cores occur in the lower part of the solum in places. The A horizon ranges from 2 to 3 in value and from 2 to 4 in chroma when dry or moist. The B horizon ranges from 2.5YR to 10YR in hue; from 2 to 3 in value when dry or moist; and from 3 to 6 in chroma when dry and from 3 to 5 in chroma when moist.

This soil is used for sugarcane, pineapple, pasture, and homesites. (Capability classification I if irrigated, IIc if nonirrigated; sugarcane group 1; pineapple group 4; pasture group 5; woodland group 5)

Wahiawa silty clay, 3 to 8 percent slopes (WaB).—On this soil, runoff is slow and the erosion hazard is slight. Included in mapping were small areas of nearly level soil.

This soil is used for sugarcane, pineapple, and pasture. (Capability classification IIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 5; pasture group 5; woodland group 5)

Wahiawa silty clay, 8 to 15 percent slopes (WaC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small areas that are stony and eroded.

This soil is used for sugarcane and pineapple. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Wahiawa silty clay, 15 to 25 percent slopes, eroded (WaD2).—Most of the surface layer of this soil, and in places part of the subsoil, has been removed by erosion. The profile is otherwise like that of Wahiawa silty clay, 0 to 3 percent slopes. The depth to soft weathered rock ranges from 2 to 3 feet. Boulders occur on the surface in a few places. Runoff is medium to rapid, and the erosion hazard is severe. Tillage is difficult. Included in mapping were small stony areas.

This soil is used for pasture. (Capability classification IVe, nonirrigated; sugarcane group 1; pineapple group 6; pasture group 5; woodland group 5)

Wahikuli Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. They have been influenced to some extent by volcanic ash from local cinder cones. They are gently to moderately sloping. Elevations range from nearly sea level to 600 feet. The annual rainfall amounts to 12 to 20 inches; most of it occurs in winter. The mean annual soil temperature is 75° F. Wahikuli soils are geographically associated with Lahaina and Molokai soils.

These soils are used mostly for sugarcane. A small acreage is used for homesites. The natural vegetation consists of bermudagrass, feather fingergrass, kiawe, and uhaloa.

Wahikuli silty clay, 3 to 7 percent slopes (WbB).—This soil is on smooth, low uplands. Included in mapping were small areas of Lahaina and Molokai soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 15 inches thick. The subsoil, about 17 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The substratum is hard basic igneous rock. The soil is mildly alkaline in the surface layer and subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot in the surface layer and 1.5 inches per foot in the subsoil. In places roots penetrate to bedrock.

Representative profile: Island of Maui, lat. 20°55′09″ N. and long. 156°41′00″ W.

Ap1—0 to 8 inches, dark reddish-brown (2.5YR 3/3) silty clay, dark red (2.5YR 3/6) when dry; weak, fine and very fine, subangular blocky structure; slightly hard, friable, sticky and plastic; abundant roots; common fine pores; few, fine, black concretions; strong effervescence with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 6 to 10 inches thick.

Ap2—8 to 15 inches, dark reddish-brown (2.5YR 3/3) silty clay, dark red (2.5YR 3/6) when dry; weak, medium and fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; many fine pores; few, fine, black concretions and stains; common sand-size aggregates that are resistant to crushing; strong effervescence with hydrogen peroxide; mildly alkaline; clear, wavy boundary. 5 to 9 inches thick.

B2—15 to 27 inches, dark reddish-brown (2.5YR 3/4) silty clay, dark red (2.5YR 3/6) when dry; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine and medium pores; few black stains on ped faces and in pores; patchy pressure cutans; few highly weathered pebbles; strong effervescence with hydrogen peroxide; mildly alkaline; gradual, wavy boundary. 10 to 15 inches thick.

B3—27 to 32 inches, dark reddish-brown (2.5YR 3/4) gravelly silty clay, red (2.5YR 4/6) when dry; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few roots; common fine and medium pores; 30 to 40 percent highly weathered to slightly weathered gravel; few cobblestones; strong effervescence with hydrogen peroxide; mildly alkaline; abrupt, wavy boundary. 4 to 7 inches thick.

R—32 inches, gray, porous basalt that has dark reddish-brown coatings and very little soil material in voids and cracks; in irrigated areas this material is very difficult to grind out with an auger; in dry areas this material is extremely difficult to chip with a spade; very slight effervescence with hydrochloric acid on some rock surfaces.

The depth to bedrock is 20 to 40 inches. The A horizon ranges from 2.5YR to 5YR in hue, and from 2 to 3 in chroma when moist and 3 to 6 when dry. The B horizon ranges from 2.5YR to 5YR in hue and from 3 to 4 in value when dry. In places patchy lime coatings occur in the lower part of the B horizon.

This soil is used for sugarcane. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 3)

Wahikuli stony silty clay, 3 to 7 percent slopes (WcB).—This soil is similar to Wahikuli silty clay, 3 to 7 percent slopes, except that there are enough stones on the surface to hinder cultivation.

This soil is used mostly for sugarcane. A small acreage is used for homesites. (Capability classification IIe if irrigated, IVs if nonirrigated; sugarcane group 1; pasture group 3)

Wahikuli stony silty clay, 7 to 15 percent slopes (WcC).—This soil is similar to Wahikuli silty clay, 3 to 7 percent slopes, except that there are enough stones on the surface to hinder cultivation. Runoff is slow to medium, and the erosion hazard is slight to moderate. Included in mapping were small, nonstony areas and some moderately steep areas.

This soil is used mostly for sugarcane. A small acreage is used for homesites. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 3)

Wahikuli very stony silty clay, 3 to 7 percent slopes (WdB).—This soil is similar to Wahikuli silty clay, 3 to 7 percent slopes, except that as much as 3 percent of the surface is covered by stones. Included in mapping were small areas where stones cover 3 to 15 percent of the surface.

This soil is used mostly for sugarcane. A small acreage is used for homesites. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 3)

Waiakoa Series

This series consists of well-drained soils on uplands on the island of Maui. These soils developed in material weathered from basic igneous rock. The upper part of the profile is influenced by volcanic ash. These soils are gently sloping to moderately steep. Elevations range from 100 to 1,000 feet. The annual rainfall amounts to 12 to 20 inches; most of it occurs in winter. The mean annual soil temperature is 74° F. Waiakoa soils are geographically associated with Keahua and Keawakapu soils.

These soils are used for sugarcane, pasture, homesites, and wildlife habitat. The natural vegetation consists of buffelgrass, feather fingergrass, ilima, kiawe, uhaloa, and zinnia.

Waiakoa very stony silty clay loam, 3 to 7 percent slopes (WgB).—This soil is on smooth, low uplands. Included in mapping were small areas of Keahua and Keawakapu soils. Also included were small, nearly level areas.

In a representative profile the surface layer is dark reddish-brown silty clay loam about 2 inches thick. The subsoil, about 23 inches thick, is dark reddish-brown and very dark grayish-brown silty clay loam that has prismatic structure or is massive. The substratum is very dark brown silty clay loam and hard, basic igneous rock. The soil is neutral in the surface layer and slightly acid to neutral in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.5 inches per foot of soil. In places roots penetrate to bedrock.

Representative profile: Island of Maui, lat. 20°47′20″ N. and long. 156°24′30″ W.

Ap—0 to 2 inches, dark reddish-brown (5YR 3/3) very stony silty clay loam, reddish brown (5YR 3/4) when dry; moderate, medium and thick, platy structure; hard, friable, sticky and plastic; abundant roots; many fine pores; roots tend to follow plates; 1 to 3 percent stones on surface; strong effervescence with hydrogen peroxide; neutral; abrupt, smooth boundary. 1 to 3 inches thick.

B21—2 to 8 inches, dark reddish-brown (5YR 3/2) silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, coarse, prismatic structure; hard, friable, sticky and plastic; abundant roots; many fine and very fine pores; compact in place except for a few pockets of loose material; 5 percent pebble-size rock fragments; strong, delayed effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 4 to 8 inches thick.

B22—8 to 16 inches, dark reddish-brown (5YR 3/3) silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, coarse, prismatic structure; hard, friable, sticky and plastic; abundant roots; many fine pores; common sand-size aggregates that are resistant to crushing; 5 percent pebble-size rock fragments; strong, delayed effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 6 to 9 inches thick.

IIB23—16 to 25 inches, very dark grayish-brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) when dry; weak, coarse, prismatic structure in place and weak, medium, subangular blocky structure where disturbed; hard, friable, sticky and plastic, and weakly smeary; plentiful roots; many fine and very fine pores; 20 to 30 percent pebble-size, highly weathered rock fragments; neutral; gradual, wavy boundary. 7 to 12 inches thick.

IIC—25 to 33 inches, very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) when dry; massive; hard, friable, sticky and plastic; plentiful roots; very porous; common, hard, earthy lumps; 10 to 20 percent soil material in cracks; 70 to 80 percent grayish-brown (2.5YR 5/2), highly weathered, basic igneous rock; 10 percent hard rock fragments; common black stains on rocks; stains effervesce violently with hydrogen peroxide; neutral.

IIR—33 inches, hard bedrock.

The depth to bedrock ranges from 20 to 40 inches. The A horizon ranges from 5YR to 2.5YR in hue, from 2 to 3 in value when moist or dry, and from 2 to 3 in chroma when moist and 3 to 4 when dry. The B horizon ranges from 5YR to 2.5YR in hue. The upper part of the B2 horizon ranges from 2 to 3 in value when dry and from 2 to 3 in chroma when moist and 3 to 4 when dry. In some areas, calcium carbonate occurs as coatings on the bedrock.

This soil is used for sugarcane, pasture, and wildlife habitat. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Waiakoa very stony silty clay loam, 7 to 15 percent slopes (WgC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate.

This soil is used for pasture and wildlife habitat. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Waiakoa silty clay loam, 3 to 7 percent slopes (WeB).—This soil has a profile like that of Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that it is nonstony. Included in mapping were small, nearly level areas.

This soil is used for sugarcane. Small acreages are used for pasture and homesites. (Capability classification IIe if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Waiakoa silty clay loam, 7 to 15 percent slopes (WeC).—This soil has a profile like that of Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that it is nonstony. Runoff is slow to medium, and the erosion hazard is slight to moderate. Included in mapping were small, moderately steep areas and small areas where cobblestones are on the surface.

This soil is used for sugarcane. (Capability classification IIIe if irrigated, VIe if nonirrigated; sugarcane group 1; pasture group 1)

Waiakoa cobbly silty clay loam, 3 to 7 percent slopes (WfB).—This soil is similar to Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that it is cobbly on the surface.

This soil is used for sugarcane. (Capability classification IIe if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Waiakoa extremely stony silty clay loam, 3 to 7 percent slopes (WhB).—This soil is similar to Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that stones cover 3 to 15 percent of the surface. Included in mapping were small, nearly level areas.

This soil is used for sugarcane, pasture, and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 1)

Waiakoa extremely stony silty clay loam, 7 to 15 percent slopes (WhC).—This soil is similar to Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that stones cover 3 to 15 percent of the surface. Runoff is slow to medium, and the erosion hazard is slight to moderate.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 1)

Waiakoa extremely stony silty clay loam, 3 to 25 percent slopes, eroded (WID2).—This soil is similar to Waiakoa very stony silty clay loam, 3 to 7 percent slopes, except that it is eroded and stones cover 3 to 15 percent of the surface. In most areas about 50 percent of the surface layer has been removed by erosion. Runoff is medium, and the erosion hazard is severe. Included in mapping were small, steep areas. Also included were a few cinder cones.

This soil is used for pasture and wildlife habitat. (Capability classification VIIs, nonirrigated; pasture group 1)

Waialeale Series

This series consists of somewhat poorly drained soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock. They are very steep. Elevations range from 3,500 to 4,800 feet. The annual rainfall amounts to 100 to 450 inches. The mean annual soil temperature is 56° F. Waialeale soils are geographically associated with Alakai soils.

These soils are used for water supply and wildlife habitat. The natural vegetation consists of ohia, lapalapa, Hawaiian lobelia, mokihana, puakeawe, treefern, brackenfern, uki uki, and associated plants.

Waialeale mucky silty clay loam, 30 to 70 percent slopes (rWAF).—This soil is on high upland slopes. Included in mapping were small areas that have an ironstone sheet in the B horizon.

In a representative profile the surface layer, about 3 inches thick, is dark reddish-brown, massive mucky peat. This is underlain by about 4 inches of dark-gray silty clay loam that has subangular blocky structure. The subsoil, about 17 inches thick, is strong-brown, gravelly silty clay loam that has subangular blocky structure. The substratum is hard and soft, weathered rock.

Permeability is moderately rapid. Runoff is rapid, and the erosion hazard is severe. Roots penetrate to the weathered rock.

Representative profile: Island of Kauai, lat. 22°09′02″ N. and long. 159°37′7.5″ W.

O2—3 inches to 0, dark reddish-brown (5YR 2/2) mucky peat, dark reddish brown (5YR 2/2) when dry; massive; slightly hard, friable, slightly sticky and slightly plastic; plentiful roots; moderate, delayed effervescence with hydrogen peroxide; extremely acid; abrupt, smooth boundary. 2 to 6 inches thick.

A2g—0 to 4 inches, dark-gray (5YR 4/1) silty clay loam, gray (10YR 5/1) when dry; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; abundant roots; very slight, delayed effervescence with hydrogen peroxide; a few, fine, ironstone-gibbsite pebbles that have soft centers; extremely acid; clear, wavy boundary. 3 to 7 inches thick.

B2ir—4 to 21 inches, strong-brown (7.5YR 4/6) gravelly silty clay loam, dark reddish brown (5YR 3/4) when dry; weak, fine, subangular blocky structure; hard, friable, sticky and plastic, and smeary; few roots; coatings of reddish black (10R 2/1) in some pores and on some pebbles; pockets of dark reddish-brown (5YR 3/2) silt loam, as much as 8 inches thick, that is very friable, slightly sticky and slightly plastic; no effervescence with hydrogen peroxide; the amount of gravel increases with depth; extremely acid; gradual, irregular boundary. 4 to 18 inches thick.

C&R—21 inches, this layer consists of soft and hard saprolite that is dominantly gray (N 5/0); some coatings and pockets of strong brown (7.5YR 5/6); soft saprolite is very smeary; hard saprolite is fractured.

The A horizon ranges from 5YR to 10YR in hue. The B2 horizon ranges from 4 to 6 in chroma. It ranges from gravelly silty clay loam to silty clay in texture. The amount of gravel in the B2 horizon ranges from 5 to 50 percent.

This soil is used for water supply and wildlife habitat. (Capability classification VIIe, nonirrigated; woodland group 16)

Waialua Series

This series consists of moderately well drained soils on alluvial fans on the island of Oahu. These soils developed in alluvium weathered from basic igneous rock. They are nearly level to steep. Elevations range from 10 to 100 feet. The annual rainfall amounts to 25 to 50 inches; most of it occurs between November and April. The mean annual soil temperature is 73° F. Waialua soils are geographically associated with Honouliuli, Kaena, and Kawaihapai soils.

These soils are used for sugarcane, truck crops, orchards, and pasture. The natural vegetation is swollen fingergrass, koa haole, and uhaloa.

Waialua silty clay, 0 to 3 percent slopes (WkA).—This soil is on smooth coastal plains. Included in mapping were small areas of Honouliuli, Kaena, and Kawaihapai soils. Also included were small areas that are gravelly.

In a representative profile the surface layer is dark reddish-brown silty clay about 12 inches thick. The subsoil, about 26 inches thick, is dark reddish-brown and reddish-brown silty clay that has subangular blocky structure. The substratum is dark reddish-brown, mottled silty clay. The soil is neutral in the surface layer and slightly acid in the subsoil.

Permeability is moderate. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.8 inches per foot in the surface layer and 1.6 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°34′03″ N. and long. 158°08′39″ W.

Ap—0 to 12 inches, dark reddish-brown (5YR 3/2) silty clay, dark reddish brown (5YR 3/3) when dry; moderate, medium and coarse, subangular blocky structure; very hard, firm, very sticky and very plastic; abundant very fine roots; common, very fine and fine, interstitial and tubular pores; thin layer of moderate, very fine, and fine granules on surface; common, fine, black concretions; strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 5 to 15 inches thick.

B21—12 to 20 inches, dark reddish-brown (5YR 3/2) silty clay, dark reddish brown (5YR 3/3) when dry; moderate, fine and medium, subangular blocky structure; very hard, friable, very sticky and very plastic; abundant very fine and fine roots and few medium roots; common, fine and medium, tubular pores; few, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 6 to 8 inches thick.

B22—20 to 30 inches, reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 4/3) when dry; weak, medium and coarse, subangular blocky structure; very hard, friable, very sticky and very plastic; abundant fine roots; many, fine, tubular pores; common thin clay films in pores; few black concretions; strong effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 8 to 12 inches thick.

B23—30 to 38 inches, dark reddish-brown (5YR 3/3) silty clay; common, medium, distinct, dark-red (2.5YR 3/6) mottles; dark reddish brown (5YR 3/4) when dry; weak, medium and coarse, subangular blocky structure; very hard, friable, very sticky and very plastic; abundant fine roots; many, fine, tubular pores; thin, patchy clay films in pores and on ped faces; abundant, fine, black concretions; black stains 2 to 5 millimeters wide; strong effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 6 to 10 inches thick.

C—38 to 55 inches, dark reddish-brown (5YR 3/3) silty clay; common, medium, distinct, dark-red (2.5YR 3/6) mottles; dark reddish brown (5YR 3/4) when dry; weak, coarse, subangular blocky structure; very hard, friable, very sticky and very plastic; few fine roots; common, fine, tubular pores; few, fine, black concretions; black stains 2 to 5 millimeters wide; slight effervescence with hydrogen peroxide; slightly acid.

In places fine black concretions occur throughout the solum. Reaction ranges from slightly acid to neutral. The amount of highly weathered cobblestones and pebbles in the profile ranges from 5 to 30 percent. The plasticity of the clay ranges from very sticky and very plastic at the lower elevations to sticky and plastic at the higher elevations. The solum ranges from 5YR to 10YR in hue. Silty clay and clay types are mapped. The A horizon ranges from 2 to 3 in value when moist and from 3 to 4 when dry. It ranges from 1 to 2 in chroma when moist and from 2 to 4 when dry. The B horizon ranges from weak to moderate in structure.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification I if irrigated, IIIc if nonirrigated; sugarcane group 4; pasture group 3; woodland group 1)

Waialua silty clay, 3 to 8 percent slopes (WkB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane, truck crops, and pasture. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 4; pasture group 3; woodland group 1)

Waialua stony silty clay, 3 to 8 percent slopes (WlB).—This soil has a profile like that of Waialua silty clay, 0 to 3 percent slopes, except that there are sufficient stones to hinder tillage but not enough to make intertilled crops impractical. Runoff is slow, and the erosion hazard is slight. Workability is slightly difficult. Included in mapping were small, nonstony areas and small, moderately sloping areas.

This soil is used for sugarcane, truck crops, orchards, and pasture. (Capability classification IIIe if irrigated, IIIs if nonirrigated; sugarcane group 4; pasture group 3; woodland group 1)

Waialua stony silty clay, 12 to 30 percent slopes (WlE).—This soil has a profile like that of Waialua silty clay, 0 to 3 percent slopes, except that there are sufficient stones to hinder tillage but not enough to make intertilled crops impractical. Runoff is medium to rapid, and the erosion hazard is moderate to severe. Workability is difficult. Included in mapping were small areas of steep stony land, talus slopes, and eroded spots.

This soil is used for pasture. (Capability classification IVe, nonirrigated; pasture group 3; woodland group 1)

Waialua very stony silty clay, 12 to 20 percent slopes (WmD).—This soil is similar to Waialua silty clay, 0 to 3 percent slopes, except that stones cover as much as 3 percent of the surface. Runoff is medium, and the erosion hazard is moderate. Workability is difficult. Included in mapping were areas of stony land and eroded spots.

This soil is used for pasture. (Capability classification VIs, nonirrigated; pasture group 3; woodland group 1)

Waialua clay, 2 to 6 percent slopes (WnB).—On this soil, runoff is slow and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot in the surface layer and 1.6 inches per foot in the subsoil. Workability is slightly difficult. Included in mapping were small areas that are nearly level, gravelly, or stony. Also included were small areas of wet soils.

This soil is used for truck crops, orchards, and pasture. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 4; pasture group 3; woodland group 1)

Waiawa Series

This series consists of well-drained, very shallow, extremely rocky soils on uplands on the island of Kauai. These soils developed in colluvium and in material weathered from basic igneous rock. They are steep to very steep. Elevations range from nearly sea level to about 2,000 feet. The annual rainfall amounts to 22 to 40 inches. The mean annual soil temperature is 74° F. Waiawa soils are geographically associated with Makaweli and Niu soils.

These soils are used for pasture, wildlife habitat, and water supply. The natural vegetation consists of koa haole, pricklypear cactus, klu, feather fingergrass, lantana, and piligrass.

Waiawa extremely rocky clay, 30 to 80 percent slopes (WJF).—This soil occurs on slopes of gulches in the uplands. Rock outcrop covers 25 to 50 percent of the surface.

In a representative profile the surface layer is dark reddish-brown, strong, granular heavy clay loam about 2 inches thick. This layer is underlain by dark reddish-brown clay about 12 inches thick. It has angular blocky structure. The substratum is hard rock. The soil is slightly acid to neutral throughout the profile.

Permeability is moderate to moderately slow. Runoff is very rapid, and the erosion hazard is severe. Roots penetrate to bedrock and follow cracks in the rock.

Representative profile: Island of Kauai, lat. 21°59′22.3″ N. and long. 159°43′15.3″ W.

A11—0 to 2 inches, dark reddish-brown (5YR 3/2) heavy clay loam, dark reddish brown (5YR 3/4) when rubbed, dark reddish brown (5YR 3/3) when dry; strong, very fine, granular structure; slightly hard, friable, sticky and plastic; abundant coarse, medium, fine, very fine, and micro roots; moderate effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. ½ inch to 3 inches thick.

A12—2 to 14 inches, dark reddish-brown (5YR 3/4) clay, dark reddish brown (5YR 3/4) when rubbed, dark reddish brown (5YR 3/3) when dry; moderate, coarse, angular blocky structure; very hard, very firm, sticky and plastic; abundant coarse, medium, and micro roots and plentiful fine and very fine roots; shiny pressure cutans and slickensides on some peds; moderate effervescence with hydrogen peroxide; neutral; abrupt, irregular boundary. 6 to 12 inches thick.

R—14 inches, basalt rock. Soil and roots in cracks.

The soil color ranges from 2 to 4 in chroma. The soil depth ranges from 6 to 15 inches.

This soil is used for pasture or is idle. (Capability classification VIIs, nonirrigated; pasture group 2)

Waihuna Series

This series consists of well drained and moderately well drained soils on alluvial fans and in depressions on the islands of Lanai and Molokai. These soils formed in old, fine-textured alluvium. They are nearly level to moderately steep. Elevations are mainly between 1,000 and 2,000 feet, but they range from 400 to 2,000 feet. The annual rainfall amounts to 20 to 35 inches; most of it occurs between November and April. The mean annual soil temperature is 69° F. Waihuna soils are geographically associated with Lahaina, Kalae, and Hoolehua soils.

These soils are used for pineapple, pasture, and wildlife habitat. The natural vegetation is Natal redtop, lantana, and guineagrass.

Waihuna clay, 0 to 3 percent slopes (WoA).—This is the most extensive soil in the Waihuna series. It occurs on Lanai, mainly as two large areas. Included in mapping were small areas that are subject to ponding. These areas are in the central part of the Palawai Basin and in other depressions. In some years water remains in these depressions long enough to damage crops or interfere with farming operations.

In a representative profile the surface layer, about 18 inches thick, is dark-brown, very sticky and very plastic clay. The next layer, 40 to more than 50 inches thick, is dark-brown, very sticky and very plastic clay and silty clay that has subangular blocky structure. This is underlain by relatively soft, weathered pebbles and stones. The soil is strongly acid in the surface layer as a result of pineapple culture, but it is neutral to medium acid in the rest of the profile. Cracks, ½ inch to 1 inch wide, form when the soil dries.

Permeability is moderately slow. Runoff is slow, and the erosion hazard is no more than slight. The available water capacity is about 1.3 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more. This soil is difficult to work because it is very sticky and very plastic when wet.

Representative profile: Island of Lanai, lat. 20°49′52″ N. and long. 156°55′58″ W.

Ap1—0 to 1 inch, very dark grayish-brown (10YR 3/2), moist and dry, clay; strong, very fine and fine, granular structure; hard, friable, very sticky and very plastic; violent effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. ½ inch to 2 inches thick.

Ap2—1 inch to 6 inches, dark-brown (10YR 3/3) clay, dark yellowish brown (10YR 3/4) when dry; moderate, very fine, granular structure; very hard, friable, very sticky and very plastic; many interstitial pores; cracks as much as 1 inch wide develop upon drying; many variegated sand grains can be seen under a hand lens; common plant remains that have been plowed under; violent effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 5 to 6 inches thick.

Ap3—6 to 12 inches, dark-brown (7.5YR 3/2), moist and dry, clay; massive; hard, friable, very sticky and very plastic; few, very fine, tubular pores; cracks as much as 1 inch wide develop upon drying; many plant remains that have been plowed under; many variegated sand grains can be seen under a hand lens; violent effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 5 to 6 inches thick.

Ap4—12 to 18 inches, dark-brown (10YR 3/3) clay, dark yellowish brown (10YR 3/4) when dry; weak, very fine, subangular blocky structure; very hard, friable, very sticky and very plastic; common pores; cracks as much as 1 inch wide develop upon drying; common plant remains that have been plowed under; many variegated sand grains can be seen under a hand lens; a few highly weathered pebbles; violent effervescence with hydrogen peroxide; strongly acid; clear, smooth boundary. 6 to 7 inches thick.

AC—18 to 25 inches, dark-brown (10YR 3/3), moist and dry, clay; weak, coarse, prismatic structure breaking to moderate, very fine and fine, subangular blocky; very hard, firm, very sticky and very plastic; no roots; common pores; common pressure cutans; some are weakly grooved; few highly weathered pebbles; many variegated sand grains can be seen under a hand lens; firm in place; violent effervescence with hydrogen peroxide; medium acid; gradual, wavy boundary. 7 to 8 inches thick.

C1—25 to 41 inches, dark-brown (7.5YR 3/2), moist and dry, clay; strong, very fine, subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; common pores; many variegated sand grains can be seen under a hand lens; few highly weathered pebbles; common pressure cutans; few slickensides; strong effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 15 to 17 inches thick.

C2—41 to 53 inches, dark-brown (7.5YR 3/2), moist and dry, clay; moderate, very fine and fine, subangular blocky structure; very hard, firm, very sticky and very plastic; no roots; many, very fine, tubular pores; many variegated sand grains can be seen under a hand lens; common highly weathered pebbles; common pressure cutans; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 11 to 12 inches thick.

C3—53 to 65 inches, dark-brown (7.5YR 3/2), moist and dry, silty clay; moderate, very fine and fine, subangular blocky structure; hard, firm, very sticky and very plastic; no roots; many, very fine and fine, tubular pores and few, coarse, tubular pores; common patchy pressure cutans; common manganese stains; many variegated sand grains, more than in the horizons above; common highly weathered pebbles; strong effervescence with hydrogen peroxide; slightly acid.

In some areas weathered gravel and cobblestones are scattered throughout the profile. A strong granular surface mulch, ½ inch to 2 inches thick, develops upon drying. Cracks ½ inch to 1 inch wide form to a depth of more than 20 inches when the soil dries. The A horizon ranges from 10YR to 7.5YR in hue and from 2 to 3 in chroma. In most places the soil color is yellowest near the source of alluvium and is somewhat redder as distance from the source increases. Texture of the lower part of the C horizon ranges from silty clay to clay. In places few to common mottles occur in the lower part of the profile.

This soil is used for pineapple. (Capability classification IIs if irrigated, IIIs if nonirrigated; pineapple group 1; pasture group 3)

Waihuna clay, 3 to 7 percent slopes (WoB).—This soil occurs on Molokai and Lanai. Runoff is slow, and the erosion hazard is slight.

This soil is used for pineapple. (Capability classification IIe if irrigated, IIIs if nonirrigated; pineapple group 2; pasture group 3)

Waihuna clay, 7 to 15 percent slopes (WoC).—This soil occurs on Molokai and Lanai. Runoff is slow to medium, and the erosion hazard is slight to moderate. Included in mapping were small, gravelly areas.

This soil is used for pineapple, pasture, and wildlife habitat. (Capability classification IIIe, irrigated or nonirrigated; pineapple group 3; pasture group 3)

Waihuna clay, 15 to 25 percent slopes (WoD).—This soil occurs as narrow bands along sharp slope breaks and on foot slopes. Runoff is medium, and the erosion hazard is moderate. In a few places the texture of the surface layer is silty clay.

Most of this soil is used for pasture and wildlife habitat. Small areas on Molokai are used for pineapple. (Capability classification IVe, irrigated or nonirrigated; pineapple group 3; pasture group 3)

Waihuna gravelly clay, 3 to 7 percent slopes (WohB).—This soil is on Lanai, mainly in two areas at the mouth of drainageways. It is similar to Waihuna clay, 0 to 3 percent slopes, except that gravel makes up 15 to 30 percent of the surface layer.

This soil is used for pineapple. (Capability classification IIe if irrigated; IIIs if nonirrigated; pineapple group 2; pasture group 3)

Waikane Series

This series consists of well-drained soils on alluvial fans and terraces on the island of Oahu. These soils developed in alluvium and colluvium derived from basic igneous rock. They are nearly level to very steep. Elevations range from 200 to 1,000 feet. The annual rainfall amounts to 50 to 70 inches. It is well distributed throughout the year. The mean annual soil temperature is 71° F. Waikane soils are geographically associated with Alaeloa, Kaneohe, Lolekaa, and Paumalu soils.

These soils are used for pasture, truck crops, and homesites. The natural vegetation consists of Christmas berry, guava, hilograss, and ricegrass.

Waikane silty clay, 25 to 40 percent slopes (WpE).—This soil is on steep terraces and alluvial fans. Included in mapping were small areas of Alaeloa, Kaneohe, and Lolekaa soils. Also included were small, eroded spots and moderately steep areas.

In a representative profile the surface layer is dark-brown silty clay about 8 inches thick. The subsoil, about 52 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The substratum is soft, weathered, gravelly alluvium and colluvium. The soil is very strongly acid in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is medium to rapid, and the erosion hazard is moderate to severe. The available water capacity is about 1.1 inches per foot in the surface layer and 1.3 inches per foot in the subsoil. In places roots penetrate to a depth of 5 feet or more. Workability is difficult.

Representative profile: Island of Oahu, lat. 21°32′04″ N. and long. 157°51′30″ W.

Ap—0 to 8 inches, dark-brown (7.5YR 3/2) silty clay, dark brown (7.5YR 3/4) when dry; strong, fine and very fine, subangular blocky structure; very hard, firm, sticky and plastic; abundant very fine and fine roots; many, very fine and fine, tubular pores; many wormholes and worm casts; very slight effervescence with hydrogen peroxide; very strongly acid; abrupt, smooth boundary. 6 to 9 inches thick.

B21—8 to 19 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; moderate, medium, subangular blocky structure; hard, firm, sticky and plastic; abundant very fine and fine roots; many, very fine and fine, tubular pores; common, patchy coatings on peds; few, hard, earthy lumps; very strongly acid; gradual, smooth boundary. 6 to 11 inches thick.

B22t—19 to 31 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; moderate, fine and very fine, subangular blocky structure; hard, firm, sticky and plastic; plentiful fine roots; common, very fine and fine, tubular pores; common, dark-red (2.5YR 3/6), thin, continuous clay films on peds and within pores; few highly weathered pebbles; very strongly acid; clear, smooth boundary. 7 to 12 inches thick.

B23t—31 to 60 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish brown (5YR 3/4) when dry; few fine roots; common, fine, tubular pores; thin, continuous, dark-red (2.5YR 3/6) clay films on peds and in pores; common highly weathered pebbles; very strongly acid.

The content of highly weathered gravel in the solum increases with depth; it ranges from 5 percent in the upper part to 40 percent in the lower part. The A horizon ranges from 7.5YR to 10YR in hue, from 2 to 3 in value, and from 2 to 4 in chroma when moist. The B horizon ranges from 5YR to 7.5YR in hue and from 3 to 4 in value when moist.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Waikane silty clay, 3 to 8 percent slopes (WpB).—On this soil, runoff is slow and the erosion hazard is slight. Workability is easy. Included in mapping were small, nearly level areas.

This soil is used for truck crops, pasture, and homesites. (Capability classification IIe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Waikane silty clay, 8 to 15 percent slopes (WpC).—On this soil, runoff is slow to medium and the erosion hazard is slight to moderate. Workability is slightly difficult.

This soil is used for truck crops, pasture, and homesites. (Capability classification IIIe, irrigated or nonirrigated; pasture group 8; woodland group 7)

Waikane silty clay, 40 to 70 percent slopes (WpF).—On this soil, runoff is rapid to very rapid and the erosion hazard is severe. Included in mapping were small areas of eroded spots, rock outcrop, and stony areas.

This soil is used for pasture and woodland. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Waikane silty clay, 40 to 70 percent slopes, eroded (WpF2).—This soil is similar to Waikane silty clay, 25 to 40 percent slopes, except that it is very steep. Most of the surface layer and, in places, part of the subsoil have been removed by erosion. In a few areas soft, weathered rock is exposed. Runoff is rapid to very rapid, and the erosion hazard is very severe. Included in mapping were small, uneroded areas and small areas of rock outcrop.

This soil is used for pasture and woodland. (Capability classification VIIe, nonirrigated; pasture group 8; woodland group 14)

Waikane stony silty clay, 15 to 30 percent slopes (WpoE).—On this soil, runoff is medium to rapid and the erosion hazard is moderate to severe. Workability is difficult. Included in mapping were small areas where the slope is as much as 40 percent.

This soil is used for pasture. (Capability classification VIe, nonirrigated; pasture group 8; woodland group 7)

Waikapu Series

This series consists of well-drained soils on uplands on the islands of Lanai and Molokai. These soils formed in fine-textured old alluvium. They are nearly level to moderately sloping. Elevations range from 100 to 1,250 feet. The annual rainfall amounts to 15 to 25 inches, most of which occurs from November to April. The mean annual soil temperature is 73° F. Waikapu soils are geographically associated with Holomua, Molokai, and Uwala soils.

These soils are used for pineapple, pasture, and wildlife habitat. The natural vegetation consists of lantana, bermudagrass, ilima, and feather fingergrass.

Waikapu silty clay loam, 0 to 3 percent slopes (WrA).—This soil is on uplands in depressions on old alluvial fans. Included in mapping was an area, about 150 acres in size, that is severely eroded. This area is 1½ miles southwest of Molokai Airport. There are a few stones on the surface and a few shallow gullies.

In a representative profile the surface layer and the subsoil are dark reddish-brown, friable silty clay loam. The surface layer is about 12 inches thick. The subsoil, about 48 inches thick, has subangular and angular blocky structure. The soil is typically slightly acid to neutral but is strongly acid to very strongly acid in the surface layer in areas where pineapple is grown.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.4 inches per foot of soil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Lanai, lat. 20°47′13″ N. and long. 156°56′12″ W.

Ap1—0 to 4 inches, dark reddish-brown (5YR 2/3 moist, 3/3 dry) silty clay loam; weak, very fine, granular structure; soft, very friable, sticky and plastic; few roots; many interstitial pores and common, very fine, vertical, tubular pores; many, fine, black concretions; violent effervescence with hydrogen peroxide; strongly acid; clear, wavy boundary. 3 to 5 inches thick.

Ap2—4 to 12 inches, dark reddish-brown (5YR 2/3) heavy silt loam or light silty clay loam, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular blocky structure and some pockets of weak, very fine, granular structure; soft, friable, sticky and plastic; many roots; many, very fine, tubular pores and few, fine, tubular pores; common, fine, black concretions; violent effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 7 to 10 inches thick.

B1—12 to 24 inches, dark reddish-brown (2.5YR 3/4) silty clay loam, reddish brown (2.5YR 4/4) when dry; strong, fine and very fine, angular and subangular blocky structure; slightly hard, friable, sticky and plastic; few roots; many, very fine and fine, tubular pores and few, medium, tubular pores; patchy glaze on ped faces; firm in place; common, fine, black concretions; violent effervescence with hydrogen peroxide; common, fine, hard, earthy lumps that disappear slowly when rubbed; neutral; gradual, wavy boundary. 10 to 14 inches thick.

B21—24 to 34 inches, dark reddish-brown (2.5YR 3/4), moist and dry, silty clay loam; moderate, medium, subangular blocky structure breaking to strong, fine and very fine, angular blocky; soft, friable, sticky and plastic; many, very fine and fine, tubular pores and few, medium, tubular pores; moderately firm in place; weakly developed, patchy pressure cutans; many, fine, black concretions commonly as much as 2 millimeters in diameter; violent effervescence with hydrogen peroxide; neutral; gradual, wavy boundary. 8 to 12 inches thick.

B22—34 to 44 inches, dark reddish-brown (5YR 3/3 moist, 5YR 3/4 dry) silty clay loam; weak, medium and fine, subangular blocky structure; soft, very friable, sticky and plastic; many, very fine and fine, tubular pores and common, medium, tubular pores; few weakly grooved slickensides; many black concretions; violent effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 8 to 12 inches thick.

B3—44 to 60 inches, dark-red (2.5YR 2/6) silty clay loam, dark reddish brown (2.5YR 3/4) when dry; weak, medium, subangular blocky structure breaking to moderate, fine and very fine, subangular blocky; soft, friable, sticky and plastic; many, very fine and fine, tubular pores and common, medium, tubular pores; patchy glaze on some peds; common, fine, hard, earthy lumps that disappear when persistently rubbed; few slickensides; few, fine, black concretions; slight effervescence with hydrogen peroxide; neutral.

Black concretions that range from fine specks to 3 millimeters in size occur throughout the solum. Effervescence with hydrogen peroxide ranges from strong to violent in the A and B2 horizons. The solum ranges from 5YR to 2.5YR in hue. The A horizon ranges from 2 to 3 in value and chroma when moist and from 3 to 4 in value when dry. The B horizon ranges from 2 to 3 in value when moist and from 3 to 4 when dry. It ranges from 3 to 6 in chroma when moist. Slickensides range from few to common in the lower part of the B horizon.

This soil is used for pineapple, pasture, and wildlife habitat. (Capability classification I if irrigated, IVc if nonirrigated; pineapple group 1; pasture group 2)

Waikapu silty clay loam, 3 to 7 percent slopes (WrB).—This soil is on smooth alluvial fans on Molokai. Runoff is slow, and the erosion hazard is slight to moderate. Included in mapping were small areas where the slope is 7 to 15 percent.

This soil is used for pineapple, pasture, and wildlife habitat. (Capability classification IIe if irrigated, IVc if nonirrigated; pineapple group 2; pasture group 2)

Waikapu silty clay loam, 3 to 7 percent slopes, severely eroded (WrB3).—This soil occurs as two areas in the northwestern part of the Hoolehua Plains on Molokai. It is similar to Waikapu silty clay loam, 0 to 3 percent slopes, except that it is severely eroded. Most of the surface layer and, in many places, part of the subsoil have been removed by erosion. The erosion is caused by strong winds, as well as by water. There are a few bare blown-out spots. Runoff is medium, and the hazard of wind and water erosion is severe.

This soil is used for pasture and wildlife habitat. (Capability classification IIIe if irrigated, IVe if nonirrigated; pineapple group 2; pasture group 2)

Waikapu silty clay loam, 7 to 15 percent slopes, severely eroded (WrC3).—This soil is similar to Waikapu silty clay loam, 0 to 3 percent slopes, except that it is severely eroded. Runoff is medium, and the hazard of wind and water erosion is severe. Most of the topsoil and, in most places, part of the subsoil have been removed by erosion. Moderately deep gullies occur in many areas.

This soil is used for pasture and wildlife habitat. (Capability classification IVe, irrigated or nonirrigated; pineapple group 3; pasture group 2)

Waikomo Series

This series consists of well-drained, stony and rocky soils on uplands on the island of Kauai. These soils developed in material weathered from basic igneous rock, probably with a mixture of ash and alluvium in places. These soils are gently sloping. Elevations range from nearly sea level to 360 feet. The annual rainfall amounts to 35 to 60 inches. The mean annual soil temperature is 74° F. Waikomo soils are geographically associated with Koloa soils.

These soils are used for sugarcane, pasture, wildlife habitat, and homesites. The natural vegetation consists of lantana, koa haole, Java plum, pricklypear cactus, swollen fingergrass, bermudagrass, and guineagrass.

Waikomo stony silty clay (Ws).—This soil is on low uplands. The slope ranges from 2 to 6 percent. Included in mapping were small areas where the slope is as much as 12 percent. Also included were some soils that have a hue of 5YR in the A horizon and 2.5YR in the B horizon.

In a representative profile the surface layer is very dark grayish-brown stony silty clay about 14 inches thick. The subsoil, about 6 inches thick, is reddish-brown stony heavy silty clay loam that has subangular and angular blocky structure. The substratum is hard rock. The soil is neutral to mildly alkaline throughout.

Permeability is moderate. Runoff is slow, and the erosion hazard is slight. The available water capacity is about 1.0 inch per foot of soil. Except for cracks in the rock, roots penetrate to a depth of no more than 20 inches.

Representative profile: Island of Kauai, lat. 21°54′41.2″ N. and long. 159°26′47″ W.

Ap—0 to 14 inches, very dark grayish-brown (10YR 3/2) stony silty clay, dark brown (7.5YR 3/2) when dry; weak, fine and very fine, subangular blocky structure; very hard, very firm, sticky and plastic; abundant medium, fine, and very fine roots; stones makes up about 25 percent of the volume; moderate effervescence with hydrogen peroxide; neutral; clear, smooth boundary. 12 to 16 inches thick.

B2—14 to 20 inches, reddish-brown (5YR 4/4) stony heavy silty clay loam, reddish brown (5YR 4/4) when rubbed and dry; moderate, fine and very fine, subangular and angular blocky structure; very hard, firm, sticky and plastic; plentiful medium, fine, and very fine roots; common medium and fine pores and many very fine pores; stones make up about 25 percent of the volume; thin, discontinuous coatings on ped faces; coatings look like clay films; when dry, peds are nearly covered with yellowish-brown, sugarlike coatings; many very fine, dark reddish-brown concretions that effervesce with hydrogen peroxide; concretions are hard to very hard; slight to moderate effervescence with hydrogen peroxide; mildly alkaline; abrupt, irregular boundary. 4 to 10 inches thick.

B3&R—20 inches, this layer consists of cracked and broken pahoehoe rock that contains soil material in the few cracks. The soil material is dark-brown (7.5YR 4/4) heavy silty clay loam, strong brown (7.5YR 5/6) when dry; weak, very fine, subangular blocky structure; firm, sticky and plastic; few medium, fine, and very fine roots; common medium and fine pores and many very fine pores; when dry, peds are nearly covered with yellowish-brown, sugarlike coatings; no effervescence with hydrogen peroxide; mildly alkaline.

The A horizon ranges from 7.5YR to 10YR in hue and from 2 to 3 in chroma. The B horizon ranges from 5YR to 10YR in hue, from 3 to 4 in value, and from 2 to 6 in chroma.

This soil is used for sugarcane, pasture, wildlife habitat, and homesites. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 5; woodland group 13)

Waikomo very rocky silty clay (Wt).—This soil is similar to Waikomo stony silty clay, except that rock outcrops cover 3 to 25 percent of the surface.

This soil is used for pasture, wildlife habitat, and homesites. Some small areas are irrigated. (Capability classification VIs, irrigated or nonirrigated; pasture group 5; woodland group 13)

Waikomo extremely rocky silty clay (Wu).—This soil is similar to Waikomo stony silty clay, except that rock outcrops cover 25 to 50 percent of the surface.

This soil is used for pasture, wildlife habitat, and homesites. (Capability classification VIIs, nonirrigated; pasture group 5; woodland group 13)

Wailuku Series

This series consists of well-drained soils on alluvial fans on the island of Maui. These soils developed in alluvium derived from weathered basic igneous rock. They are gently to moderately sloping. Elevations range from 50 to 1,000 feet. The annual rainfall amounts to 20 to 40 inches. The mean annual soil temperature is 73° F. Wailuku soils are geographically associated with Iao and Pulehu soils.

These soils are used for sugarcane, pasture, and homesites. The natural vegetation consists of bermudagrass, guineagrass, koa haole, lantana, and Natal redtop.

Wailuku silty clay, 7 to 15 percent slopes (WvC).—This soil is on smooth alluvial fans. Included in mapping were small areas of Iao and Pulehu soils. In a few places moderately steep soils and small, eroded spots were included.

In a representative profile the surface layer is dark reddish-brown silty clay about 12 inches thick. The subsoil, about 48 inches thick, is dark reddish-brown silty clay that has subangular blocky structure. The substratum is gravelly and cobbly alluvium. The soil is slightly acid to medium acid in the surface layer and slightly acid in the subsoil.

Permeability is moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 1.6 inches per foot in the surface layer and subsoil. In places roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°56′26″ N. and long. 156°31′10″ W.

Ap1—0 to 4 inches, dark reddish-brown (5YR 3/3) silty clay, dark reddish gray (5YR 4/2) when dry; weak, fine and very fine, granular structure; hard, friable, very sticky and very plastic; few roots; many very fine pores; few, fine, black concretions that effervesce with hydrogen peroxide; strong effervescence with hydrogen peroxide; slightly acid; clear, wavy boundary. 2 to 5 inches thick.

Ap2—4 to 12 inches, dark reddish-brown (5YR 3/3) silty clay, reddish brown (5YR 4/3) when dry; weak, medium and fine, subangular blocky structure; hard, firm, very sticky and very plastic; abundant roots; many fine pores; compact in place; few, fine, black concretions; strong effervescence with hydrogen peroxide; medium acid; clear, wavy boundary. 7 to 10 inches thick.

B21—12 to 26 inches, dark reddish-brown (5YR 3/4) silty clay, reddish brown (5YR 4/3) when dry; moderate, medium and fine, subangular blocky structure; slightly hard, friable, very sticky and very plastic; few roots; many fine and very fine pores; continuous pressure cutans; compact in place; few, fine, black concretions; few highly weathered, basic igneous rock pebbles; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 11 to 16 inches thick.

B22—26 to 35 inches, dark reddish-brown (5YR 3/4) silty clay, dark reddish gray (5YR 4/2) when dry; moderate, medium and fine, subangular blocky structure; slightly hard, firm, very sticky and very plastic; few roots; many fine pores; continuous pressure cutans; few, fine, black concretions; few highly weathered basic igneous rock pebbles and cobblestones; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 8 to 12 inches thick.

B3—35 to 60 inches, dark reddish-brown (5YR 3/4) silty clay, reddish gray (5YR 5/2) when dry; moderate, medium to very fine, subangular blocky structure; slightly hard, firm, very sticky and very plastic; few roots; many fine and very fine pores; 10 to 15 percent highly weathered pebbles and cobblestones; strong effervescence with hydrogen peroxide; slightly acid.

The solum is more than 40 inches thick. A few cobblestones and stones are on the surface in some places. The A horizon ranges from 2 to 3 in value when moist and 2 to 4 when dry and from 2 to 3 in chroma when moist or dry. The B horizon ranges from 3 to 5 in value when dry and from 2 to 4 in chroma when moist and 2 to 3 when dry.

This soil is used mostly for sugarcane. A small acreage is used for pasture and homesites. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Wailuku silty clay, 3 to 7 percent slopes (WvB).—This soil has a profile like that of Wailuku silty clay, 7 to 15 percent slopes, except for the slope. Runoff is slow, and the erosion hazard is slight.

This soil is used for sugarcane and homesites. (Capability classification IIe if irrigated, IIIc if nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Wailuku cobbly silty clay, 7 to 15 percent slopes (WwC).—This soil is similar to Wailuku silty clay, 7 to 15 percent slopes, except that it is cobbly in the surface layer. Included in mapping were small areas of nearly level soils and a few areas of moderately steep soils.

This soil is used mostly for sugarcane. A small acreage is used for pasture. (Capability classification IIIe, irrigated or nonirrigated; sugarcane group 1; pasture group 3; woodland group 1)

Wainee Series

This series consists of well-drained soils on alluvial fans on the island of Maui. These soils developed in alluvium derived from weathered basic igneous rock. They are gently to moderately sloping. Elevations range from nearly sea level to 1,000 feet. Rainfall amounts to 10 to 20 inches annually; most of it occurs in winter. The mean annual soil temperature is 75° F. Wainee soils are geographically associated with Pulehu and Wahikuli soils.

These soils are used mostly for sugarcane. A small acreage is used for pasture and homesites. The natural vegetation is fingergrass, kiawe, and uhaloa.

Wainee extremely stony silty clay, 7 to 15 percent slopes (WyC).—This soil is moderately sloping and occurs on smooth, alluvial fans. Included in mapping were small areas of Wahikuli soils.

In a representative profile the surface layer is dark reddish-brown silty clay about 12 inches thick. Stones make up 10 to 15 percent of the volume. The subsoil, 24 inches thick, consists of dark reddish-brown silty clay that has subangular blocky structure. Gravel, cobblestones, and stones make up 30 to 80 percent of the volume. The substratum is dark-brown silty clay. As much as 80 to 90 percent of this layer is gravel, cobblestones, and stones. This soil is neutral in the surface layer and subsoil.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. The available water capacity is about 0.6 inch per foot of soil. Stones cover 3 to 15 percent of the surface. Roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Maui, lat. 20°51′26″ N. and long. 156°39′28″ W.

Ap—0 to 12 inches, dark reddish-brown (5YR 3/3) extremely stony silty clay, reddish brown (5YR 4/4) when dry; moderate, fine and very fine, granular structure; slightly hard, friable, sticky and plastic; abundant roots; many fine pores; 10 to 15 percent stones; few highly weathered rock fragments; strong effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 11 to 14 inches thick.

B2—12 to 26 inches, dark reddish-brown (5YR 3/3) extremely stony silty clay, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine and medium pores; few very fine black specks; moderately firm in place; 30 to 40 percent hard and highly weathered gravel, cobblestones, and stones; strong, delayed effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 12 to 15 inches thick.

B3—26 to 36 inches, dark reddish-brown (5YR 3/3) extremely stony silty clay, reddish brown (5YR 4/4) when dry; weak, medium and fine, subangular blocky structure; slightly hard, friable, sticky and plastic; plentiful roots; many fine pores; few very fine black specks; 70 to 80 percent gray and light yellowish-brown gravel, cobblestones, and stones; strong, delayed effervescence with hydrogen peroxide; neutral; clear, wavy boundary. 9 to 12 inches thick.

IIC—36 to 56 inches, dark-brown (7.5YR 3/2) extremely stony silty clay, dark brown (7.5YR 4/4) when dry; massive; slightly hard, firm, sticky and plastic; few fine and medium pores; 80 to 90 percent gray and light yellowish-brown gravel, cobblestones, and stones; strong effervescence with hydrogen peroxide; slight effervescence with hydrochloric acid on small pebbles; neutral.

Stoniness on the surface ranges from very stony to extremely stony. The texture throughout the profile ranges from silty clay to clay. The content of gravel, cobblestones, and stones in the B horizon ranges from 30 to 80 percent. The A horizon ranges from 2 to 3 in value when moist and from 3 to 4 when dry. The chroma of the A horizon when dry or of the B horizon when moist is 3 to 4. A few of the stones in the C horizon are coated with lime.

This soil is used mostly for sugarcane; a small acreage is used for pasture and homesites. (Capability classification VIs, irrigated or nonirrigated; pasture group 1)

Wainee extremely stony silty clay, 3 to 7 percent slopes (WyB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane. (Capability classification VIs, irrigated or nonirrigated; pasture group 1)

Wainee very stony silty clay, 3 to 7 percent slopes (WxB).—On this soil, runoff is slow and the erosion hazard is slight. Stones cover as much as 3 percent of the surface. Included in mapping were small areas where bedrock is at a depth of about 36 inches.

Most of this soil is used for sugarcane; a small acreage is used for homesites. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Wainee very stony silty clay, 7 to 15 percent slopes (WxC).—Stones cover as much as 3 percent of the surface of this soil. Included in mapping were small areas where bedrock is at a depth of about 36 inches. In a few places the slope is moderately steep.

This soil is used mainly for sugarcane; a small acreage is used for homesites. (Capability classification IVs if irrigated, VIs if nonirrigated; sugarcane group 1; pasture group 1)

Waipahu Series

This series consists of well-drained soils on marine terraces on the island of Oahu. These soils developed in old alluvium derived from basic igneous rock. They are nearly level to moderately sloping. Elevations range from nearly sea level to 125 feet. Rainfall amounts to 25 to 35 inches annually; most of it occurs between November and April. The mean annual soil temperature is 75° F. Waipahu soils are geographically associated with Hanalei, Honouliuli, and Waialua soils.

These soils are used for sugarcane and homesites. The natural vegetation is fingergrass, bermudagrass, bristly foxtail, and kiawe.

Waipahu silty clay, 0 to 2 percent slopes (WzA).—This soil is nearly level and occurs on dissected terraces adjacent to the ocean. Included in mapping were small areas of Hanalei, Honouliuli, and Waialua soils. Also included were small areas of clay, where permeability is moderately slow.

In a representative profile the surface layer is dark grayish-brown silty clay about 12 inches thick. The subsoil, about 58 inches thick, is dark-brown silty clay that has prismatic structure. It is very sticky and very plastic in the lower part. The substratum is clayey alluvium. The soil is slightly acid in the surface layer and subsoil.

Permeability is moderately slow. Runoff is slow or very slow, and the erosion hazard is none to slight. The available water capacity is about 1.4 inches per foot in the surface layer and about 1.6 inches per foot in the subsoil. Roots penetrate to a depth of 5 feet or more.

Representative profile: Island of Oahu, lat. 21°22′58″ N. and long. 158°01′13″ W.

Ap—0 to 12 inches, dark grayish-brown (10YR 4/2) silty clay, dark brown (10YR 4/3) when dry; moderate, fine and very fine, granular structure and moderate, medium, subangular blocky; very hard, friable, sticky and plastic; abundant roots; common, fine and very fine, interstitial pores; few coral fragments; violent effervescence with hydrogen peroxide; slightly acid; clear, smooth boundary. 8 to 12 inches thick.

B21—12 to 26 inches, dark-brown (10YR 4/3) silty clay, dark yellowish brown (10YR 4/4) when dry; strong, very coarse, prismatic structure breaking to moderate, medium and coarse, subangular blocky; hard, firm, sticky and plastic; few coarse roots and abundant very fine roots; few, coarse, tubular pores and common, fine and very fine, tubular pores; many weak pressure faces; few coatings in pores; few, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; gradual, wavy boundary. 10 to 14 inches thick.

B22—26 to 36 inches, dark-brown (10YR 4/3) silty clay, dark yellowish brown (10YR 4/4) when dry; strong, very coarse, prismatic structure breaking to moderate, medium and coarse, subangular and angular blocky; hard, firm, sticky and plastic; few coarse roots and plentiful very fine roots; few, coarse tubular pores and common, fine and very fine, tubular pores; common pressure faces on peds, thin coatings in pores; few, fine, black concretions; strong effervescence with hydrogen peroxide; slightly acid; gradual, smooth boundary. 8 to 12 inches thick.

B23—36 to 46 inches, dark-brown (10YR 4/3) silty clay, dark yellowish brown (10YR 4/4) when dry; strong, coarse, prismatic structure breaking to moderate, medium and coarse, subangular and angular blocky; hard, firm, sticky and plastic; few coarse roots and plentiful fine roots, mainly matted between prisms; few, coarse, tubular pores and many, very fine, tubular pores; black stains in pores and on ped faces; common pressure faces on peds; common, deeply grooved slickensides, oriented at 20 degrees; strong effervescence with hydrogen peroxide; slightly acid; gradual, smooth boundary. 8 to 12 inches thick.

B24—46 to 70 inches, dark-brown (10YR 4/3) silty clay, dark yellowish brown (10YR 4/4) when dry; strong, coarse, prismatic structure breaking to strong, medium and coarse, subangular blocky; very hard, firm, very sticky and very plastic; few fine roots; many very fine pores; coatings in pores; common pressure faces; many, fine, black concretions; prominent black stains; common, deeply grooved slickensides; strong effervescence with hydrogen peroxide; slightly acid.

The solum ranges from 10YR to 7.5YR in hue. The A and B horizons range from 2 to 4 in value when moist. The B horizon ranges from 4 to 5 in value when dry. The A and B horizons range from 2 to 3 in chroma when moist and from 3 to 5 when dry.

This soil is used for sugarcane and homesites. (Capability classification I if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 3)

Waipahu silty clay, 2 to 6 percent slopes (WzB).—On this soil, runoff is slow and the erosion hazard is slight.

This soil is used for sugarcane and homesites. (Capability classification IIe if irrigated, IVc if nonirrigated; sugarcane group 1; pasture group 3)

Waipahu silty clay, 6 to 12 percent slopes (WzC).—On this soil, runoff is medium and the erosion hazard is moderate. Included in mapping were small gravelly areas where the slope is as much as 20 percent. Also included was a small area of clay where the slope is 12 to 15 percent.

This soil is used for sugarcane and homesites. (Capability classification IIIe if irrigated, IVe if nonirrigated; sugarcane group 1; pasture group 3)

Use and Management of the Soils

The soils of the Hawaiian Islands are used for sugarcane, pineapple, pasture, woodland, truck crops, orchards, and wildlife. This section describes the limitations and management needs of the soils for each of these uses. It explains the land capability groupings used by the Soil Conservation Service and also discusses soil properties that are significant in engineering.

Sugarcane Management

Sugarcane is grown on the islands of Kauai, Maui, and Oahu. It is not grown on Molokai and Lanai because the supply of irrigation water is inadequate.

Sugarcane is harvested about every 20 to 24 months. The age that the cane is harvested depends to a large extent on the variety of cane and the climate. The harvesting is not necessarily followed by the planting of a new crop. After harvest, the cane root system sends up new sprouts or shoots of the next crop. Replanting is needed only in introducing new varieties, altering the irrigation or field layout, reducing compaction of the soil, or repairing field damage caused by harvesting. Cultural practices vary according to the nature of the soil and the climatic conditions.

If a new planting of sugarcane is to be established, the fields are smoothed and subsoiled or disk plowed and harrowed. If the field is to be irrigated, the irrigation, drainage, and road systems are installed. Terraces, diversions, grassed waterways, and roads are installed in nonirrigated areas. Then the seed stalk is planted, by machine or by hand, in the bottom of a machine-opened furrow and covered with a few inches of soil. Furrows near the contour facilitate irrigation and minimize erosion. After harvest, the furrows, terraces, diversions, roads, and waterways are reshaped and the ditches are repaired.

Fertilizer is applied by hand, machine, or airplane, or by the use of soluble forms of fertilizer in the irrigation water. Lime is needed on some soils. Nitrogen, phosphorus, and potassium are used in the amounts indicated by soil tests, tissue analysis, field trials, and experience.

Herbicides and hand weeding are used to control weeds.

Erosion control, fertilizer, and irrigation in the drier areas are needed to protect the soil and produce good growth.

The sugarcane industry is highly mechanized. The use of heavy equipment permits the production of sugarcane on some extremely stony soils that otherwise would be considered unsuited to cultivation.

The present method of harvesting sugarcane consists of burning the canefields to remove excess leaves. Immediately after burning, a machine-mounted push rake pushes the cane stalks into piles. Large track-type cranes

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load the stalks into trucks that transport the cane to the mill. These operations cause soil disturbance and increase the erosion hazard. Harvesting during periods of low rainfall reduce soil and water losses. The harvest schedule should provide time for regrowth so that the soil is protected during periods of high rainfall. The hazard of erosion can be reduced by establishing grassed waterways, irrigating and planting on the contour, lining ditches and canals, and using diversion ditches in the fields.

Sugarcane groups

The soils of the islands are grouped according to their suitability for sugarcane. The grouping is based on the similarity of management needs, including irrigation, and the amounts of solar insolation. There are four groups. Each group is described in the following pages, and suggestions for management are given.

The names of the soil series represented are listed in the description of each group, but this does not mean that all the soil mapping units of a given series are in the group. The designated group for each soil can be found in the "Guide to Mapping Units."

SUGARCANE GROUP 1

This group consists of excessively drained to well-drained soils of the following series:

Alae	Koloa	Pakala
Ewa	Kunia	Pohakupu
Haleiwa	Lahaina	Puhi
Haliimaile	Lihue	Pulehu
Iao	Mahana	Wahiawa
Ioleau	Makaweli	Wahikuli
Jaucas	Mamala	Waiakoa
Kawaihapai	Manana	Waikomo
Keahua	Mokuleia	Wailuku
Kekaha	Molokai	Wainee
Kemoo	Niu	Waipahu
Kolekole	Paia	

These soils are sands, loams, silt loams, clay loams, silty clay loams, silty clays, and clays. They occur in areas where insolation is high. The slope ranges from 0 to 25 percent. Average annual rainfall amounts to 12 to 80 inches. The mean annual soil temperature is between 60° and 75° F.

Permeability is moderate to rapid. Runoff is very slow to medium, and the erosion hazard is slight to moderate. From 0.5 inch to 2.2 inches of water is available per foot of soil. The rooting depth is 15 to 60 inches or more.

These soils are irrigated by sprinklers (fig. 9) or by furrows from ditches or aluminum and concrete flumes. Furrows are laid out across the slope near the contour. Their gradient is 0.5 to 1.5 percent. All planting and tilling are done across the slope near the contour. Secondary field roads crosswise of the slope serve as diversions.

Yields are 12 to 15 tons per acre per crop.

SUGARCANE GROUP 2

This group consists of moderately well drained and well drained soils of the Halii, Hanamaulu, Kalapa, Kapaa, Lawai, Leilehua, Paaloa, and Pooku series. These soils are silty clay loams, silty clays, and clays. They occur in areas where solar insolation is relatively low. The slope ranges from 0 to 25 percent. Rainfall is well distributed throughout the year. The average annual amount is 50 to 150 inches for all except Halii and Hanamaulu soils, which receive 200 to 250 inches. The mean annual soil temperature is between 69° and 74° F.

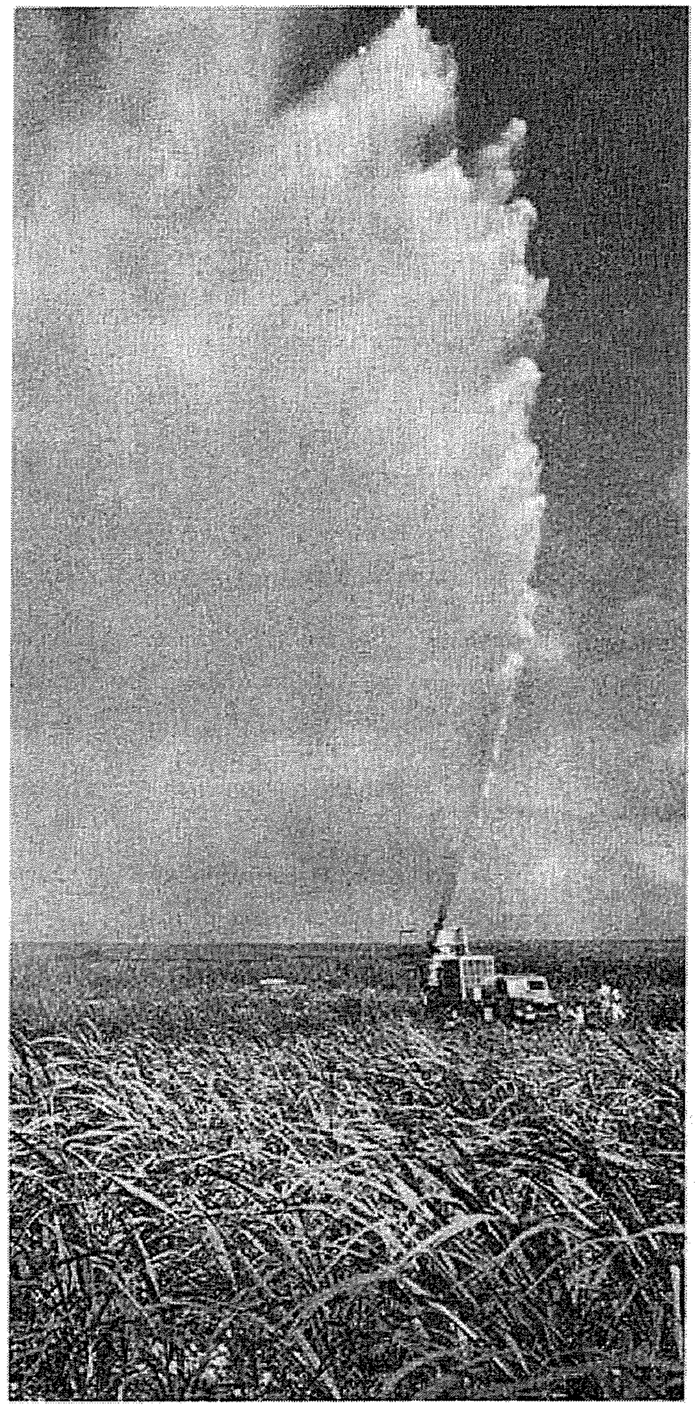

Figure 9.—Irrigation of sugarcane by high-volume gun sprinkler.

Permeability is moderate to moderately rapid. Runoff is very slow to medium, and the erosion hazard is slight to moderate. About 1 or 2 inches of water is available per foot of soil. The rooting depth is 24 to 60 inches or more.

These soils are generally not irrigated. Young cane should be alternated with old cane in strips. The width of the strips is determined by the kind of soil, the length and gradient of the slope, and the intensity and frequency of rainfall. All planting and tilling should be done across the slope near the contour. Secondary roads crosswise of the slope serve as diversions.

Yields are 8 to 10 tons per acre per crop.

SUGARCANE GROUP 3

This group consists of very poorly drained and poorly drained soils of the Hanalei, Kaena, Kalihi, Kaloko, Keaau, Mokuleia, and Nohili series. These soils are silty clay loams, silty clays, and clays. They occur in areas where solar insolation is high. The slope ranges from 0 to 25 percent. The average annual rainfall is 20 to 60 inches for all except Hanalei soils, which receive 120 inches. The rooting depth is 20 to 60 inches.

Permeability is very slow to moderately rapid. Runoff is very slow to medium, and the erosion hazard is slight to moderate. About 1.4 to 2.1 inches of water is available per foot of soil.

These soils are irrigated by furrows generally from ditches constructed across the slope near the contour. Aluminum and concrete flumes are used if the slope is more than 1.5 percent. Cutoff drains and drainage ditches reduce seepage and help in controlling the height of the water table. Streambank stabilization and suitable outlets minimize flood damage.

Yields are 9 to 12 tons per acre per crop.

SUGARCANE GROUP 4

This group consists of moderately well drained and well drained soils of the Honouliuli, Kaena, Lualualei, Makalapa, Nonopahu, and Waialua series. These soils are silty clays and clays. They occur in areas where solar insolation is high. They are sticky and very plastic and can be cultivated within only a narrow range of moisture content. The slope ranges from 0 to 25 percent. The average annual rainfall is 18 to 50 inches. The mean annual soil temperature is between 72° and 75° F.

Permeability is slow to moderate. Runoff is slow to medium, and the erosion hazard is slight to moderate. About 1.3 to 2 inches of water is available per foot of soil. The rooting depth is 20 to 60 inches or more.

These soils are irrigated by furrows from ditches or from aluminum and concrete flumes. The furrows are laid out across the slope near the contour. Their gradient is 0.5 to 1.5 percent. Secondary field roads crosswise of the slope serve as diversions. All harvesting is done during dry periods.

Yields are 12 to 15 tons per acre per crop.

Pineapple Management

Pineapple, which is grown on all the islands in this survey area, is the second most important farm crop in Hawaii. It grows best in well-drained, nonstony soils in areas where solar insolation is high.

Pineapple is grown in a cycle that extends over a period of about 40 months. The cycle extends from the time the crop is planted until the same soil is again prepared and planted. Two crops of pineapple are commonly harvested from each cycle. The first crop, or the plant crop, matures in 16 to 24 months, depending on the kind of planting material and the weather conditions. The second crop, or the ratoon crop, matures a year later.

Cultural practices for growing pineapple vary from one plantation to the next. Seedbed preparation begins with the removal of the old pineapple plants. The plants are removed either by a clean tillage method in which the plants are chopped and plowed under, or by a method in which the plants are chopped and the crop residue is left on the surface as a mulch. In the first method the soil is plowed and disked several times, whereas in the second method little tillage is done. In order to reduce the amount of residue the plants are sometimes partially burned after they are chopped.

A few days before planting, a machine, in one operation, applies a soil fumigant and fertilizer, forms a planting bed, and covers it with a strip of polyethylene. The polyethylene serves as a mulch and reduces soil losses, controls weeds, and forms a seal for the soil fumigants. Slips, suckers, or crowns are planted by hand through the polyethylene strips.

Fertilizer is applied in the soil before planting and as a foliar spray as needed. Plants respond well to nitrogen, phosphorus, and potassium. Iron is needed on all soils, and zinc and lime are needed on some. The kind and amount of fertilizer needed are determined by soil tests, tissue analysis, field trials, and experience.

Pineapple fields are divided into blocks 100 to 130 feet wide. The blocks are of uniform width and are separated by roads used by spraying and harvesting machines. The machines have arms that extend to half the width of the blocks. Hormones that control fruiting time, insecticides, and herbicides are applied.

Pineapple groups

The soils of the islands are grouped according to their suitability for pineapple. The grouping is based on the similarity of management needs, the slope, the amount of solar insolation, and the amount of rainfall. There are eight groups. Each group is described in the following pages, and suggestions for management are given.

The names of the soil series represented are listed in the description of each group, but this does not mean that all the soil mapping units of a given series are in the group. The designated group for each soil can be found in the "Guide to Mapping Units."

PINEAPPLE GROUP 1

This group consists of well drained or moderately well drained soils of the Ewa, Holomua, Hoolehua, Kunia, Lahaina, Molokai, Waihuna, and Waikapu series. These soils are dominantly silt loams, silty clay loams, and silty clays. They occur in areas where insolation is high. The slope ranges from 0 to 3 percent. In most places the elevation is less than 1,000 feet, but it ranges from near sea level to 2,000 feet. The annual rainfall is 10 to 40 inches.

Permeability is moderately slow to moderately rapid. Runoff is very slow to slow, and the erosion hazard is slight. About 1 or 2 inches of water is available per foot of soil. The rooting depth is 40 to 60 inches or more.

All planting and tilling are done across the slope. Grassed waterways are needed in some areas. In most places a mulch of crop residue (fig. 10) is beneficial, but a mulch should not be used at elevations of more than 1,000 feet, because above this level the environment is favorable for the growth of organisms that cause plant diseases. At the lower elevations mulching not only conserves moisture and controls weeds but also protects the soil from erosion.

If a mulch is used, pineapple can be grown without irrigation in areas where the annual rainfall is less than 25 inches. In these areas, planting is scheduled to take advantage of the rainy season.

If irrigation water is available, areas that receive less than 25 inches of rainfall annually are usually irrigated by truck-mounted sprinklers or giant sprinklers (fig. 11). An inch of water is applied at each irrigation, usually in summer, or as needed soon after planting. Irrigation insures uniform establishment of plants.

Yields amount to 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 2

This group consists of well-drained soils of the following series:

Ewa	Lahaina
Holomua	Molokai
Hoolehua	Uwala
Keahua	Waihuna
Koele	Waikapu
Kunia	

These soils are dominantly silt loams, silty clay loams, and silty clays. They occur in areas where solar insolation is high. The slope ranges from 3 to 8 percent. The elevation ranges from near sea level to 2,000 feet but is generally less than 1,000 feet. The average annual rainfall is 15 to 40 inches.

Permeability is moderately slow to moderately rapid. Runoff is slow to medium, and the erosion hazard is slight. About 1 or 2 inches of water is available per foot of soil. The rooting depth is 40 to 60 inches or more.

All planting and tilling are done across the slope. Field roads serve as diversions. Grassed waterways are needed in some areas. A mulch of crop residue is beneficial except at elevations of more than 1,000 feet. At the lower elevations mulching conserves moisture, controls weeds, and reduces the hazard of erosion, but at the higher elevations it increases the growth of organisms that cause plant diseases.

If a mulch is used, pineapple can be grown without irrigation in areas where the annual rainfall is less than 25 inches. In these areas, planting is scheduled to take advantage of the rainy season.

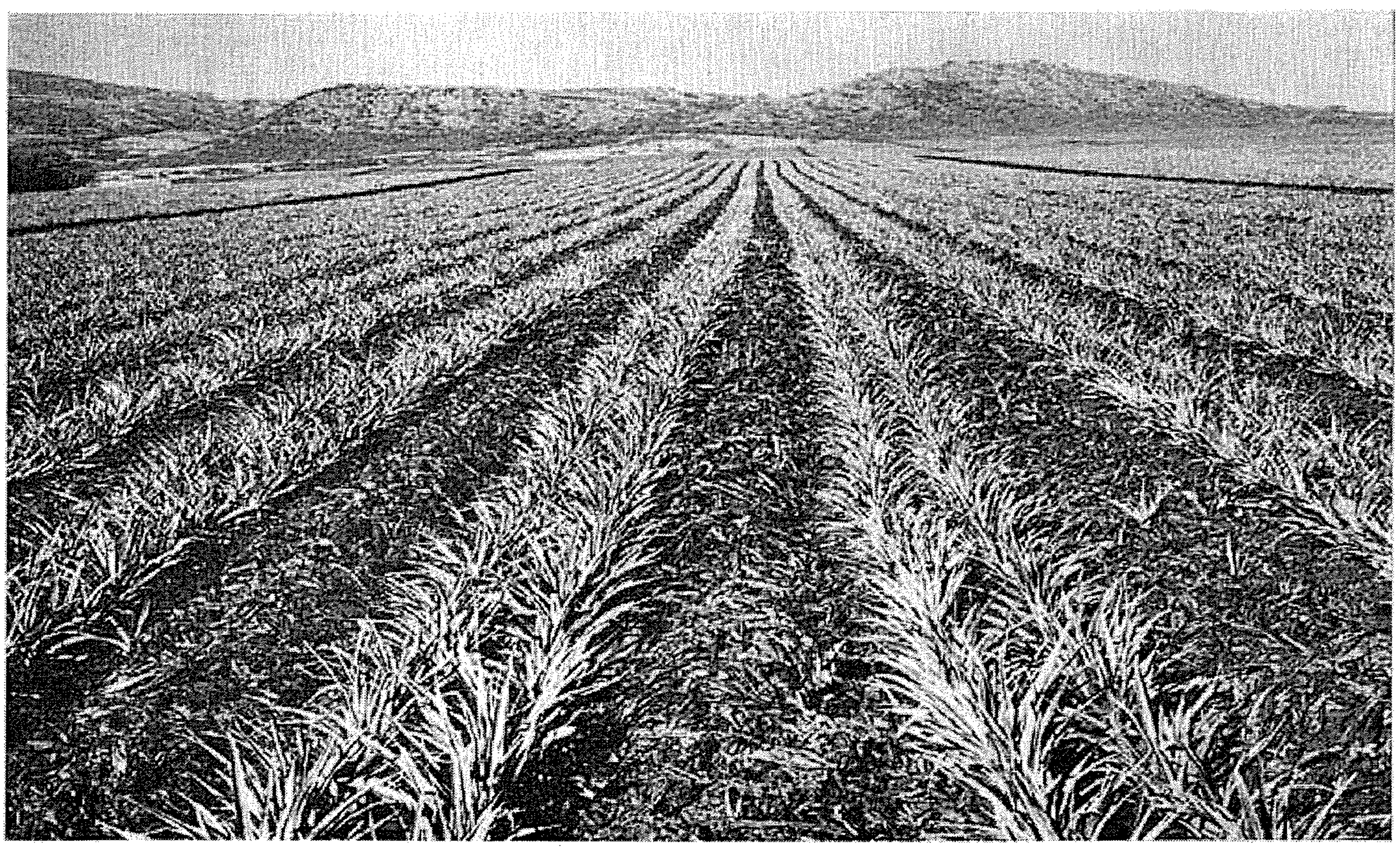

Figure 10.—Young pineapple plants mulched with crop residue. The soil is a Holomua silt loam.

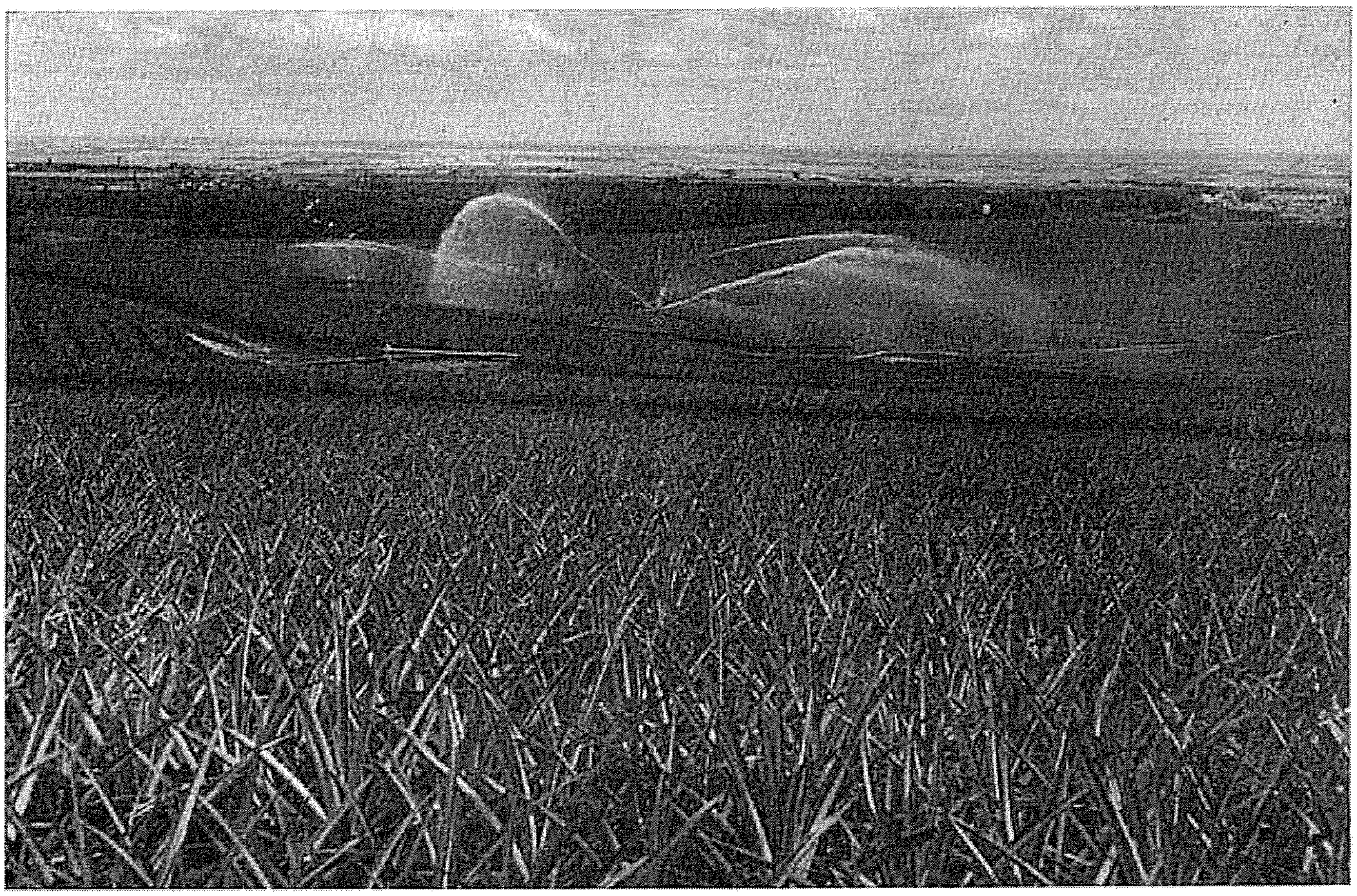

Figure 11.—Pineapple irrigated by giant sprinklers.

If irrigation water is available, areas that receive less than 25 inches of annual rainfall are usually irrigated by truck-mounted sprinklers or giant sprinklers. An inch of water is applied at each application, usually in summer, or as needed soon after planting. Irrigation insures uniform establishment of plants.

Yields are 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 3

This group consists of well-drained soils of the following series:

Ewa	Kunia
Holomua	Lahaina
Honolua	Molokai
Hoolehua	Uwala
Kealua	Waihuna
Koele	Waikapu

These soils are dominantly silt loams, silty clay loams, and silty clays. They occur in areas where solar insolation is high. The slope ranges from 8 to 25 percent. The elevation ranges from near sea level to 2,000 feet but is generally less than 1,000 feet. The average annual rainfall is 15 to 40 inches.

All planting and tilling are done across the slope or on the contour (fig. 12). Workability is slightly difficult because of the slope. Diversion ditches on a graded contour carry runoff water from the fields. Grassed waterways and outlets are needed. A mulch of crop residue conserves moisture, controls weeds, and reduces the hazard of erosion. In areas where the elevation is more than 1,000 feet, mulching increases heart rot and root rot diseases.

If a mulch is used, pineapple can be grown without irrigation in areas where the annual rainfall is less than 25 inches. In these areas, planting is scheduled to take advantage of the rainy season.

If irrigation water is available, areas that receive less than 25 inches of annual rainfall are usually irrigated by truck-mounted sprinklers or stationary sprinklers. An inch of water is applied at each application, usually in summer, or as needed soon after planting. Irrigation insures uniform establishment of plants.

Yields are 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 4

This group consists of well-drained soils of the Puhi and Wahiawa series. These soils are silty clays and silty

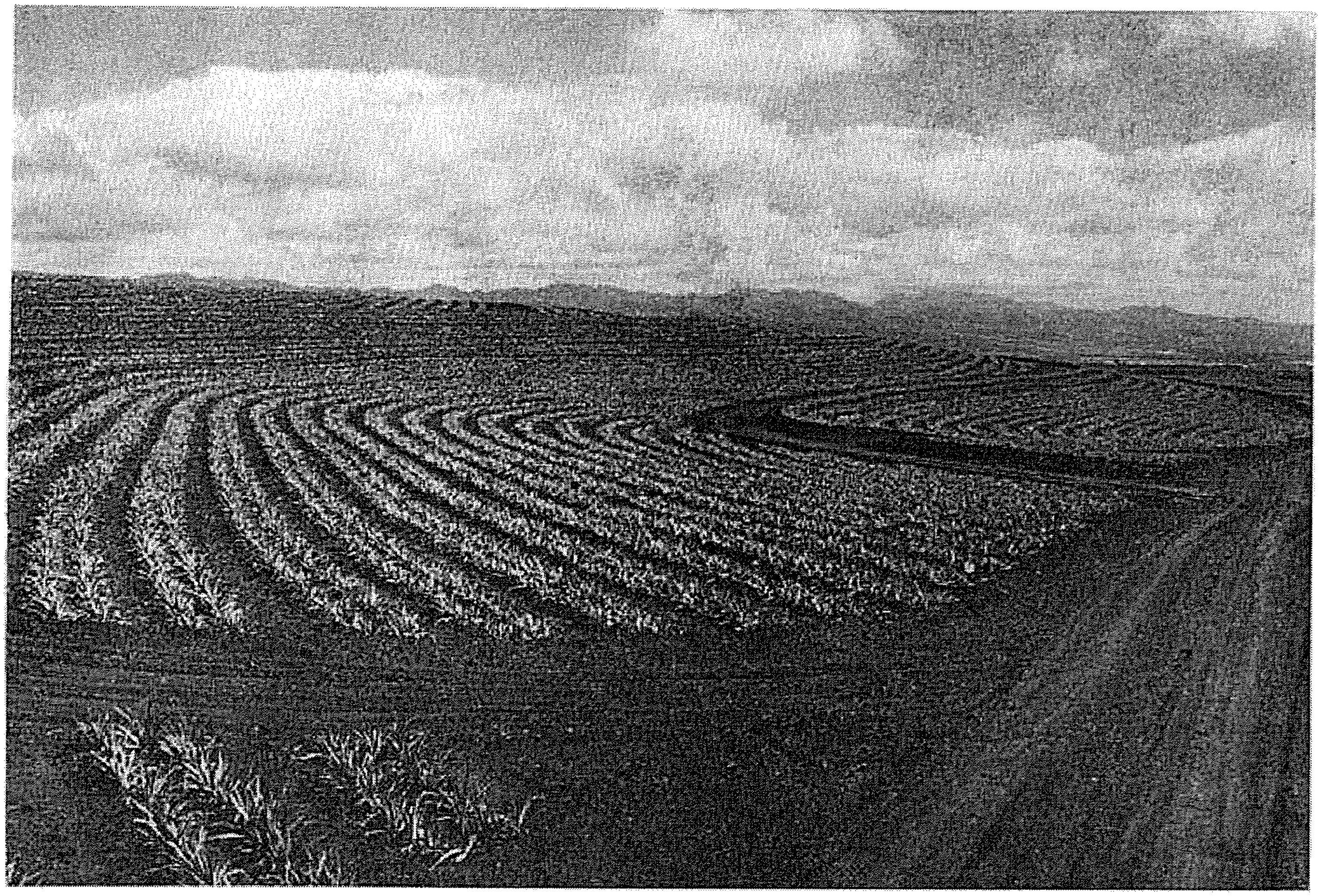

Figure 12.—Erosion controlled by planting pineapple on the contour. Infield roads serve as diversions during intense storms.

clay loams. They occur in areas where solar insolation is moderate to high. The slope ranges from 0 to 3 percent. The elevation ranges from near sea level to 1,200 feet. The average annual rainfall is 40 to 70 inches.

Permeability is moderately rapid. Runoff is very slow to slow, and the erosion hazard is slight. About 1 to 2 inches of water is available per foot of soil. The rooting depth is 20 to 60 inches or more.

All planting and tilling are done across the slope. Grassed waterways are needed in some areas. Rainfall is ample; no irrigation is needed. In nearly all areas the old plants are plowed under. Crop-residue mulch is not used because it increases heart rot and root rot diseases.

Yields are 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 5

This group consists of well-drained soils of the following series:

Alaeloa	Kahana
Haiku	Kalae
Haliimaile	Kemoo
Hamakuapoko	Kolekole
Ioleau	Leilehua
Lihue	Puhi
Makawao	Wahiawa
Manana	

These soils are dominantly clays, silty clays, and silty clay loams. They occur in areas where solar insolation is moderate to high. The slope ranges from 3 to 8 percent. The elevation ranges from near sea level to 2,200 feet. The average annual rainfall is 40 to 70 inches.

Permeability is slow to moderately rapid. Runoff is slow, and the erosion hazard is slight to moderate. About 1 to 2 inches of water is available per foot of soil. The rooting depth is 20 to 60 inches or more.

All planting and tilling are done across the slope or on the contour. Field roads serve as diversions. Grassed waterways are needed in some areas. Rainfall is ample; no irrigation is needed. In nearly all areas the old plants are plowed under. Crop residue mulch is not used because it increases heart rot and root rot diseases.

Yields are 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 6

This group consists of well-drained soils of the following series:

Alaeloa	Kolekole
Haiku	Leilehua
Haliimaile	Lihue
Hamakuapoko	Mahana
Ioleau	Makawao
Kahana	Manana
Kalae	Puhi
Kemoo	Wahiawa

These soils are dominantly clays, silty clays, and silty clay loams. They occur in areas where solar insolation is moderate to high. The slope ranges from 8 to 25 percent. The elevation ranges from near sea level to 2,200 feet. The average annual rainfall is 40 to 70 inches.

Permeability is slow to moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to moderate. About 1 to 2 inches of water is available per foot of soil. The rooting depth is 20 to 60 inches or more.

All planting and tilling are done across the slope or on the contour. Workability is slightly difficult because of the slope. Diversion ditches on a graded contour carry runoff water from the fields. Waterways and outlets are grassed. No irrigation is needed. In nearly all areas the old plants are plowed under. Crop residue mulch is not used because it increases heart rot and root rot diseases.

Yields are 35 to 45 tons per acre for the plant crop and 25 to 35 tons per acre for the ratoon crop.

PINEAPPLE GROUP 7

This group consists of moderately well drained to well drained soils of the Halii, Kapaa, and Pauwela series. These soils are dominantly silty clay loams, silty clays, and clays. They occur in areas where solar insolation is low. The slope ranges from 3 to 8 percent. The elevation ranges from 100 to 1,500 feet. The average annual rainfall is 70 to 120 inches.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight. About 1 to 2 inches of water is available per foot of soil. The rooting depth is 30 to 60 inches or more.

All planting and tilling are done across the slope or on the contour. Field roads serve as diversions. Grassed waterways are needed in some areas. Rainfall is ample; no irrigation is needed. In nearly all areas the old plants are plowed under. Crop residue mulch is not used because it increases heart rot and root rot diseases.

Yields are 30 to 40 tons per acre for the plant crop and 20 to 30 tons per acre for the ratoon crop.

PINEAPPLE GROUP 8

This group consists of moderately well drained to well drained soils of the Halii, Kapaa, and Pauwela series. These soils are dominantly silty clay loams, silty clays, and clays. They occur in areas where insolation is low. The slope ranges from 8 to 25 percent. The elevation ranges from 100 to 1,500 feet. The average annual rainfall is 70 to 120 inches.

Permeability is moderately rapid. Runoff is slow to medium, and the erosion hazard is slight to severe. About 1 to 2 inches of water is available per foot of soil. The rooting depth is 30 to more than 60 inches.

All planting and tilling are done across the slope or on the contour. Workability is impaired somewhat by the slope. Diversion ditches on a graded contour carry runoff from the fields. No irrigation is needed. Waterways and outlets are grassed. In nearly all areas the old plants are plowed under. Crop residue is not used on the soils in this group, because mulching increases heart rot and root rot diseases.

Yields are 30 to 40 tons per acre for the plant crop and 20 to 30 tons per acre for the ratoon crop.

Pasture Management [2]

Approximately 385,000 acres in this survey area is used for cattle grazing. Ranches range in size from 66,000 acres to small units operated by part-time ranchers. Nearly all ranches are the cow-calf type. Beef animals are generally marketed as yearlings; some weaners are sold as feeders.

The native vegetation of the Hawaiian Islands quickly disappeared after the introduction of cattle. All of the present improved forage species have been introduced from other areas of the world.

Forage production in areas of low rainfall is extremely variable from year to year. In seasons of adequate rainfall, the green-feed period extends from November to July. In seasons of low rainfall the period is much shorter. During droughts, green forage is generally nonexistent. In areas of heavier rainfall forage production is more consistent from year to year.

Establishment of pasture

A prepared seedbed insures a good stand of the seeded species and is essential for the establishment of pasture. In areas where it is impractical to prepare a seedbed by cultivation, other practices, such as chain dragging, brush rake dozing, controlled burning, and chemicals, can be used to control the existing vegetation.

An application of nitrogen or nitrogen-phosphorus fertilizer is generally needed for the establishment of grasses. A phosphorus or phosphorus-lime fertilizer is generally needed for the successful establishment of grass-legume pasture. Periodic applications of fertilizer are needed for good pasture production and maintenance. The rate of application and the timing depend on the pasture species, the soil, the climatic condition, and the season of use.

Using the best planting stock available, that is, clean seed that has a high germination percentage, helps insure a good stand. Inoculating legumes with the proper Rhizobium species is essential for the establishment of a stand, for maximum forage yields, and for sustained production. Weeds can be controlled with chemicals, by clipping or mowing, or by controlled grazing.

Improved grasses and legumes suited to the survey area are described in the following paragraphs.

KOA HAOLE (*Leucaena leucocephala*).—This is a deep-rooted, leguminous, long-lived shrub or small tree. It is suited to areas that have 25 to 60 inches of annual rainfall and elevations up to 1,500 feet.

Koa haole is established from seed. For best results it should be mechanically planted in a prepared seedbed, with either guineagrass or green panicgrass, and managed to fit the growth cycle of the companion grass.

[2] D. N. PALMER AND T. A. BOWN, plant materials specialists, SCS, assisted in the preparation of this section.

BIG TREFOIL (*Lotus uliginosus*).—This is a long-lived, semiprostrate legume that has rhizomes and a large fibrous root system. It is suited to areas that have more than 60 inches of annual rainfall and elevations of more than 1,000 feet. It grows in open sunlight or partial shade.

This legume is established from seed or cuttings and is planted with either kikuyugrass or pangolagrass. It has a 30-day regrowth cycle during the warmest months and a 45-day regrowth cycle during the coldest months. It withstands close grazing, that is, as close as 2 inches, on a rotational basis.

INTORTUM (*Desmodium intortum*).—This is a long-lived legume that has a long decumbent stem. It is suited to areas that have 60 to 120 inches of annual rainfall and elevations up to 3,000 feet.

Intortum is established from either seed or cuttings. For best results seeds should be mechanically planted in rows on a prepared seedbed. This legume is generally planted with pangolagrass, and the two are managed for the intortum. After the leaves have been stripped from the stems, grazing should be deferred and the intortum allowed to regrow. The regrowth cycle is about 60 days in summer and 90 days in winter.

BUFFELGRASS (*Cenchrus ciliaris*).—This is a long-lived bunchgrass. It is well suited to areas that have 10 to 40 inches of annual rainfall and elevations of less than 2,000 feet. It has a high potential for forage production and a large fibrous root system that helps control erosion.

Buffelgrass is readily established from seed. It is best established by shallow seeding with a mechanical planter on a prepared seedbed. A rotational system of deferred grazing that provides a seed crop improves thin stands and helps in maintaining the pasture. After a significant rain, the pasture can be grazed within 21 to 30 days. If enough soil moisture is available, buffelgrass is grazed on a 30-day rotation. It should never be grazed closer than 2 to 3 inches.

GREEN PANICGRASS (*Panicum maximum* var. *tricoglume*).—This is a long-lived bunchgrass 3 to 6 feet tall. It is suited to areas that have 22 to 60 inches of annual rainfall and elevations of less than 2,000 feet. It is a high-producing forage plant that makes good ground cover and helps control erosion.

Green panicgrass is easily established from seed. It has excellent seedling vigor. For best results it should be mechanically planted on a prepared seedbed. The stands can be improved and forage can be provided during the dry season by a system of deferred grazing that produces a seed crop. Established pasture of green panicgrass can be grazed 30 to 40 days after the end of the dry season. It has a 30-day regrowth cycle during the warm months and a 45-day regrowth cycle during the cool months. For best results, green panicgrass should not be grazed closer than 4 to 6 inches.

GUINEAGRASS (*Panicum maximum*).—This is a long-lived bunchgrass 6 to 8 feet tall. It is suited to areas that have 25 to 60 inches of annual rainfall and elevations of less than 2,000 feet. It has a high potential for forage production. The large fibrous root system is a good soil binder and helps control erosion.

Guineagrass is easily established from seed on a prepared seedbed. Thin stands can be improved by a system of deferred grazing that provides a seed crop. An established guineagrass pasture can be grazed 40 to 60 days after the end of the dry season. If soil moisture is sufficient, guineagrass can be grazed on a 60-day cycle during the hot months and a 90-day cycle during the cool months. To maintain good production and a good stand, this grass should not be grazed closer than 8 to 10 inches.

KIKUYUGRASS (*Pennisetum clandestinum*).—This is a long-lived, deep-rooted, sod-forming grass that spreads by stolons and forms a dense turf. It is an excellent pasture and soil-stabilizing grass. It is suited to all elevations where annual rainfall is 40 to 80 inches.

Kikuyugrass is established from sprigs. It has a 30-day regrowth cycle during the warmest months, and a 45-day regrowth cycle during the coolest months. For best results it should not be grazed closer than 2 inches.

PANGOLAGRASS (*Digitaria decumbens*).—This is a long-lived grass 2 to 3 feet tall. It has long stolons that root at the nodes and an open turf. It produces good forage and provides excellent ground cover that helps control erosion. It is suited to areas that have 60 to 120 inches of annual rainfall and elevations of less than 3,000 feet.

Pangolagrass does not produce viable seed. It is propagated by sprigging. For best results the sprigs should be planted less than 2 inches deep in a prepared seedbed. Established pangolagrass has a regrowth cycle of 30 days during the warm months and 45 days during the cool months.

CALIFORNIAGRASS (*Brachiaria mutica* syn. *Panicum purpurascens*).—This is a long-lived, sod-forming grass. It has a coarse trailing stem that roots at the nodes. The flower stem is as much as 6 feet tall. Californiagrass, also commonly called paragrass, has a high potential for forage production. It is particularly suited to poorly drained soils that are less than 2,000 feet in elevation. Californiagrass is a poor seed producer and is usually propagated from cuttings, or sprigs. Established paragrass has a regrowth cycle of 60 days during the warm months and 90 days during the cool months. Locally, it is used mainly as green-chop forage.

Forage production

The consistent variation in forage production from season to season, the lengths of the green-feed period, and a balance between the number of stock and the amount of forage are all factors to be considered in planning pasture management. Pasture rotation, periodic deferment, and a good fertilization program help in maintaining the desirable forage plants. Extreme care in grazing newly seeded pastures prevents the destruction of the new seedlings. During the first year it is desirable to allow bunchgrasses to produce a seed crop to insure a good stand.

Continuous grazing lowers forage yields, weakens the vigor of the forage plants, and reduces their ability to compete with other plants. Rotational grazing of pasture improves the utilization and production of forage, reduces weeds, and prolongs the life of the plantings (fig. 13).

Most pastures eventually need reseeding. The productive life of the forage plant depends on the species and the kind of management.

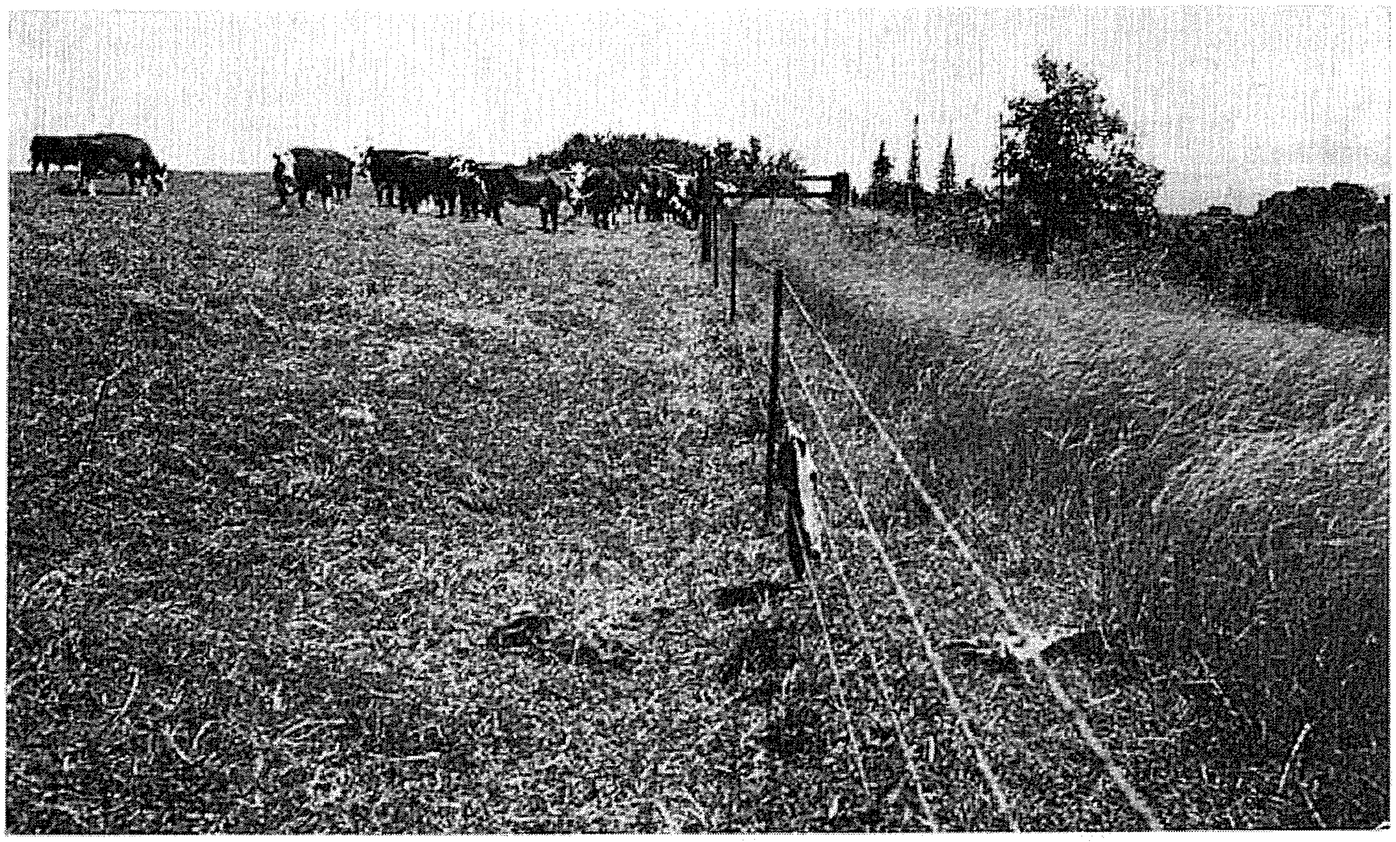

Figure 13.—Rotation grazing on fertilized pangolagrass-kaimi clover pasture.

Pasture groups

The soils of the islands are grouped according to their suitability for pasture. In each group are soils that produce about the same kinds and amounts of vegetation and require similar management. There are 14 groups, 13 of which consist of soils and 1 of land types. Each is described in the following pages. Also, the species suitable for each group are named and the estimated potential productivity is given.

The names of the soil series represented are mentioned in the description of each group, but this does not mean that all the soil mapping units of a given series are in the group. The designated group for each soil can be found in the "Guide to Mapping Units." No designations are given in the guide for the miscellaneous land types mapped in the reconnaissance survey. All are in pasture group 14.

PASTURE GROUP 1

This group consists of soils of the following series:

Alae	Makena
Holomua	Mala
Jaucas	Puuone
Kapuhikani	Waiakoa
Kealia	Wainee
Keawakapu	

These soils are on alluvial fans, terraces, and low uplands in the drier parts of the survey area. They developed in material weathered from basic igneous rocks and in alluvium, coral sand, and volcanic ash. They are 20 to more than 60 inches deep. The slope range is 0 to 15 percent. The elevation ranges from sea level to 1,500 feet. In most places average annual rainfall amounts to 10 to 20 inches annually. The mean annual air temperature is between 73° and 78° F. This pasture group makes up about 66,500 acres.

Drainage is good, except in areas of Kealia soils. Permeability is rapid to moderate in all except Kapuhikani soils, where it is moderately slow to slow.

The vegetation in unimproved pasture is dominantly piligrass, white piligrass, feather fingergrass, ilima, uhaloa, Japanese tea, golden crownbeard, and zinnia. Kiawe trees grow in dense stands along the coastal flats and in open stands on the uplands. In summer the main source of forage along the coastal flats is kiawe pods. Pickleweed is the dominant plant on Kealia soils. Unimproved pasture produces 400 to 1,300 pounds of air-dry forage per acre per year. Three-fourths or more of the annual forage crop is produced during the rainy season. In summer, most of the annuals die and the perennials become dormant.

Forage species for improved pasture are buffelgrass, white piligrass, and giant bermudagrass. Buffelgrass is especially well suited; it spreads rapidly and provides ground cover for eroded areas. Guineagrass and koa haole are suitable in areas where rainfall is more plentiful and in areas along the coast where ground water is near the surface. Australian saltbush is the only improved species suitable for the saline Kealia soils. Well-managed improved pasture produces 1,700 to 2,600 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult in stony areas. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods. Improvement of pasture on eroded soils is difficult because of strong winds and low rainfall.

PASTURE GROUP 2

This group consists of soils of the following series:

Ewa	Nonopahu
Honouliuli	Oanapuka
Keahua	Pakala
Kekaha	Pulehu
Koko	Puu Pa
Lualualei	Uwala
Makaweli	Waikapu
Mamala	Waiawa
Molokai	

These soils are on alluvial fans, terraces, and low uplands. They developed in alluvium, marine sediments, volcanic ash, and material weathered from basic igneous rocks. Mamala and Waiawa soils are less than 20 inches deep; the rest are 20 to more than 60 inches deep. Slopes are dominantly 0 to 35 percent but range from 50 to 80 percent on Waiawa soils. The elevation is less than 1,000 feet in most places but ranges to 2,500 feet in areas of Puu Pa and Waiawa soils. The average annual rainfall is mainly 15 to 35 inches. The mean annual air temperature is between 70° and 75° F. This pasture group makes up about 157,000 acres.

Drainage is good to moderately good. Permeability is moderately rapid to slow.

The vegetation in unimproved pasture is dominantly kiawe, koa haole, klu, ilima, uhaloa, lantana, buffelgrass, bermudagrass, piligrass, fingergrass, and bristly foxtail. Forage production in winter is estimated to be approximately three times as much as that in summer. Total production is 700 to 1,700 pounds of air-dry forage per acre per year.

Buffelgrass, white piligrass, giant bermudagrass, guineagrass, and koa haole are suitable species for improved pasture. Well-managed improved pasture produces 1,400 to 2,600 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on extremely stony and extremely rocky soils and on soils steeper than 40 percent. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods. Improvement is difficult on eroded soils because of strong winds and low rainfall. It is difficult on Lualualei soils because these soils are very sticky and very plastic and have poor workability.

PASTURE GROUP 3

This group consists of soils of the following series:

Haleiwa	Kahana	Koele	Pamoa
Haliimaile	Kamaole	Kokokahi	Papaa
Helemano	Kanepuu	Kunia	Wahikuli
Hoolehua	Kaupo	Lahaina	Waialua
Iao	Kawaihapai	Makalapa	Waihuna
		Mokuleia	Wailuku
		Niu	Waipahu
		Paia	

These soils are on coastal plains, alluvial fans, terraces, and low uplands. They developed in alluvium, volcanic ash, and material weathered from basic igneous rocks. They are 20 to more than 60 inches deep. Slopes are dominantly 0 to 35 percent but are more than 35 percent on Helemano and Papaa soils. The elevation ranges from near sea level to about 2,000 feet. The average annual rainfall is mainly 25 to 40 inches but ranges from 20 to 60 inches. The mean annual temperature is between 69° and 75° F. This pasture group makes up about 151,700 acres.

Drainage is good to moderately good except on the Mokuleia poorly drained variant. Permeability is moderately rapid to slow.

The vegetation in unimproved pasture is dominantly kiawe, koa haole, klu, lantana, molassesgrass, bermudagrass, dallisgrass, Natal redtop, uhaloa, ilima, sourgrass, piligrass, and fuzzy top. Guava and Christmas berry grow in the areas of heaviest rainfall. Forage production in winter is estimated to be about three times as much as that in summer. Total production is 1,000 to 2,000 pounds of air-dry forage per acre per year.

Buffelgrass, guineagrass, green panicgrass, and koa haole are suitable species for improved pasture. Well-managed improved pasture produces 2,000 to 4,800 pounds of air-dry forage per acre per year.

PASTURE GROUP 4

This group consists of soils of the Kula, Io, and Uma series. These soils are on low and intermediate uplands. They developed in volcanic ash and cinders. Kula soils are 24 to more than 60 inches deep over bedrock. Io soils are 20 to 40 inches deep over fine cinders. Uma soils are less than 10 inches deep over fine cinders. The slope range is dominantly 0 to 40 percent but is as much as 70 percent for Uma soils. The elevation is dominantly 1,000 to 4,000 feet but ranges to 6,000 feet for Uma soils. The average annual rainfall is 25 to 40 inches. The mean annual air temperature is between 56° and 69° F. This pasture group makes up 17,450 acres.

Drainage is good to excessive. Permeability is very rapid to moderately rapid.

The vegetation in unimproved pasture is dominantly bermudagrass, rattailgrass, yellow foxtail, Natal redtop, black wattle, and joee. Forage production in winter is about twice as much as that in summer. Total production of unimproved pasture is 2,000 to 3,000 pounds of air-dry forage per acre per year.

Guineagrass, green panicgrass, kikuyugrass, and Glycine are suitable species for improved pasture. Well-managed improved pasture produces 3,500 to 6,000 pounds of air-dry forage per acre per year.

PASTURE GROUP 5

This group consists of soils of the Kaimu, Kalaupapa, Kemoo, Koloa, Lihue, Pane, Ulupalakua, Wahiawa, and Waikomo series. These soils are on uplands. They developed in volcanic ash and material weathered from basic igneous rocks. The slope range is up to 70 percent for Kemoo soils but is 0 to 40 percent for the rest. The elevation ranges from near sea level to 4,500 feet. The average annual rainfall is 30 to 60 inches. The mean annual air temperature is between 65° and 74° F. This pasture group makes up about 57,800 acres.

Drainage is good. Permeability is very rapid to moderate.

The vegetation in unimproved pasture is dominantly joee, Japanese tea, koa haole, lantana, bermudagrass, Natal redtop, rattailgrass, pricklypear cactus, and guava. There are dense stands of koa haole at the lower elevations. Unimproved pasture produces 2,000 to 3,200 pounds of air-dry forage per acre per year.

Forage species for improved pasture are kikuyugrass, pangolagrass, intortum, guineagrass, and green panicgrass. Koa haole grows well at elevations of less than 1,100 feet. Well-managed improved pasture produces 4,000 to 7,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on extremely stony, extremely rocky, very rocky, and very steep soils. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods. Improvement on eroded soils is difficult because of low fertility and high erodibility.

PASTURE GROUP 6

This group consists of soils of the following series:

Alaeloa	Mahana
Halawa	Manana
Hamakuapoko	Naiwa
Ioleau	Oli
Kalae	Pohakupu
Kolekole	Puu Opae

These soils are on alluvial fans, terraces, and low uplands. They developed in alluvium, volcanic ash, and material weathered from basic igneous rocks. They are 24 to more than 60 inches deep. Slopes are dominantly 0 to 40 percent but range to as much as 70 percent on Alaeloa, Halawa, and Oli soils. The elevation ranges from 50 to 3,250 feet. The average annual rainfall is 30 to 60 inches. The mean annual air temperature is between 67° and 73° F. This pasture group makes up about 75,500 acres.

Drainage is good. Permeability is moderately rapid to slow.

The vegetation in unimproved pasture is dominantly hilograss, yellow foxtail, molassesgrass, Natal redtop, koa haole, joee, Japanese tea, guava, Christmas berry, and Java plum. There are dense stands of koa haole at the lower elevations. Unimproved pasture produces 2,400 to 3,200 pounds of air-dry forage per acre per year.

Forage species for improved pasture are kikuyugrass, pangolagrass, guineagrass, green panicgrass, intortum, and koa haole. Well-managed improved pasture produces 5,000 to 9,000 pounds of air-dry forage per acre per year.

Seeding, fertilization, and weed and brush control are limited to hand and aerial methods on the very steep soils. Improvement of pasture on eroded soils is difficult because of low fertility and high erodibility.

PASTURE GROUP 7

This group consists of soils of the Hanalei, Kaena, Kalihi, Kaloko, Keaau, Nohili, and Pearl Harbor series. These soils are on coastal plains, alluvial fans, terraces, and low uplands. They developed in alluvium, colluvium, and marine sediments. They are 20 to more than 60 inches deep. The slope range is dominantly 0 to 6 percent but ranges to 35 percent on Kaena soils. The elevation ranges from sea level to 300 feet. The average annual rainfall is 18 to 120 inches. The mean annual air temperature is between 73° and 75° F. This pasture group makes up about 19,500 acres.

Drainage is somewhat poor to very poor. Permeability is moderate to very slow.

The dominant vegetation in unimproved pasture is californiagrass, honohono, sensitiveplant, sedges, Java plum, and koa haole. Unimproved pasture produces 3,000 to 6,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are pangolagrass, intortum, and californiagrass. Pangolagrass and intortum are suited to the better drained soils, californiagrass to the wetter soils. Well-managed improved pasture produces 7,000 to 16,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on the very stony Kaena soils. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods.

PASTURE GROUP 8

This group consists of soils of the following series:

Haiku	Lolekaa
Hanamaulu	Makaalae
Hihimanu	Makawao
Honolua	Olelo
Kahanui	Paaloa
Kalapa	Paumalu
Kaneohe	Pauwela
Kolokolo	Puhi
Lawai	Waikane
Leilehua	

These soils are on alluvial fans, terraces, and low uplands. They developed in alluvium, colluvium, volcanic ash, and material weathered from basic igneous rocks. They are 30 to more than 60 inches deep. Slopes range from 0 to 70 percent. The elevation ranges from near sea level to 3,750 feet. The average annual rainfall is mainly 50 to 150 inches. The mean annual air temperature is between 62° and 73° F. This pasture group makes up about 112,800 acres.

Drainage is somewhat poor to moderate for Lawai soils and is good to moderate for the rest. Permeability is moderately rapid to moderate for all.

The vegetation in unimproved pasture is dominantly Japanese tea, bermudagrass, ricegrass, hilograss, carpetgrass, glenwoodgrass, yellow foxtail, honohono, paragrass, sensitiveplant, guava, lantana, Christmas berry, koa, and ohia. Unimproved pasture produces 3,000 to

5,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are kikuyugrass, pangolagrass, and intortum (fig. 14). Well-managed improved pasture produces 8,000 to 14,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on extremely stony, very rocky and bouldery soils and very steep soils. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods. Improvement of pasture on eroded soils is difficult because of low fertility and high erodibility.

PASTURE GROUP 9

This group consists of soils of the Hana variant, Malama, Niulii, Opihikao, and Tantalus series. These soils are on recent lava flows, cinder cones, and low uplands. They developed in volcanic ash, cinders, organic material, and material weathered from basic igneous rocks. They are less than 10 inches to more than 40 inches deep. Slopes are dominantly 0 to 30 percent but range to 70 percent on Tantalus soils. The elevation ranges from near sea level to 2,200 feet. The average annual rainfall is mainly 60 to 100 inches but ranges from 50 to 150. The mean annual air temperature is between 70° and 72° F. This pasture group makes up about 8,900 acres.

Drainage is good except in depressions in the very shallow Opihikao soils. In these soils ponding is common. Permeability is moderately rapid to very rapid. This pasture group makes up about 8,900 acres.

The vegetation in unimproved pasture is dominantly hilograss, guava, kukui, hala, and ohia. Unimproved pasture produces 3,000 to 5,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are kikuyugrass, pangolagrass, and intortum. Well-managed improved pasture produces 8,000 to 14,000 pounds of air-dry forage per acre per year.

Except on Niulii soils, improvement of pasture is difficult because of the extremely stony and rocky conditions or the very steep slopes. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods.

PASTURE GROUP 10

This group consists of soils of the Halii, Kapaa, Makapili, and Pooku series. These soils are on low uplands. They developed in material weathered from basic igneous rocks. They are more than 60 inches deep. Slopes range

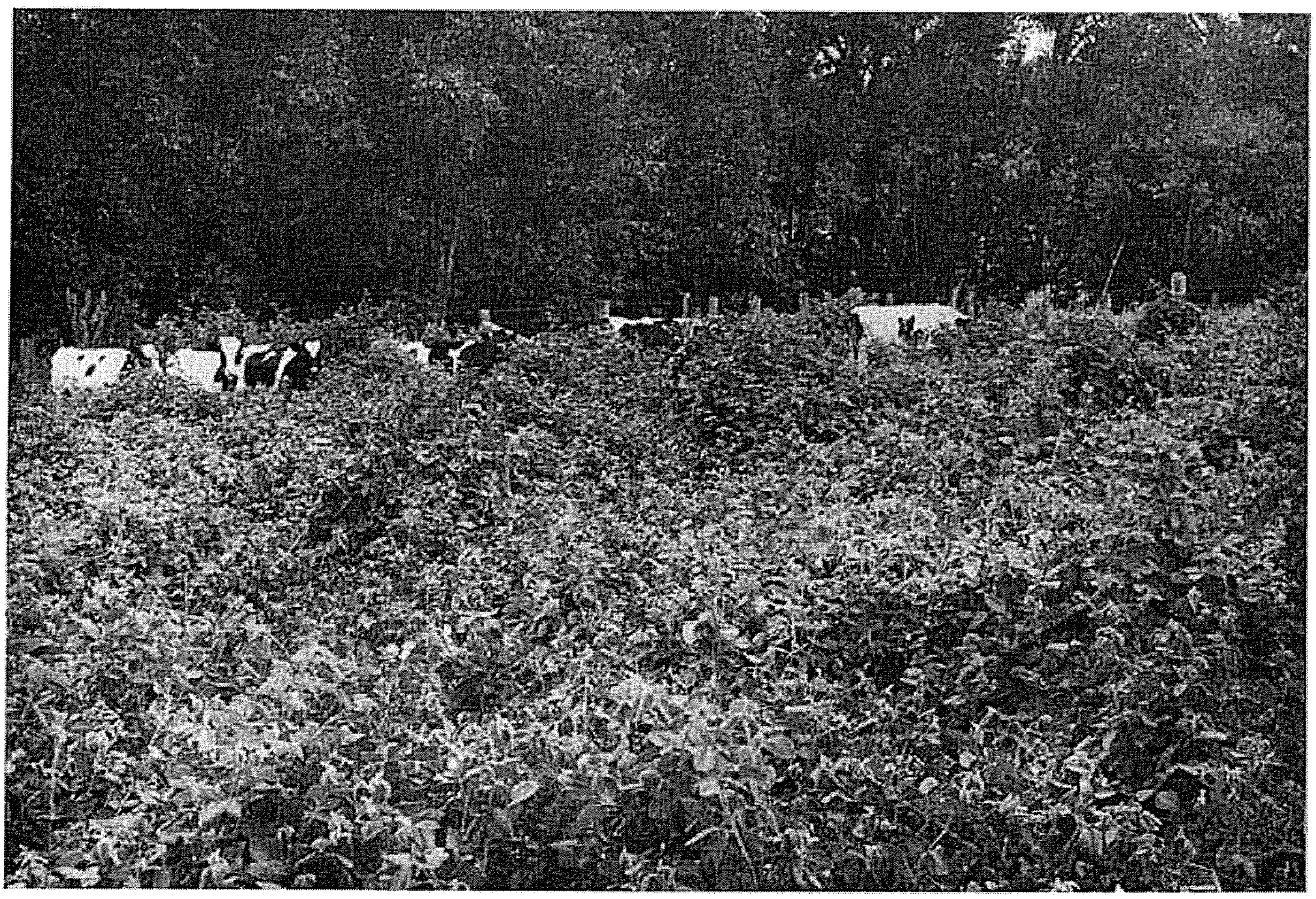

Figure 14.—Intortum pasture on a Makawao soil.

from 0 to 40 percent except for the very steep Kapaa soils. The elevation ranges from 100 to 1,800 feet. The average annual rainfall is 70 to 200 inches. The mean annual air temperature is between 70° and 73° F. This pasture group makes up about 37,700 acres.

Drainage is good to moderately good. Permeability is moderately rapid.

The vegetation in unimproved pasture is dominantly ricegrass, hilograss, yellow foxtail, lantana, joee, false staghornfern, melastoma, rhodomyrtus, sensitiveplant, guava, Christmas berry, and ohia. Unimproved pasture produces 3,000 to 5,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are kikuyugrass, pangolagrass (fig. 15), and intortum. Well-managed improved pasture produces 8,000 to 10,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on the very steep Kapaa soils. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods. Improvement on the eroded Halii soils is difficult because of low fertility.

PASTURE GROUP 11

This group consists of soils of the Hana, Kailua, Koolau, and Honomanu series. These soils are on uplands. They developed in volcanic ash. They are 20 to 50 inches deep. Slopes range from 0 to 25 percent. The elevation ranges from near sea level to 2,000 feet. The average annual rainfall is 80 to 250 inches. The mean annual temperature is between 65° and 75° F. This pasture group makes up about 16,600 acres.

Drainage is good. Permeability is moderately rapid.

The vegetation in unimproved pasture is dominantly ricegrass, hilograss, kaimiclover, false staghornfern, treefern, guava, kukui, ohia and koa. Unimproved pasture produces 3,000 to 5,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are kikuyugrass, pangolagrass, intortum, and big trefoil. Well-managed improved pasture produces 8,400 to 14,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on the extremely stony Hana soils. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods.

PASTURE GROUP 12

This group consists of soils of the Kokee, Kunuweia, Olinda, and Paaiki series. These soils are on intermediate uplands. They developed in volcanic ash and material weathered from basic igneous rocks. They are 20 to more than 60 inches deep. Slopes are dominantly 0 to 40 percent but range to 70 percent on Kokee and Paaiki soils. The elevation ranges from 2,500 to 5,000 feet. The average annual rainfall is mainly 40 to 70 inches but ranges to 150 inches on Kunuweia soils. The mean air tempera-

Figure 15.—Pangolagrass pasture on Pooku soil in East Kauai.

ture is between 57° and 60° F. This pasture group makes up about 14,100 acres.

Drainage is good. Permeability is moderately rapid.

The vegetation in unimproved pasture is dominantly false staghornfern, yellow foxtail, koa, guava, Christmas berry, ohia, and puakeawe. Unimproved pasture produces 2,200 to 3,500 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are kikuyugrass, orchardgrass, and big trefoil. Intortum grows well at the lower elevations. Well-managed improved pasture produces 4,200 to 8,000 pounds of air-dry forage per acre per year.

Improvement of pasture is difficult on the extremely stony and stony soils that are mapped as complexes. Seeding, fertilization, and weed and brush control are limited to hand and aerial methods on the very steep Kokee and Paaiki soils.

PASTURE GROUP 13

This group consists of soils of the Kaipoioi and Laumaia series. These soils are on intermediate and high uplands. They developed in volcanic ash. They are 40 to more than 60 inches deep. Slopes are mainly 7 to 40 percent but range to 70 percent on Laumaia soils. The elevation ranges from 3,500 to 8,000 feet. The average annual rainfall is 30 to 50 inches. The mean annual air temperature is between 49° and 57° F. This pasture group makes up about 21,500 acres.

Drainage is good. Permeability is moderately rapid.

The vegetation in unimproved pasture is dominantly rattailgrass, sweet vernal, Yorkshire fog, and puakeawe. Unimproved pasture produces 1,800 to 3,000 pounds of air-dry forage per acre per year. Forage production is well distributed throughout the year.

Forage species for improved pasture are orchardgrass, kikuyugrass, white clover, and red clover. Well-managed improved pasture produces 3,500 to 6,500 pounds of air-dry forage per acre per year.

Seeding, fertilization, and weed and brush control are limited to hand and aerial methods on the very rocky Kaipoioi soils and the very steep Laumaia soils.

PASTURE GROUP 14

This group consists of land types on alluvial fans, terraces, and uplands. The soil material is derived from basic igneous rocks, alluvium, colluvium, and volcanic ash. The soil depth ranges from very shallow to more than 60 inches. Slopes range from nearly level to very steep. The elevation ranges from near sea level to about 8,000 feet. The annual rainfall ranges from 15 to more than 100 inches. The mean annual air temperature is between 49° and 75° F.

Drainage is good to excessive.

This pasture group is extremely variable because of the wide range in rainfall, elevation, temperature, and soil characteristics. The vegetation and forage production of each land type are similar to those of associated soils.

No reference is made in the "Guide to Mapping Units" for pasture group 14.

Woodland Management [3]

Approximately 396,000 acres in the survey area is used for commercial timber. Most of the commercial woodland consists of introduced species. For this reason, site preparation that involves rough land clearing is often needed before planting to remove competing plants. Generally, plantings are made at 8x8- to 12x12-foot spacings. After regeneration is established and until the seedlings are well established, competing grasses, ferns, shrubs, or tree reproductions are removed. To insure adequate tree survival and good form, the initial plantings are generally closer than needed. The removal of surplus trees by thinning between the ages of 5 and 20 years improves the growth and quality of the merchantable tree crop. Only the trees left for later cuttings are pruned. Periodic commercial thinnings maintain a fast growth rate on the remaining quality trees. When the stand has reached a desired size, it is harvested either by a system of clearcutting or by some type of shelterwood cutting.

Access and protection are of primary importance to any feasible land-use program. Good roads should be developed and maintained on grades of less than 12 percent and protected by water bars and culverts.

The degrees of hazards and limitations for growing wood crops are explained in the following paragraphs.

Seedling mortality is the mortality of naturally occurring or planted tree seedlings as influenced by the quality of soil, the topographic features, and the climate. A rating of *slight* indicates that expected mortality is less than 25 percent. A rating of *moderate* indicates an estimated mortality of between 25 and 50 percent. A rating of *severe* indicates that the mortality rate is more than 50 percent. These ratings indicate the expected survival from natural regeneration or planting, the choice and intensity of seedbed treatment, the grade of planting stock and type of planting methods, and the possibility of interplanting or replanting for establishment of an adequate stand.

Plant competition is the invasion or growth of undesirable plant species. A rating of *slight* indicates that competition does not prevent adequate natural regeneration and growth or interfere with development of planted seedlings. A rating of *moderate* indicates that competition delays natural or artificial regeneration in both establishment and growth rate but does not prevent the eventual development of adequately stocked stands. A rating of *severe* indicates that competition prevents adequate regeneration unless there is intensive site preparation and followup weeding. These ratings indicate the choice of species, the method of regeneration, the intensity of soil preparation, the required stand treatment, and the probability of obtaining adequate and immediate restocking.

Equipment limitation refers to characteristics of the soils that restrict or prevent the use of equipment commonly used in tending and harvesting the trees. A rating of *slight* indicates that equipment is not restricted in kind or time of year. A rating of *moderate* indicates that equipment is moderately restricted because of slope, stones or obstructions, seasonal soil wetness, or physical soil

[3] JOHN HULTGREN, woodland conservationist, SCS, assisted in the preparation of this section.

characteristics. A rating of *severe* indicates that special equipment is needed.

Erosion hazard indicates the degree of potential soil erosion. Soil erosion in woodland seldom occurs until the vegetation is disturbed or destroyed by fire, excessive grazing, logging, or roadbuilding. Erosion becomes a major problem during roadbuilding and logging operations. The slope, the stability of the soil, the permeability and water-holding capacity, and the effects of past erosion all influence the rating. A rating of *slight* indicates only minor problems. A rating of *moderate* indicates that measures are needed to control erosion. A rating of *severe* indicates that intensive treatment and specialized equipment and methods of operation must be applied.

Windthrow hazard indicates the possibility of trees being blown over by wind. A rating of *slight* indicates that trees in forested areas are not likely to be blown down by commonly occuring winds. A rating of *moderate* indicates that some trees are expected to blow down during high winds because of soil shallowness or wetness.

Woodland groups

The soils of the islands are grouped according to their suitability for woodland. Each group is made up of soils that produce similar kinds of wood crops, need similar management, and have about the same potential productivity. There are 16 groups. Each is described in the following pages. For each group, the species suitable for producing wood crops are named, estimated productivity is given, and the relative degrees of hazards and limitations for growing wood crops are given.

Ohia and koa are the main native species satisfactory for production of commercial timber. Foresters consider these species inferior, slow growing, or difficult to reestablish. Most of the suitable species mentioned in the following pages are exotics. These introduced trees are considered the most suitable commercial species now known.

At present, there are no site or yield tables for any species grown in Hawaii. Nevertheless, many stands of trees that have a known age have been measured, and yields have been estimated, based on a 30-60-year cutting cycle. Annual productivity is estimated in board feet (International ½″ rule). The variation in growth among the species accounts for the wide range in productivity within a group.

The names of the soil series represented are mentioned in the description of each group, but this does not mean that all the soil mapping units of a given series are in the group. To find the woodland classification for each soil, refer to the "Guide to Mapping Units."

WOODLAND GROUP 1

This group consists of soils of the following series:

Haleiwa	Lahaina
Haliimaile	Niu
Kahana	Papaa
Kaupo	Waialua
Kawaihapai	Wailuku
Kunia	

These are well drained to moderately well drained clay loams, silty clays, and clays that developed in residuum and alluvium derived from basalt and andesite. They are on low uplands and also in intermittent drainageways and on alluvial fans on the coastal plains. Kaupo soils are 20 to 40 inches deep, and the rest are more than 60 inches deep. The elevation ranges from sea level to 1,800 feet. The slope ranges from 0 to 40 percent except for a small area of Papaa soils where it is more than 40 percent. The average annual rainfall is 22 to 60 inches.

Suitable species are monkeypod, Norfolk Island pine, silk oak, saligna eucalyptus, and blackbutt eucalyptus. The estimated annual productivity is 100 to 500 board feet per acre. Seedling mortality is moderate to severe. Plant competition from koa haole, guava, and grasses is slight to moderate. The equipment limitation is severe on the very steep Papaa soil but is slight on the rest. The erosion hazard is slight, and the windthrow hazard is slight.

WOODLAND GROUP 2

This group consists of soils of the Kula and Io series. They are well-drained loams and silt loams that developed in volcanic ash. They are gently sloping to moderately steep and are on uplands. They are 20 to more than 40 inches deep over cinders or bedrock. The elevation ranges from 1,000 to 3,500 feet. The average annual rainfall is 25 to 40 inches.

Suitable species are loblolly pine, slash pine, cluster pine, gray ironbark eucalyptus, and red ironbark eucalyptus. The estimated annual productivity is 100 to 200 board feet per acre. Seedling mortality is moderate to severe. Plant competition is slight. The equipment limitation is moderate on the very rocky Kula soils but is slight on the rest. The erosion hazard is moderate to severe. The windthrow hazard is slight.

WOODLAND GROUP 3

This group consists of soils of the Kaimu, Pane, and Ulupalakua series. These are well-drained soils that developed in volcanic ash and cinders and in organic matter. They are moderately sloping to moderately steep and are on intermediate uplands. The Kaimu soil is 3 to 8 inches deep over fragmental Aa lava. The others are 24 to more than 40 inches deep over fine cinders or fragmental Aa lava. The elevation ranges from 1,000 to 4,500 feet. The slope ranges from 7 to 25 percent. The average annual rainfall is 30 to 50 inches.

Suitable species are saligna eucalyptus, lemon-gum eucalyptus, tallowwood eucalyptus, blackbutt eucalyptus, loblolly pine, slash pine, Monterey pine, and Norfolk Island pine. The estimated annual productivity is 200 to 500 board feet per acre. Seedling mortality, plant competition, the equipment limitation, and the windthrow hazard are all slight. The erosion hazard is moderate.

WOODLAND GROUP 4

This group consists of soils of the following series:

Hanalei	Kekaha
Kaena	Lualualei
Kalihi	Pakala
Keaau	Pearl Harbor

These are poorly drained or very poorly drained silty clays and clays that developed in alluvium and colluvium derived from basalt and andesite. They are on alluvial fans, colluvial slopes, and coastal plains. Pearl Harbor soils are 20 to 50 inches deep over muck or peat. The rest are more than 60 inches deep. The elevation ranges from sea level to 300 feet. The slope ranges from 0 to 35 percent. The average annual rainfall is 18 to 100 inches.

A suitable species is robusta eucalyptus. The estimated annual productivity is 300 to 800 board feet per acre. Seedling mortality is slight to moderate. Plant competition from californiagrass is severe. The equipment limitation is severe. The erosion hazard is moderate on the steeper Kaena soils but is slight on the rest. The windthrow hazard is moderate.

WOODLAND GROUP 5

This group consists of soils of the following series:

Alaeloa	Mahana
Halawa	Naiwa
Hamakuapoko	Oli
Kalae	Pohakupu
Kemoo	Puu Opae
Koloa	Wahiawa
Lihue	

These are well-drained silt loams, silty clay loams, and silty clays that developed in alluvium, colluvium, and residuum derived from basalt and andesite, and in volcanic ash. They are on terraces, alluvial fans, and low uplands. They are 20 to more than 60 inches deep. The elevation ranges from near sea level to 3,000 feet. The slope ranges from 0 to 40 percent. The average annual rainfall is 30 to 60 inches.

Suitable species are saligna eucalyptus, blackbutt eucalyptus, and Norfolk Island pine. Slash pine and loblolly pine are suitable at elevations above 1,600 feet (fig. 16) and monkeypod at elevations below 1,000 feet. The estimated annual productivity is 700 to 1,000 board feet. Seedling mortality is slight to moderate. Plant competition from guava, Christmas berry, koa haole, and grasses is moderate. The equipment limitation and the erosion hazard are both slight to moderate. The windthrow hazard is slight.

WOODLAND GROUP 6

This group consists of soils of the Ioleau, Kolekole, and Manana series. These are well-drained silty clay loams and silty clays that developed in old alluvium and residuum derived from basalt and andesite. They are on low uplands. They are 15 to 50 inches deep over a compact, panlike layer. The elevation ranges from 100 to 1,200 feet. The slope ranges from 0 to 40 percent. The average annual rainfall is 35 to 70 inches.

Suitable species are saligna eucalyptus, blackbutt eucalyptus, silk-oak, and monkeypod. The estimated annual

Figure 16.—Six-year-old plantings of slash pine on a Naiwa silty clay loam, woodland group 5. The trees are about 10 feet tall.

productivity is 200 to 600 board feet. Seedling mortality is moderate. Plant competition from koa haole, Christmas berry, and grasses is slight to moderate. The equipment limitation is slight. The erosion hazard is slight to moderate. The windthrow hazard is moderate to severe.

WOODLAND GROUP 7

This group consists of soils of the following series:

Haiku	Makaalae
Hanamaulu	Makawao
Honolua	Olelo
Kalapa	Paaloa
Kaneohe	Paumalu
Kolokolo	Pauwela
Lawai	Puhi
Leilehua	Waikane
Lolekaa	

These are well-drained silt loams, silty clay loams, silty clays, and clays that developed in alluvium, colluvium, and residuum derived from basalt and andesite, and in volcanic ash. They are on fans, terraces, and low uplands. They are 30 to more than 60 inches deep. The elevation ranges from 0 to 2,200 feet. The slope ranges from 0 to 40 percent. The average annual rainfall is 50 to 100 inches.

Suitable species are saligna eucalyptus, tallowwood eucalyptus, robusta eucalyptus, Norfolk Island pine, and albizzia. Monkeypod is suitable at elevations of less than 1,000 feet. The estimated annual productivity is 500 to 1,500 board feet per acre. Seedling mortality is slight. Competition from false staghornfern, guava, Christmas berry, and grasses is moderate to severe. The equipment limitation and the erosion hazard are both slight to moderate. The windthrow hazard is slight.

WOODLAND GROUP 8

This group consists of soils of the Hana, Kailua, Malama, Niulii, Tantalus, and Honomanu series. These are well-drained silt loams, silty clay loams, and silty clays that developed in volcanic ash and cinders. They are 15 to more than 60 inches deep over cinders, fragmental Aa lava, or soft weathered rock. The elevation is dominantly from near sea level to 2,000 feet, but ranges to 4,500 feet for Honomanu soils. The slope ranges from 3 to 70 percent. The average annual rainfall is dominantly 90 to 150 inches but measures as little as 50 inches on Tantalus soils and as much as 250 inches on Honomanu soils.

Suitable species are saligna eucalyptus, robusta eucalyptus, Nepal alder, Norfolk Island pine, Australian toon, Queensland maple, tropical ash, blackwood, sugi, and redwood. Monkeypod is suitable below an elevation of 1,000 feet. Ohia and koa are well suited native species. The estimated annual productivity is 600 to 1,200 board feet per acre. Seedling mortality is slight. Plant competition from treefern, false staghornfern, melastoma, downy rosemyrtle, and kikuyugrass is severe. The equipment limitation is moderate to severe. The erosion and windthrow hazards are slight.

WOODLAND GROUP 9

This group consists of soils of the Halii, Kapaa, Makapili, and Pooku series. These are well drained to moderately well drained silty clay loams and silty clays that developed in material weathered from basalt and andesite. They are gently sloping to steep and are on dissected low uplands. They are more than 60 inches deep. The elevation ranges from near sea level to 1,000 feet. The slope ranges from 0 to 40 percent. The average annual rainfall is 70 to 200 inches.

Suitable species are saligna eucalyptus, blackbutt eucalyptus, robusta eucalyptus, tallowwood eucalyptus, lemon-gum eucalyptus, Nepal alder, albizzia, monkeypod, Norfolk Island pine, Australian toon, and Queensland maple. The estimated annual productivity is 400 to 800 board feet per acre. Seedling mortality is slight. Plant competition is severe from melastoma, rhodomyrtus, false staghornfern, and guava. The equipment limitation is slight. The erosion hazard is slight to moderate. The windthrow hazard is slight.

WOODLAND GROUP 10

This group consists of soils of the Kokee, Olinda, and Paaiki series. These are well-drained silty clay loams and heavy loams that developed in volcanic ash and in residuum derived from basalt and andesite. They are on intermediate uplands. They are more than 36 inches deep over weathered basalt and andesite. The elevation ranges from 2,500 to 5,000 feet. The slope is dominantly 0 to 40 percent but ranges to 70 percent on Kokee and Paaiki soils. The average annual rainfall is 40 to 70 inches.

Suitable species are saligna eucalyptus, tallowwood eucalyptus, robusta eucalyptus, blackbutt eucalyptus, slash pine, loblolly pine, Monterey pine, Australian toon, albizzia, tropical ash, redwood, sugi, and blackwood. The estimated annual productivity is 400 to 1,500 board feet per acre. Seedling mortality is slight. Plant competition is slight. The equipment limitation is slight if the slope is less than 35 percent and severe if it is more than 35 percent. The erosion hazard is moderate if the slope is less than 35 percent and severe if it is more than 35 percent. The windthrow hazard is severe.

WOODLAND GROUP 11

This group consists of soils of the Kaipoioi, Laumaia, and Uma series. These are well-drained to excessively drained silt loams, loams, and loamy coarse sands that developed in volcanic ash and fine cinders. They are on intermediate to high uplands. Laumaia and Kaipoioi soils are more than 40 inches deep over cinders or rock. Uma soils are less than 10 inches deep over fine cinders. The elevation is dominantly 3,500 to 8,000 feet. The slope is dominantly 7 to 40 percent but ranges to 70 percent on Laumaia and Uma soils. The average annual rainfall is dominantly 35 to 60 inches.

Suitable species for Kaipoioi and Laumaia soils are saligna eucalyptus, blackbutt eucalyptus, sugi, redwood, Monterey pine, and tropical ash. The estimated annual productivity is 400 to 600 board feet per acre. Suitable species for Uma soils are Jeffery pine or cluster pine, on a trial basis. The estimated annual productivity on these soils is 50 to 200 board feet per acre. Seedling mortality is slight to moderate on Kaipoioi and Laumaia soils and severe on Uma soils. Plant competition is slight. The equipment limitation is slight to moderate if the slope is less than 40 percent and severe if it is more than 40 percent. The erosion hazard is moderate on Kaipoioi and

Laumaia soils and severe on Uma soils if the slope is less than 40 percent. It is severe on Laumaia soils if the slope is more than 40 percent. The windthrow hazard is slight.

WOODLAND GROUP 12

This group consists of soils of the Kahanui and Kunuweia series. These are well drained to moderately well drained gravelly clay loams and gravelly silty clays that developed in residuum derived from basalt and andesite. These soils are gently sloping to moderately sloping and are on intermediate uplands. They are 10 to 24 inches deep over a discontinuous ironstone sheet or soft weathered rock. The elevation ranges from 1,250 feet to 4,000 feet. The slope ranges from 0 to 20 percent. The average annual rainfall is dominantly 60 to 150 inches. On the island of Lanai, it measures 35 inches, but the amount of moisture is equivalent to 80 inches because of fog drip and cloud cover.

Suitable species are saligna eucalyptus, robusta eucalyptus, blackbutt eucalyptus, Nepal alder, Norfolk Island pine, slash pine, loblolly pine, redwood, sugi, and blackwood. The estimated annual productivity is 200 to 600 board feet per acre. Seedling mortality is slight. Plant competition is moderate. The equipment limitation is slight, and the erosion hazard is slight. The windthrow hazard is moderate to severe.

WOODLAND GROUP 13

This group consists of soils of the Waikomo and Kalaupapa series. These are well-drained silty clay loams and silty clays that developed in volcanic ash and in residuum derived from basalt and andesite. These soils are gently sloping to moderately steep and are on low uplands. They are less than 20 inches deep over bedrock. The elevation ranges from near sea level to 400 feet. The slope ranges from 3 to 25 percent. The average annual rainfall is 35 to 60 inches.

Monkeypod is the most suitable species. The estimated annual productivity is 100 to 300 board feet per acre. Seedling mortality is moderate. Plant competition from koa haole and lantana is moderate. The equipment limitation and the erosion hazard are both slight to moderate. The windthrow hazard is severe.

WOODLAND GROUP 14

This group consists of soils of the Hihimanu, Kalapa, Kaneohe, Kapaa, Lolekaa, Paumalu, and Waikane series. These are well-drained silty clay loams and silty clays that developed in volcanic ash and in alluvium, colluvium, and residuum derived from basalt and andesite. They are on fans, terraces, and low uplands. The depth to soft weathered rock is 30 to more than 60 inches. The elevation ranges from sea level to 2,000 feet. The slope ranges from 30 to 100 percent. The average annual rainfall is dominantly 60 to 90 inches but ranges from 50 to 120 inches.

Suitable species are saligna eucalyptus, tallowwood eucalyptus, robusta eucalyptus, and Norfolk Island pine. The estimated annual productivity is 500 to 1,500 board feet per acre. Seedling mortality is slight. Plant competition from guava, Christmas berry, false staghornfern, and grasses is moderate to severe. The equipment limitation and the erosion hazard are both severe. The windthrow hazard is slight.

WOODLAND GROUP 15

This group consists of Colluvial land and soils of the Alaeloa, Halawa, Helemano, Kemoo, and Oil series. These are well-drained silt loams, silty clay loams, and silty clays that developed in volcanic ash and in colluvium and residuum derived from basalt and andesite. They are on colluvial slopes and low uplands. The depth to highly weathered rock is 25 to more than 60 inches. The elevation ranges from near sea level to 3,000 feet. The slope ranges from 30 to 90 percent. The average annual rainfall is 30 to 60 inches.

Suitable species are saligna eucalyptus, blackbutt eucalyptus, and Norfolk Island pine. The estimated annual productivity is 700 to 1,000 board feet per acre. Seedling mortality is slight to moderate. Plant competition from guava, Christmas berry, koa haole, and grasses is moderate. The equipment limitation and the erosion hazard are both severe. The windthrow hazard is slight.

WOODLAND GROUP 16

This group consists of Alakai mucky peat and soils of the Amalu, Hulua, Koolau, Olokui, and Waialeale series. These are poorly drained to very poorly drained upland soils that developed in organic material and volcanic ash, and in residuum derived from basalt and andesite. They are 15 to more than 60 inches deep. The elevation is dominantly 1,500 to 5,000 feet, but there are small areas at lower elevations. The slope is dominantly less than 30 percent, but it ranges to 70 percent for Hulua and Waialeale soils. The average annual rainfall is 75 to more than 400 inches. Fog and cloud cover, which are present most days throughout the year, significantly increase the amount of effective moisture over most of the area.

This group is of little value for commercial woodland. Its best use is for water supply and for the woodland plants that have commercial value for flower arrangements, leis, and landscape plantings, such as treefern, clubmoss, swordfern, lacefern, and mokihana. Treefern is also used for fences and tiki carvings and as a media for growing orchids, anthuriums, and other plants. The equipment limitation and the windthrow hazard are both severe.

Truck Crop Management

A variety of vegetable crops is commercially produced for local consumption. Lettuce, cabbage, cucumber, snap beans, tomatoes, onions, peppers, broccoli, corn, eggplant, and gingerroot are the major crops. All have similar management.

Soil preparation consists of disk harrowing to chop plant residue. This is followed by plowing and smoothing.

Soil fumigants are used before planting to control nematodes.

The kind of fertilizer and the rate and time of application vary and depend on the soil and the crop. They are best determined by soil tests, field trials, and experience. Fertilizers are applied in dry form or in liquid form, by foliar application. Nitrogen, phosphorus, and potassium are beneficial. Minor elements and lime are applied as needed.

Most vegetable crops require frequent irrigation. Both overhead and furrow irrigation are used.

Weeds are controlled by chemicals and by mechanical and hand weedings. Both preemergence and contact herbicides are used. Insects and fungi are controlled by chemicals.

Windbreaks are needed to protect vegetable crops in areas exposed to strong winds.

Orchard Management

Bananas, papayas, and macadamia nuts are the most commonly grown orchard crops in this area.

Bananas are relatively easy to grow but require good management. New plants are generally started from suckers removed from the parent plant. The Chinese and Bluefield varieties are the two most important commercial varieties. The time required to grow a crop is about 1 year, depending on climate, soil, and other factors.

Bananas require abundant moisture and good drainage. Applications of trash mulch and shallow cultivation help in controlling weeds. A complete fertilizer is needed three or more times a year. The rate of application depends on the soil, the amount of rainfall, and the size of the plants. Yields are about 20,000 pounds per acre per year.

Papayas grow well along the coastal plains and on the uplands to an elevation of about 1,000 feet. The solo papaya is the most common variety grown. The plants are started from seeds, generally in seed flats, and are then transferred to the field. Unlike other orchard crops, papaya is a short-term crop. It begins to produce marketable fruit at the end of the first year and is normally productive for about 3 years. After the third year, the trees grow too tall and harvesting becomes difficult.

Soil preparation for papayas consists of plowing and harrowing. On sloping soil where the erosion hazard is severe, papaya plants are planted on the contour. A complete fertilizer, high in phosphorus, is applied at planting time and at frequent intervals thereafter. If the amount of rainfall is inadequate, the plants are irrigated by sprinklers or furrows. Weeds are controlled by chemicals or by machine or hand weeding. Insects and disease are controlled by chemicals. Papaya trees are easily damaged by wind, so windbreaks are needed in areas exposed to tradewinds.

Macadamia trees grow at elevations that range from sea level up to 2,500 feet. They grow best in areas where the annual rainfall is 50 to 120 inches. Only grafted trees of the best varieties should be planted. The three most promising varieties are Kakea, Ikaika, and Keauhou. They take about 7 years to come into commercial production. Yields vary between 2,500 and 3,500 pounds per acre per year, depending on the climate and the soil.

Herbicides are used to control weeds. A complete fertilizer is applied 3 to 5 times a year. The rate and frequency of applications vary, depending on the soil, the amount of rainfall, and the size of the plants. Control of anthracnose, nut borers, and rats are essential for maximum production. Windbreaks are needed in areas exposed to strong winds.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of crops. The groups are made according to the limitations of the soils when used for crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, and does not take into consideration possible but unlikely major reclamation projects.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In this publication all kinds of soil are grouped at two levels, the capability class and the subclass. The classification is designated in the "Guide to Mapping Units" for all soils on the islands, both irrigated and nonirrigated soils. The classification is described in the following paragraphs.

CAPABILITY CLASSES, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife habitat, or recreation.

The eight classes in the capability system and the subclasses represented on the islands are defined as follows:

Class I soils have few limitations that restrict their use. (No subclasses)

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

- Subclass IIe soils are subject to moderate erosion if they are cultivated and not protected. The soils are 30 to more than 60 inches deep and have slopes of 0 to 8 percent.
- Subclass IIw soils have moderate limitations because of excess water. The soils are poorly drained, are subject to seasonal flooding, and have slopes of 0 to 2 percent.
- Subclass IIs soils have moderate limitations of stoniness, unfavorable texture, shallowness, or low waterholding capacity. The soils are more than 20 inches deep and have slopes of 0 to 2 percent.

Subclass IIc soils have moderate limitations because of climate. The soils are slightly droughty because of limited rainfall. They are well drained, are more than 60 inches deep, and have slopes of 0 to 2 percent.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Subclass IIIe soils are subject to severe erosion if they are cultivated and not protected. In most places the soils are more than 20 inches deep and have slopes of 0 to 15 percent.

Subclass IIIw soils have severe limitations because of excess water. The soils are poorly drained or subject to seepage, are more than 20 inches deep, and have slopes of 0 to 12 percent.

Subclass IIIs soils have severe limitations because of stoniness, unfavorable texture, shallowness, or low water-holding capacity. The soils are well drained, are more than 20 inches deep, and have slopes of 0 to 8 percent.

Subclass IIIc soils have severe limitations because of climate. These soils are droughty because of limited rainfall. They are well drained to moderately well drained, are more than 36 inches deep, and have slopes of 0 to 8 percent.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Subclass IVe soils are subject to severe erosion if they are cultivated and not protected. The soils are well drained to moderately well drained, are more than 20 inches deep, and have slopes of 0 to 25 percent.

Subclass IVw soils have very severe limitations because of excess water. The soils are poorly drained or very poorly drained or subject to seepage, are more than 20 inches deep, and have slopes of 0 to 20 percent.

Subclass IVs soils have very severe soil limitations because of stoniness, shallowness, unfavorable texture, or low water-holding capacity. In places the soils are stony. They are well drained to excessively drained, are more than 20 inches deep, and have slopes of 0 to 20 percent.

Subclass IVc soils have very severe limitations because of climate. These soils are very droughty because of limited rainfall. They are well drained, are more than 20 inches deep, and have slopes of 0 to 8 percent.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass Vw soils have very severe limitations because of excess water. The soils are poorly drained, are more than 20 inches deep, and have slopes of 0 to 2 percent.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIe soils are severely limited by the hazard of erosion. The soils are well drained, are more than 20 inches deep, and have slopes of 6 to 40 percent.

Subclass VIw soils are severely limited by excess water. The soils are poorly drained and have slopes of 12 to 20 percent.

Subclass VIs soils have very severe limitations because of stoniness or unfavorable texture. The soils are very stony, very rocky, extremely stony, or extremely rocky, and have slopes of 0 to 35 percent.

Subclass VIc soils have very severe limitations because of climate. These soils are very droughty because of limited rainfall. They are more than 36 inches deep and have slopes of 0 to 6 percent.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Subclass VIIe soils are very severely limited by risk of erosion. The soils are well drained to excessively drained and have slopes that range from 0 to 100 percent.

Subclass VIIw soils are very severely limited by excess water. The soils are on mountain summits or within closed craters and are very poorly drained. Slopes range from 0 to 20 percent.

Subclass VIIs soils have very severe soil limitations because of unfavorable texture, or because they are extremely rocky or stony. Also included are land types that are steep, rocky, or stony.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes.

Subclass VIIIe soils are subject to very severe erosion if the existing cover is removed. These are areas of very steep, shallow, rough mountainous land.

Subclass VIIIw soils are severely limited by excess water, but may be used for wildlife habitat, watershed protection, or recreation. These are areas of marshes.

Subclass VIIIs soils have very severe limitations that restrict their use for wildlife habitat or recreation. These are areas of cinderland, outcrops, or coastal beaches.

Wildlife Production

Wildlife production is an important land use on the islands of Molokai, Lanai, Maui, and Kauai. It is a primary land use on two-thirds of the island of Lanai and a secondary land use on many of the pasturelands and woodlands in the survey area. There are several public shooting grounds on private and State lands that are managed by the State Division of Fish and Game. In addition there are other private lands that produce wildlife for hunting by landowners and their guests.

Several species of big game animals and game birds are available for hunting. The axis deer is the most sought after big game animal. The deer occurs throughout the islands of Molokai and Lanai, from the dry lowlands to the rain forest of the uplands. The mouflon sheep, introduced in 1956 on Lanai and Kauai, has recently become available for hunting. Antelope also has been recently introduced and established on Lanai. Wild goats are on all the islands, and wild pigs on all except Lanai.

Game birds available for hunting are ring-necked pheasants, California and Japanese quails, barred doves, lace-necked doves, chuckar partridge, Indian grey francolins, and Indian black francolins. These francolins are recent introductions and have become established in a short time. Another recently introduced game species, the Rio Grande turkey, is not yet available for hunting.

Bass and bluegill are stocked in some plantation reservoirs. Rainbow trout is found in streams in the Kokee area of Kauai.

Wildlife is usually compatible in woodland and pasture and can be a secondary use of these lands. On soils that are severely eroded, very stony, very rocky, or very steep, wildlife production can be an important land use. Such land types have low potential for pasture and other uses but have high potential for wildlife production.

Engineering Uses of the Soils [4]

This section provides information of special interest to engineers, contractors, farmers, and others who use soil as structural material or as foundation material upon which structures are built. Information is given in this section about those properties of the soils that affect construction and maintenance of roads and airports, pipelines, building foundations, water storage facilities, erosion control structures, drainage systems, and sewage disposal systems. Among the soil properties most important in engineering are permeability, shear strength, shrink-swell potential, water-holding capacity, and reaction.

Information concerning these and related soil properties are furnished in tables 2, 3, and 4. The estimates and interpretations of soil properties in these tables can be used in—

1. Planning and designing agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and other structures for controlling water and conserving soils.
2. Selecting potential locations for highways, airports, pipelines, and underground cables.
3. Locating probable sources of sand, gravel, or rock suitable for use as construction material.
4. Selecting potential industrial, commercial, residential, and recreational areas.

None of the miscellaneous land types mapped in the reconnaissance survey are included in tables 2 and 3, and not all of the high- and medium-intensity surveys are included. Reliable estimates and interpretations of the engineering properties of these land types cannot be given, because features are variable and only limited investigations and observations have been made.

With the use of the soil map for identification, the engineering interpretations reported here can be useful for many purposes. It should be emphasized that they do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads or excavations deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected. In any given mapping unit, there may be inclusions of other soils or land types that are too small to delineate on the map or that are not within the objective of the survey. These inclusions may account for variations that affect engineering practices in such places.

Some of the terms used in this publication have a special meaning to soil scientists and a different meaning to engineers. The Glossary defines many such terms as they are used in soil science.

[4] HARLAN G. COLLINS, irrigation engineer, and HUGO T. SHOGREN, State conservation engineer, Soil Conservation Service, Honolulu, assisted in the preparation of this section.

Engineering classification systems

The two systems most commonly used in classifying samples of soil horizons for engineering purposes are the system used by the American Association of State Highway Officials (AASHO) (*2*) and the Unified system developed by the Waterways Experiment Station, Corps of Engineers, and now used by the United States Department of Defense (*18*).

No AASHO classification is shown in table 2 for soils of the area surveyed, because the AASHO system has limited value in classification of Hawaiian soils. Most soils of this area are fine grained and fall within AASHO groups A–6 or A–7. Hawaiian soils classified in these groups do not exhibit the engineering properties associated with these groups in soils of temperate regions.

In table 2 the soil materials are classified according to the Unified system. In this system, soil materials are identified as coarse grained (G or S), fine grained (M or C), and highly organic (O), and symbols are used to identify each group. For example, soils that consist primarily of fine-grained material, either plastic or nonplastic, are identified by the symbols ML or CL if the liquid limit is low and by MH or CH if the liquid limit is high. If the classification is borderline between two groups, the symbols for both groups are given, joined by a hyphen. An example of such a borderline classification is "ML–CL."

In this survey area, engineering properties of soils classified as ML, MH, and CL may be significantly different in properties normally associated with these groups in temperate regions. These soils exhibit a higher shear strength and lower shrink-swell volume change with change in moisture content. The difference in magnitude of these properties is apparently related to the very fine particle size, microstructure, and high aggregate stability.

Estimated properties

Table 2 provides estimates of soil properties important in engineering uses. The estimates are based on field classification and descriptions, physical and chemical tests of selected representative samples, test data from comparable soils in adjacent areas, and on detailed experience in working with the individual kind of soil in the survey area.

The profile is described by soil layers that have significantly different engineering properties. The thickness of these layers and the depth from the surface are shown.

TABLE 2.—*Estimated*

[Miscellaneous land types are not listed in this table, because the soil material is too

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	Classification: Dominant USDA texture
	Feet	*Feet*	*Inches*	
Alae: AaB, AcA, AcB	>5	>5	0–14	Cobbly sandy loam or sandy loam
			14–55	Coarse sand
Alaeloa: AeB, AeC, ALF, AME3, ANE, AeE, ALE3.	>5	>5	0–58	Silty clay
Alakai: rAAE	>5	(1)	0–32	Muck
			32–51	Clay
Amalu: rAMD, rAOD. For Olokui part of rAOD, see Olokui series.	>5	(1)	8–0	Peat
			0–8	Clay
			8–8¼	Ironstone sheet
			8¼–60	Saprolite
Dystrandepts. Mapped only with Tropohumults.	>5	>5	0–39	Silt loam and loam
			39–65	Gravelly loam
Ewa: EaA, EaB, EaC, EmB, EsA, EsB, EtB, EwA, EwB, EwC, EcA, EcB, EmA.	>5	>5	0–60	Silty clay loam
Haiku: HaB, HaC, HbB, HbC	>5	>5	0–45	Clay
			45–66	Saprolite
Halawa: HID, HID3, HJE, HJF2	>5	>5	0–58	Silty clay
			58	Saprolite.
Haleiwa: HcB, HdC, HeA, HeB	>5	>5	0–65	Silty clay
Halii: HfB, HfC, HfD2, HfE2	>5	>5	0–60	Gravelly silty clay, silty clay loam, silty clay, and clay loam.
Haliimaile: HgB, HgC, HhB, HhC, HkC2	>5	>5	0–65	Silty clay, clay
Hamakuapoko: H1B, H1C, H1C2	>5	>5	0–51	Silty clay
Hana:				
HKLD, HKMD	3–4	>5	0–7	Very stony or extremely stony silty clay loam.
			7–34	Silty clay loam
			34	Cinders over lava.
HKNC, HKOC	1.5–3.0	>5	0–8	Silty clay; loam extremely stony in places
			8–20	Cobbly silty clay
			20	Lava.
Hanalei: HmA, HnA, HnB, HoB, HpA, HrB	>5	0–5	0–13	Silty clay; peaty in places
			13–36	Silty clay loam
Hanamaulu: HsB, HsC, HsD, HsE, HtE, HuE	>5	>5	0–72	Silty clay and silty clay loam
Helemano: HLMG	>5	>5	0–60	Silty clay
Hihimanu: HMMF	>5	>5	0–72	Silty clay
Holomua: HvA, HvB, HvB3, HvC, HvC3	>5	>5	0–66	Silt loam and silty clay loam
Honolua: HwC, HwD	>5	>5	0–70	Silty clay
Honomanu: rHOD, rHR. For Amalu part of rHR, see Amalu series.	>5	>5	3–0	Peat
			0–37	Silty clay
			37–60	Cobbly loam

See footnotes at end of table.

properties

variable for reliable evaluations to be made. Dashed lines indicate data are not applicable]

Classification—Con.					Corrosivity	
Unified	Permeability	Available water capacity	Reaction	Shrink-swell potential	Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
SM	2. 0–6. 3	0. 08–0. 12	6. 6–7. 3	Low	Low	Low.
GW	6. 3–20. 0	0. 06–0. 08	7. 9–8. 4	Low	Moderate	Low.
MH	2. 0–6. 3	0. 12–0. 14	5. 1–6. 0	Moderate	High	Moderate.
Pt	6. 3–20. 0	----------	3. 3–4. 0	(2)	High	High.
CH	0. 06–0. 20	----------	4. 0–4. 5	High	High	High.
Pt	6. 3–20. 0	----------	3. 9–4. 2	(2)	High	High.
OH	0. 06–0. 63	----------	4. 2–4. 5	Moderate	High	High.
----------	<0. 06	----------	----------	----------	----------	
MH	2. 0–6. 3	----------	4. 0–5. 0	Low	High	High.
MH	2. 0–6. 3	0. 14–0. 16	6. 1–7. 3	(2)	Moderate	Low.
SM or GM	2. 0–6. 3	0. 08–0. 10	6. 6–7. 3	Low	Low	Low.
ML or CL	0. 63–2. 0	0. 10–0. 12	6. 6–7. 3	Moderate	Low	Low.
MH	2. 0–6. 3	0. 11–0. 13	4. 5–5. 0	Low	High	High.
MH	2. 0–6. 3	0. 10–0. 12	4. 5–5. 0	Low	High	High.
MH	2. 0–6. 3	0. 12–0. 14	4. 5–5. 5	Moderate	High	High.
MH–CH	0. 63–2. 0	0. 13–0. 15	6. 1–7. 3	Moderate	Low	Low.
MH	2. 0–6. 3	0. 10–0. 12	4. 0–5. 0	Low	High	High.
ML–CL	2. 0–6. 3	0. 08–0. 11	5. 1–6. 0	Low	Moderate	Moderate.
MH	2. 0–6. 3	0. 12–0. 14	4. 0–5. 5	Moderate	High	High.
OH or MH	2. 0–6. 3	0. 10–0. 12	5. 1–5. 5	(2)	High	Moderate.
MH	2. 0–6. 3	0. 12–0. 14	5. 5–6. 5	(2)	High	Low.
MH	2. 0–6. 3	0. 08–0. 10	6. 1–6. 5	(2)	High	Low.
MH	2. 0–6. 3	0. 08–0. 10	6. 1–6. 5	(2)	High	Low.
MH	0. 63–2. 0	0. 16–0. 18	4. 5–6. 5	Moderate	High	Moderate.
MH	0. 63–2. 0	0. 16–0. 18	6. 1–7. 3	Moderate	High	Low.
MH	2. 0–6. 3	0. 13–0. 15	4. 0–5. 5	Low	High	High.
MH	2. 0–6. 3	0. 11–0. 13	6. 1–7. 3	Moderate	Low	Low.
MH	2. 0–6. 3	----------	4. 5–5. 0	Low	High	High.
ML	0. 63–2. 0	0. 12–0. 14	4. 5–7. 3	Low	Low	Low.
MH	2. 0–6. 3	0. 12–0. 14	5. 1–5. 5	Moderate	High	Moderate.
Pt	6. 3–20. 0	0. 20–0. 30	3. 8–4. 5	(2)	High	High.
OH	2. 0–6. 3	0. 16–0. 18	3. 7–4. 5	(2)	High	High.
MH	2. 0–6. 3	0. 06–0. 08	4. 0–4. 5	Low	High	High.

TABLE 2.—*Estimated*

Soil series and map symbols	Depth to—		Depth from surface	Classification
	Bedrock	Seasonal high water table		Dominant USDA texture
	Feet	*Feet*	*Inches*	
Honouliuli: HxA, HxB	>5	>5	0–68	Clay
Hoolehua: HyB3, HzA, HzB, HzC, HzE	>5	>5	0–15 15–64	Silty clay Silty clay
Hulua: HNUD, HNUF	1–1½	(1)	0–16 16–18 18–60	Silty clay Ironstone sheet Clay loam
Hydrandepts: rHT For Tropaquods part of rHT, see Tropaquods.	>5	>5	3–0 0–37 37–60	Peat Silty clay loam and silty clay Cobbly loam
Iao: IaA, IaB, IbB, IbC, IcB, IcC	>5	>5	0–60	Clay or silty clay; cobbly in places
Io: ISD	>5	>5	0–30 30–39 39–45	Silty loam, silty clay loam, and clay loam Cinders Loam
Ioleau: IoB, IoC, IoD2, IoE2	>5	>5	0–61	Silty clay loam and silty clay
Jaucas:				
JaC, JfB, JkB, JL	>5	>5	0–60	Sand
JcC	>5	2–5	0–60	Sand
Kaena: KaB, KaC, KaeD, KanE, KavB, KavC, KaeB, KaeC.	>5	(3)	0–54	Stony clay
Kahana: KbB, KbC, KbD	>5	>5	0–61	Silty clay
Kahanui: KASD, KATD	>5	>5	0–30 30–60	Silty clay, clay, and ironstone fragments Saprolite
Kailua: KBID	3.5–5	>5	0–40	Silty clay and silty clay loam
Kaimu: KCXD	2–5	>5	0–8 8–20	Extremely stony peat Aa lava.
Kaipoioi: KDIE, KDVE	>5	>5	0–61	Loam, silt loam, and silty clay loam
Kalae: KcB, KcC, KcC3, KcD3, KcE3	>5	>5	0–41 41–67	Silty clay Silt loam
Kalapa: KdD, KdE, KdF, KEHF	>5	>5	0–60	Silty clay or clay
Kalaupapa: KFID	½–1½	>5	0–14 14	Silty clay loam and silt loam Pahoehoe lava.
Kalihi: Ke	>5	2–5	0–70	Clay
Kaloko: Kf, Kfa, Kfb	>5	1–2	0–60	Clay and silty clay
Kamaole: KGKC, KGLC	1½–2	>5	0–20 20	Silty clay loam and very stony silty clay Aa lava.
Kaneohe: KgB, KgC, KHMC, KHME, KHMF, KHOF.	>5	>5	0–60	Silty clay or silty clay loam
Kanepuu: KhB, KhB2, KhC, KhC2	>5	>5	0–61	Silty clay
Kapaa: KkB, KkC, KkD, KkE, KlG	>5	>5	0–60	Silty clay and clay loam
Kapuhikani: KKTC	1½–3	>5	0–20 20–27 27	Extremely stony clay and clay Soft weathered rock Bedrock.

See footnotes at end of table.

properties—Continued

Classification—Con.	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
Unified					Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
CL	0. 20–0. 63	0. 14–0. 16	6. 6–7. 8	High	Low	Low.
MH	0. 63–2. 0	0. 14–0. 16	3. 8–4. 5	Moderate	High	High.
MH	0. 63–2. 0	0. 15–0. 17	6. 1–6. 5	Low	Low	Low.
OH	2. 0–6. 3	0. 12–0. 14	5. 1–5. 5	[2]	High	Moderate.
	<0. 06					
MH	2. 0–6. 3	0. 12–0. 14	4. 5–5. 0	Low	High	High.
Pt	6. 3–20. 0	0. 20–0. 30	3. 8–4. 5	[2]	High	High.
OH	2. 0–6. 3	0. 16–0. 18	3. 7–4. 5	[2]	High	High.
MH	2. 0–6. 3	0. 06–0. 08	4. 0–4. 5	Low	High	High.
CL	0. 20–0. 63	0. 13–0. 15	6. 6–7. 3	Moderate	Low	Low.
MH	2. 0–6. 3	0. 15–0. 17	6. 6–7. 8	Low	Low	Low.
	2. 0–6. 3		7. 9–8. 4	Low	Low	Low.
ML	2. 0–6. 3	0. 15–0. 17	7. 9–8. 4	Low	Low	Low.
MH	0. 06–0. 63	0. 12–0. 14	4. 0–5. 0	Moderate	High	High.
SP	6. 3–20. 0	0. 05–0. 07	6. 6–7. 8	Low	Low	Low.
SP	6. 3–20. 0	0. 05–0. 07	7. 9–8. 4	Low	High	High.
CH	0. 06–0. 63	0. 11–0. 13	6. 6–7. 3	High	Low	Low.
MH	2. 0–6. 3	0. 10–0. 12	4. 5–7. 3	Moderate to low	Moderate to low	Moderate to low.
MH	2. 0–6. 3	0. 10–0. 12	4. 5–5. 0	Moderate	High	High.
ML or MH	2. 0–6. 3	0. 10–0. 12	4. 5–5. 0	Low	High	High.
OH or MH	2. 0–6. 3	0. 19–0. 21	4. 5–6. 0	[2]	High	High.
Pt	>20. 0	0. 10–0. 15	6. 6–7. 3	Moderate	Low	Low.
OH or MH	2. 0–6. 3	0. 13–0. 15	6. 6–7. 8	Moderate	Low	Low.
MH	2. 0–6. 3	0. 12–0. 14	5. 1–5. 5	Moderate	High	Moderate.
ML	2. 0–6. 3	0. 12–0. 14	5. 1–5. 5	Low	High	Moderate.
MH	2. 0–6. 3	0. 12–0. 14	4. 5–5. 0	Moderate	High	High.
ML	0. 63–2. 0	0. 19–0. 21	6. 6–7. 3	Low	Low	Low.
CH	0. 06–0. 20	0. 12–0. 14	6. 1–7. 3	High	High	Low.
CH	0. 06–0. 63	0. 12–0. 14	6. 1–7. 8	High	High	Moderate.
MH–CH	0. 63–2. 0	0. 09–0. 11	6. 1–7. 8	Low	Low	Low.
MH	2. 0–6. 3	0. 11–0. 13	5. 1–6. 5	Moderate	High	Moderate.
ML–MH	0. 63–2. 0	0. 11–0. 13	6. 1–7. 3	Moderate	Low	Low.
MH	2. 0–6. 3	0. 13–0. 15	4. 5–6. 0	Low	High	Moderate.
CH	0. 06–0. 20	0. 11–0. 13	7. 4–7. 8	High	Low	Low.
ML	0. 06–0. 20	0. 05–0. 07	7. 9–8. 4	Low	Low	Low.

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TABLE 2.—*Estimated*

Soil series and map symbols	Depth to—		Depth from surface	Classification
	Bedrock	Seasonal high water table		Dominant USDA texture
	Feet	*Feet*	*Inches*	
Kaupo: KLUD, KLVD	1½–3½	>5	0–27	Very stony silty clay loam; extremely stony in places.
			27	Aa lava.
Kawaihapai: KIA, KIB, KIC, KlaA, KlaB, KlbC, KlcB.	>5	>5	0–22	Clay loam; stony or very stony in places
			22–54	Sandy loam
Keaau: KmA, KmaB, KmbA	>5	1½–3	0–34	Clay and silty clay
			34–39	Consolidated coral sand
			39–57	Sand
Keahua: KnB, KnC, KnaB, KnaC, KnaD, KnbD, KncC, KnhC, KnsC.	>5	>5	0–62	Silty clay loam and clay loam; cobbly or very stony in places.
Kealia: KMW	>5	1–3½	0–63	Silt loam, loam, and fine sandy loam
Keawakapu: KNXD	>5	>5	0–9	Extremely stony silty clay loam
			9–18	Silty clay
			18	Aa lava.
Kekaha: KoA, KoB, KobA, KOYE	>5	>5	0–70	Silty clay or clay; extremely stony in places
Kemoo: KpB, KpC, KpD, KpE, KpF, KPZ	>5	>5	0–66	Silty clay
Koele: KrB, KrC, KrD, KRL, KRX	>5	>5	0–33	Silty clay loam
			33–55	Stratified clay loam, silt loam, and sandy loam.
Kokee: KSKE, KSKF	>5	>5	0–42	Silty clay loam and silty clay
			42	Saprolite
Koko: KsB, KsC, KsD	>5	>5	0–48	Silt loam and clay loam
			48	Cinders and tuff.
Kokokahi: KtC, KTKE	>5	[3]	0–44	Clay or very stony clay
Kolekole: KuB, KuC, KuD	>5	>5	0–38	Silty clay loam
			38–60	Silty clay loam; brittle pan
Koloa: KvB, KvC, KvD	1½–3½	>5	0–20	Stony silty clay
			20	Bedrock.
Kolokolo: Kw, KUL	>5	>5	0–60	Silty clay loam and loam
Koolau: KVSB, KVSE	>5	2–4	0–32	Silty clay
			32–60	Clay loam with ironstone bands
Kula: KxC, KxD, KxaD, KxbE	2–5	>5	0–54	Loam, silt loam, and silty clay loam
			54	Bedrock.
Kunia: KyA, KyB, KyC	>5	>5	0–47	Silty clay
			47–74	Silty clay loam
Kunuweia: KZC	>5	>5	0–12	Very gravelly clay loam
			12–60	Hard and soft plinthite
Lahaina: LaA, LaB, LaB3, LaC, LaC3, LaD, LaD3, LaE3.	>5	>5	0–31	Silty clay
			31–60	Silty clay loam
Laumaia: LME, LMF, LNE	3½–5	>5	0–42	Silty clay loam and silt loam
			42–51	Cemented ash and cinders
			51	Stratified silt loam and cinders

See footnotes at end of table.

properties—Continued

Classification—Con.	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
Unified					Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
CL	2.0–6.3	0.10–0.12	6.1–7.3	Low	Low	Low.
CL	0.63–2.0	0.08–0.15	6.6–7.3	Moderate	Low	Low.
SM	2.0–6.3	0.12–0.14	6.6–7.3	Low	Low	Low.
CH	0.06–0.20	0.12–0.14	7.4–7.8	High	High	Low.
	<0.06					
SP	6.3–20.0		7.9–8.4	Low	High	Low.
ML–CL	0.63–2.0	0.06–0.12	6.1–7.3	Low	Low	Low.
ML or SM	2.0–6.3	0.09–0.11	7.4–8.4	Low	High	High.
ML	0.63–2.0	0.10–0.12	6.6–7.3	Low	Low	Low.
ML–CL	0.63–2.0	0.14–0.16	6.6–7.3	Moderate	Low	Low.
MH	0.63–2.0	0.15–0.17	7.4–7.8	Moderate	Moderate	Low.
MH	0.63–6.3	0.10–0.12	6.1–7.3	Moderate	Moderate	Low.
ML	2.0–6.3	0.13–0.15	4.5–6.0	Moderate	Moderate	Moderate.
CL, ML or SM	2.0–6.3	0.12–0.14	5.6–6.5	Low	Moderate	Moderate.
MH	2.0–6.3	0.15–0.17	4.5–5.0	Moderate	High	High.
MH	2.0–6.3		4.5–5.0	Low	High	High.
ML	0.63–2.0	0.16–0.18	6.6–7.3	Low	Low	Low.
CH	0.06–0.63	0.12–0.14	6.1–7.4	High	High	Low.
ML	2.0–6.3	0.09–0.11	4.0–5.5	Moderate	High	High.
ML	0.63–2.0	0.10–0.12	4.5–6.0	Low	High	High.
ML–MH	2.0–6.3	0.10–0.12	6.1–7.3	Moderate	Low	Low.
MH	0.63–2.0	0.12–0.14	6.6–7.3	Moderate	High	Low.
MH–OH	6.3–20.0	0.12–0.14	4.0–5.0	Moderate	High	High.
MH	0.2–0.63	0.12–0.14	4.5–5.0	Low	High	High.
ML	2.0–6.3	0.14–0.16	6.1–7.3	Low	Low	Low.
ML–MH	0.63–2.0	0.12–0.14	4.0–6.5	Moderate	Moderate	High.
ML	0.63–2.0	0.14–0.16	5.6–6.0	Low	Low	Moderate.
GC	2.0–6.3		4.5–5.0	Low	High	High.
MH	2.0–6.3		4.5–5.0	Low	High	High.
CL–ML	0.63–2.0	0.10–0.12	5.6–6.5	Moderate	Low	Moderate.
ML	0.63–2.0	0.11–0.13	5.6–6.5	Low	Low	Low.
MH–OH	2.0–6.3	0.15–0.17	6.6–7.8	Moderate	Low	Low.
	<0.06			Low	Low	Low.

TABLE 2.—*Estimated*

Soil series and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	Classification: Dominant USDA texture
	Feet	*Feet*	*Inches*	
Lawai: LcB, LcC, LcD	>5	(3)	0–60	Silty clay
Leilehua: LeB, LeC	>5	>5	0–75	Silty clay and clay
Lihue: LhB, LhC, LhD, LhE2, LIB, LIC	>5	>5	0–60	Silty clay; gravelly in places.
Lolekaa: LoB, LoC, LoD, LoE, LoF	>5	>5	0–42 42–65	Silty clay Loam
Lualualei: LuA, LuB, LvA, LvB, LPE	>5	>5	0–60	Clay
Mahana: MaC, MaD, MaD3, MaE, MaE3, McC2, McD2, McE2, MBL.	>5	>5	0–61	Silt loam and silty clay loam
Makaalae: MID, MJD, MWE	2–4	>5	0–40 40	Clay and silty clay Aa lava.
Makalapa: MdB, MdC, MdD	1½–3½	>5	0–38 38	Clay Volcanic tuff.
Makapili: MeB, MeC, MeD, MeE	>5	>5	0–60	Silty clay and clay loam
Makawao: MfB, MfC	>5	>5	0–60	Silty clay
Makaweli: MgB, MgC, MgD, MgE2, MhB, MhC, MhD, MhE.	>5	>5	0–60	Silty clay loam and silt loam
Makena: MXC	3½–5	>5	0–44 44	Silt loam Aa lava.
Makiki: MkA, MIA	1½–5	>5	0–54	Clay loam; stony in places
Mala: MmA, MmB	>5	>5	0–40 40–60	Silty clay Coral sand
Malama: MYD	1½–2½	>5	0–8 8–28 28	Extremely stony muck Aa lava and muck Aa lava.
Mamala: MnC	1–1½	>5	0–19 19	Silty clay loam Hard coral.
Manana: MoB, MoC, MoD2, MpB, MpC, MpD, MpD2, MpE.	>5	>5	0–15 15–15¼ 15¼–60	Silty clay loam and silty clay Pan Silty clay
Mokuleia:				
Mr, Ms, Mt, Mtb	>5	>5	0–16 16–50	Clay loam, loam, or fine sandy loam Sand
Mta	>5	2–4	0–15 15	Clay and clay loam Sand
Molokai: MuA, MuB, MuB3, MuC, MuC3, MuD, MvD3.	>5	>5	0–72	Silty clay loam
Naiwa: NAC, NAC3	3–5	>5	0–52 52–60	Silty clay loam, silt loam, and loam Saprolite
Niu: NcC, NcD, NcD2, NcE2	>5	>5	0–60	Silty clay loam and silty clay
Niulii: NLE, NME	3–5	>5	0–40 40	Silty clay loam and silty clay Lava bedrock.

See footnotes at end of table.

properties—Continued

Classification—Con.	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
Unified					Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
MH	0. 63–6. 3	0. 14–0. 16	5. 1–6. 0	Moderate	High	Moderate.
MH–CH	2. 0–6. 3	0. 10–0. 12	4. 0–4. 5	Moderate	High	High.
MH	2. 0–6. 3	0. 13–0. 15	5. 1–7. 3	Moderate	Low	Moderate.
MH	2. 0–6. 3	0. 10–0. 12	4. 0–5. 5	Moderate	High	Moderate.
ML–MH	2. 0–6. 3	0. 11–0. 13	4. 0–4. 5	Low	High	High.
CH	0. 06–0. 20	0. 11–0. 13	5. 6–7. 3	High	Moderate	Low.
MH	2. 0–6. 3	0. 11–0. 13	5. 6–6. 5	Moderate	High	Moderate.
CH	0. 63–2. 0		5. 1–6. 5	High	High	Moderate.
CH	0. 06–0. 20	0. 11–0. 13	7. 4–8. 4	High	Moderate	Low.
MH	2. 0–6. 3	0. 12–0. 14	4. 5–5. 5	Low	High	High.
MH	2. 0–6. 3	0. 17–0. 19	5. 1–6. 5	Moderate	High	Moderate.
ML	0. 63–2. 0	0. 14–0. 16	6. 1–7. 3	Low	Low	Low.
ML	2. 0–6. 3	0. 17–0. 19	7. 4–8. 4	Low	Low	Low.
MH	2. 0–6. 3	0. 13–0. 15	5. 1–6. 0	Moderate	Moderate	Moderate.
ML–MH	0. 63–2. 0	0. 11–0. 13	6. 1–7. 8	Moderate	Moderate	Low.
SP	6. 3–20. 0	0. 06–0. 08	7. 4–7. 8	Low	Moderate	Low.
Pt	<20. 0	0. 10–0. 12	5. 1–6. 0	High shrink, low swell	High	Moderate.
	<20. 0					
CL–ML	0. 63–2. 0	0. 16–0. 18	6. 6–7. 8	Low	Low	Low.
MH	2. 0–6. 3	0. 09–0. 11	4. 5–5. 0	Moderate	High	High.
	<0. 06					
MH	0. 63–2. 0	0. 10–0. 12	4. 0–5. 0	Low	High	High.
CL or SM	0. 63–6. 3	0. 10–0. 16	6. 6–7. 3	Moderate to low	Moderate	Low.
SP	6. 3–20. 0	0. 06–0. 08	7. 9–8. 4	Low	Low	Low.
CH	0. 06–0. 20	0. 12–0. 14	7. 4–7. 8	High	Moderate	Low.
SP	6. 3–20. 0	0. 06–0. 08	7. 4–7. 8	Low	Low	Low.
ML	0. 63–2. 0	0. 11–0. 13	4. 0–7. 3	Low	Low	Low.
ML	2. 0–6. 3	0. 09–0. 11	4. 5–5. 5	Moderate	High	High.
MH						
ML–CL	0. 63–2. 0	0. 11–0. 13	5. 6–7. 3	Moderate	Low	Low.
MH–OH	2. 0–6. 3	0. 17–0. 19	4. 5–5. 0	Moderate	High	High.

TABLE 2.—*Estimated*

Soil series and map symbols	Depth to—		Depth from surface	Classification
	Bedrock	Seasonal high water table		Dominant USDA texture
	Feet	*Feet*	*Inches*	
Nohili: Nh	>5	1½–3	0–120	Clay
Nonopahu: NnC, NoC	>5	>5	0–65	Clay and silty clay
Oanapuka: OAD, OED	3½–5	>5	0–46 46–55	Very stony silt loam and loam Aa lava.
Olelo: OFC	>5	>5	0–37 37–60	Silty clay Saprolite
Oli: OID, OMB, OME, OMF	2–4	>5	0–30 30	Silt loam Bedrock.
Olinda: ONC, OND, ONE	3–5	>5	0–36 36	Silty clay loam Bedrock.
Olokui: OOE	>5	(1)	4–0 0–11 11–11½ 11½–60	Organic matter Silty clay loam Ironstone sheet Saprolite
Opihikao: OPD	<1	>5	0–5 >5	Muck Bedrock.
Paaiki: PGE, PGF	3–5	>5	0–40 40–50	Silty clay loam and silty clay Saprolite.
Paaloa: PaC, PbC	>5	>5	0–60	Silty clay and clay
Paia: PcB, PcC, PcC2	>5	>5	0–60	Silty clay and clay
Pakala: PdA, PdC, PHXC	>5	>5	0–60	Stratified clay loam, very fine sandy loam, silt loam, and silty clay loam; extremely stony in places.
Pamoa: PlD, PlD2, PJD2	>5	>5	0–62	Silty clay and clay
Pane: PXD	>5	>5	0–39 39–65	Silt loam and loam Gravelly loam
Papaa: PYD, PYE, PYF	3½–5	>5	0–28 28–40 40	Clay Silty clay loam Basalt.
Paumalu: PeB, PeC, PeD, PeE, PeF, PZ	>5	>5	0–48 48–70	Silty clay Gravelly silty clay
Pauwela: PfB, PfC, PfD	>5	>5	0–54	Clay and silty clay
Pearl Harbor: Ph	>5	1–4	0–31 31–48	Clay Muck
Pohakupu: PkB, PkC	>5	>5	0–76	Silty clay loam
Pooku: PlB, PlD, PmB, PmC, PmD, PmE	>5	>5	0–62	Silty clay and silty clay loam
Puhi: PnA, PnB, PnC, PnD, PnE	>5	>5	0–60	Silty clay loam and silty clay
Pulehu: PoB, PoaB, PpA, PpB, PrA, PrB, PsA, PtA, PtB, PuB, PvC.	>5	>5	0–60	Stratified clay loam, loam, loamy sand, fine sandy loam, and silt loam; cobbly or stony in places.
Puuone: PZUE	1½–3½	>5	0–20 20–40	Sand Cemented sand

See footnotes at end of table

properties—Continued

Classification—Con.	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
Unified					Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
CH	0.20–0.63	0.12–0.14	4.5–7.8	High	High	Moderate.
CH	0.20–0.63	0.10–0.12	7.4–7.8	High	Moderate	Low.
ML	2.0–6.3	0.08–0.10	6.6–7.8	Low	Low	Low.
MH MH	2.0–6.3 2.0–6.3	0.10–0.12 -----	4.5–5.0 -----	Moderate Low	High -----	High.
MH–ML	2.0–6.3	0.12–0.14	4.5–6.5	Low	High	High.
MH–OH	2.0–6.3	0.13–0.15	6.1–6.5	[2]	High	Low.
Pt MH–OH ----- MH	20.0 2.0–6.3 <0.06 0.63–2.0	0.20–0.30 0.12–0.14 ----- -----	4.0–4.5 4.0–5.0 ----- -----	[2] Moderate ----- Low	High High ----- High	High. High. High.
Pt	6.3–20.0	0.20–0.30	5.1–6.5	High	High	Moderate.
MH	2.0–6.3	0.17–0.19	4.5–6.0	Moderate	High	Moderate.
MH	2.0–6.3	0.10–0.12	4.5–5.5	Low	High	High.
MH	0.63–2.0	0.13–0.15	7.4–7.8	Low	Low	Low.
CL and ML	0.63–2.0	0.08–0.14	4.5–6.0	Low	Low	Moderate.
CL	0.20–0.63	0.09–0.11	4.5–7.3	High	Low to moderate	Low to moderate.
MH SM or GM	2.0–6.3 2.0–6.3	0.14–0.16 0.08–0.10	6.1–7.3 6.6–7.3	Moderate Low	Moderate Low	Low. Low.
CH C[illegible]	0.06–0.20 0.20–0.63	0.10–0.12 0.11–0.13	6.1–6.5 6.1–6.5	High Moderate	Moderate Moderate	Low. Low.
MH CL	2.0–6.3 2.0–6.3	0.10–0.12 0.07–0.09	4.5–6.0 5.5–6.0	Moderate Low	High High	High. Moderate.
MH	2.0–6.3	0.10–0.12	4.0–5.0	Low	High	High.
CH Pt	<0.06 <0.06	0.10–0.12 0.16–0.18	6.6–8.4 7.4–7.8	High High	High High	High. High.
MH	2.0–6.3	0.12–0.14	6.1–6.5	Moderate	Moderate	Low.
MH	2.0–6.3	-----	4.0–6.0	Low	High	High.
MH	2.0–6.3	0.10–0.12	4.5–6.5	Moderate to low	High	Moderate.
CL, SM or ML	0.63–2.0	0.09–0.13	6.6–7.8	Moderate to low	Low	Low.
SP -----	6.3–20.0 <0.06	0.06–0.08 -----	7.9–8.4 -----	Low -----	Low -----	Low.

TABLE 2.—*Estimated*

Soil series and map symbols	Depth to—		Depth from surface	Classification
	Bedrock	Seasonal high water table		Dominant USDA texture
	Feet	*Feet*	*Inches*	
Puu Opae: PwC, PwD, PwE	>5	>5	0–61	Silty clay loam and silty clay
Puu Pa: PZVE	1½–4	>5	0–47	Very stony silt loam
			47	Aa lava.
Tantalus: TAE, TAF, TCC, TCE	1–3	>5	0–29	Silty clay loam, silt loam, and very fine sandy loam.
			29	Cinders.
Tropaquods: rTO	>5	(1)	8–0	Peat
			0–11	Clay and silty clay loam
			11–11½	Ironstone sheet
			11½–60	Saprolite.
Tropohumults: rTP	>5	>5	0–58	Silty clay
For Dystrandepts part of rTP, see Dystrandepts.			58	Saprolite.
Ulupalakua: ULD	2–3½	>5	0–33	Silt loam and clay loam
			33	Cinders.
Uma: UME, UMF, URD	½–1	>5	0–6	Loamy coarse sand
			6–55	Cinders.
Uwala: UwB, UwC, UwC3	3–7	>5	0–60	Silty clay loam
Wahiawa: WaA, WaB, WaC, WaD2	>5	>5	0–60	Silty clay
Wahikuli: WbB, WcB, WcC, WdB	1½–3½	>5	0–32	Silty clay
			32	Bedrock.
Waiakoa: WeB, WeC, WfB, WgB, WgC, WhB, WhC, WlD2.	1½–3½	>5	0–33	Silty clay loam; cobbly or stony in places
			33	Bedrock.
Waialeale: rWAF	1–2	(1)	3–0	Mucky peat
			0–21	Silty clay loam
			21	Saprolite.
Waialua: WkA, WkB, WlB, WlE, WmD, WnB	>5	>5	0–55	Silty clay
Waiawa: WJF	½–1½	>5	0–14	Clay
			14	Bedrock.
Waihuna: WoA, WoB, WoC, WoD, WohB	>5	>5	0–65	Clay and silty clay
Waikane: WpB, WpC, WpE, WpF, WpF2, WpaE.	>5	>5	0–60	Silty clay
Waikapu: WrA, WrB, WrB3, WrC3	>5	>5	0–60	Silty clay loam
Waikomo: Ws, Wt, Wu	1–1½	>5	0–20	Stony silty clay and silty clay loam
			20	Bedrock.
Wailuku: WvB, WvC, WwC	>5	>5	0–60	Silty clay
Wainee: WxB, WxC, WyB, WyC	>5	>5	0–56	Extremely stony silty clay
Waipahu: WzA, WzB, WzC	>5	>5	0–70	Silty clay

[1] Soil is always wet.
[2] High shrink potential; low swell potential.
[3] Seep areas.

properties—Continued

Classification—Con.	Permeability	Available water capacity	Reaction	Shrink-swell potential	Corrosivity	
Unified					Uncoated steel	Concrete
	Inches per hour	*Inches per inch of soil*	*pH value*			
ML-MH	2.0-6.3	0.12-0.14	4.5-6.0	Low	High	Moderate.
ML	2.0-6.3	0.05-0.07	5.6-7.3	Low	Low	Low.
MH-OH	2.0-6.3	----------	6.1-7.3	([2])	Moderate	Low.
Pt	6.3-20.0	0.20-0.30	3.9-4.5	([2])	High	High.
OH or MH-OH	0.06-6.3	0.13-0.14	4.0-5.0	Moderate	High	High.
----------	<0.06	----------	----------	----------	----------	
MH	0.63-6.3	----------	4.0-5.0	Low	High	High.
MH	2.0-6.3	0.12-0.14	4.5-5.5	Moderate	High	High.
MH-OH	2.0-6.3	0.17-0.19	6.1-7.8	Moderate	Moderate	Low.
SM	>20.0	0.07-0.10	7.4-7.8	Low	Low	Low.
ML	0.63-2.0	0.10-0.12	4.5-6.0	Low	Low	Moderate to high.
MH	2.0-6.3	0.11-0.13	5.6-7.3	Low	Low	Moderate to low.
ML-CL	0.63-2.0	0.12-0.14	7.4-7.8	Low	Low	Low.
ML-CL	0.63-2.0	0.08-0.15	6.1-7.3	Low	Low	Low.
Pt	6.3-20.0	0.20-0.30	3.0-3.5	High	High	High.
MH-OH	2.0-6.3	0.12-0.14	4.0-4.5	Moderate	High	High.
MH	----------	----------	----------	----------	----------	
MH-CH	0.63-2.0	0.13-0.15	6.1-7.3	Moderate	Moderate	Low.
CH	0.20-2.0	0.15-0.17	6.1-7.3	High	Moderate	Low.
CH	0.20-0.63	0.09-0.11	5.1-7.3	High	Moderate	Moderate.
MH	2.0-6.3	0.10-0.12	4.5-4.0	Low	High	High.
ML	0.63-2.0	0.12-0.14	5.1-7.3	Low	Low	Low.
MH	0.63-2.0	0.09-0.11	6.6-7.8	Low	Low	Low.
MH	0.63-2.0	0.13-0.15	5.6-6.5	Low	Low	Low.
ML-CL	2.0-6.3	0.05-0.07	6.6-7.3	Low	Low	Low.
CL	0.20-2.0	0.11-0.13	6.1-6.5	High	Low	Low.

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TABLE 3.—*Engineering*

[Most of the miscellaneous land types are not listed

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir areas	Farm ponds: Embankments
Alae: AaB, AcA, AcB	Surface 14 inches is good; 14 to 55 inches is poor.	Good if soil binder is added.	Subject to flooding in winter.	Coarse and very coarse sand below a depth of 14 inches.	Sandy material; highly pervious material.
Alaeloa: AeB, AeC, AeE, ALE3, ALF, AME3, ANE.	Good	Good	Slopes as much as 70 percent.	Slopes as much as 70 percent; moderately rapid permeability.	Slopes as much as 70 percent.
Alakai: rAAE	Poor: always wet.	Poor: organic material; always wet.	Organic material; wetness.	Wetness; organic material; pervious material.	(3)
Amalu: rAMD, rAOD. For Olokui part of rAOD, see Olokui series.	Poor: peat and clay; always wet.	Poor: organic material; always wet; accessibility is difficult.	Organic material; wetness.	Wetness; organic material; pervious material.	(2)
Badland: BL, BM. For Mahana part of BM, see Mahana series.	Fair: very low fertility.	Good	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Erodible: slopes as much as 70 percent.
Blown-out land: BW	Fair: low fertility.	Good	Erodible where embankments are exposed.	Moderate permeability.	Erodible: high compacted density.
Ewa:					
EaA, EaB, EaC, EmA, EmB, EsA, EsB.	Good	Good	(3)	Moderate permeability.	(3)
EcA, EcB, EtB, EwA, EwB, EwC.	Good, except cobbly or stony.	Good, except cobbly or stony.	(3)	Moderate permeability.	All features favorable, except cobbly or stony.
Haiku: HaB, HaC, HbB, HbC.	Fair to a depth of 30 inches: clayey; low fertility.	Good	(3)	Moderately rapid permeability.	(4)
Halawa: HID, HID3, HJE, HJF2.	Good	Good	Slopes as much as 70 percent.	Slopes as much as 70 percent; moderately rapid permeability.	Slopes as much as 70 percent.
Haleiwa:					
HcB, HeA, HeB	Good	Good	Subject to localized flooding.	Moderate permeability.	(3)
HdC	Good, except stony.	Good, except stony.	(3)	Moderate permeability.	All features favorable, except stoniness.

See footnotes at end of table.

interpretations

in this table, because the soil material is too variable]

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings[1]	
(2)	Low available water capacity; high water intake rate.	Sandy substratum; rapid permeability.	Sandy substratum; excessively drained; low available water capacity.	Low shrink-swell potential; low compressibility; coarse texture; rapid permeability.	Slight: rapid permeability.
(2)	Moderate to severe erosion hazard on steep slopes.	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
Very poorly drained.	(2)	(2)	(2)	High compressibility; organic soil; wetness.	Severe: always wet.
Poorly drained	(2)	(2)	(2)	High compressibility; wetness; organic material.	Severe: always wet.
(2)	Highly erodible; slopes as much as 70 percent.	Slopes as much as 70 percent; erodible.	Slopes as much as 70 percent; difficult to establish plants.	Slopes as much as 70 percent.	Severe: slopes generally more than 10 percent.
(2)	Slow intake rate	Susceptible to siltation.	Low fertility; difficult to establish plants.	(3)	Slight: moderate permeability.
(2)	(3)	(3)	Difficult to establish plants unless irrigated.	(3)	Slight: moderate permeability; severe where soil is moderately shallow.
(2)	All features favorable, except cobbly or stony.	All features favorable, except cobbly or stony.	Difficult to establish plants unless irrigated; cobbly or stony.	(3)	Slight: moderate permeability.
(2)	(2)	Clayey; moderately rapid permeability.	Clayey; slopes as much as 15 percent.	Slopes as much as 15 percent.	Slight on slopes of not more than 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Slopes as much as 70 percent.	All features favorable where slopes are not more than 20 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	(3)	(3)	(3)	(3)	Slight, except where subject to local flooding.
(2)	All features favorable, except stoniness.	Stoniness	Stoniness	Stoniness	Slight: stoniness.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir areas	Farm ponds: Embankments
Halii: HfB, HfC, HfD2, HfE2.	Poor: low fertility.	Good	Slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	(4)
Haliimaile: HgB, HgC, HhB, HhC, HkC2.	Good to a depth of 40 inches; fair from 40 to 60 inches; very sticky.	Good	(3)	Moderately rapid permeability.	(3)
Hamakuapoko: HlB, HlC, HlC2.	Fair: very sticky and very plastic; low fertility.	Good	(3)	Moderately rapid permeability.	Very sticky and very plastic.
Hana:					
HKNC, HKOC	Fair: dehydrates irreversibly; low fertility.	Poor: poor workability; low compacted density; thixotropic.	Slopes as much as 15 percent; high compressibility; low bearing capacity.	Moderately rapid permeability; slopes as much as 15 percent; cinders at a depth of 1½ to 3 feet.	High seepage rate; low compacted density; high compressibility; poor workability.
HKLD	Fair: dehydrates irreversibly; low fertility; stony.	Poor: poor workability; low compacted density; thixotropic; stony.	Slopes as much as 25 percent; high compressibility; low bearing capacity; stoniness.	Moderately rapid permeability; slopes as much as 25 percent; cinders at a depth of 3 to 4 feet; stoniness.	High seepage rate; low compacted density; high compressibility; poor workability; stoniness.
HKMD	Fair: dehydrates irreversibly; low fertility; stony.	Poor: poor workability; low compacted density; thixotropic; stony.	Slopes as much as 25 percent; high compressibility; low bearing capacity; stoniness.	Moderately rapid permeability; slopes as much as 25 percent; cinders at a depth of 1½ to 4 feet; stoniness.	High seepage rate; low compacted density; high compressibility; poor workability; stoniness.
Hanalei: HmA, HnA, HnB, HoB, HpA, HrB.	Poor: always wet.	Poor: high water table; always wet.	High water table; subject to flooding.	High water table; subject to flooding.	Wetness; fair stability; subject to flooding.
Hanamaulu:					
HsB, HsC, HsD, HsE, HtE.	Fair: low fertility.	Good	Slopes as much as 40 percent.	Slopes as much as 40 percent; moderately rapid permeability.	Slopes as much as 40 percent. See also (4).
HuE	Fair: low fertility; bouldery.	Good, except bouldery.	Slopes as much as 35 percent; bouldery.	Slopes as much as 35 percent; moderately rapid permeability; bouldery.	Slopes as much as 35 percent; bouldery. See also (4).

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	(2)	Low fertility; slopes as much as 40 percent.	Low fertility; slopes as much as 40 percent.	Slopes as much as 40 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 15 percent.	(3)	(3)	All features favorable, except slopes as much as 15 percent.	Slight on slopes of not more than 7 percent; moderate on slopes of as much as 15 percent.
(2)	Slopes as much as 15 percent.	Very sticky and very plastic.	Very sticky and very plastic.	Moderate shrink-swell potential; slopes as much as 15 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	(2)	Poor workability	Poor workability	High shrinkage; low bearing capacity; high compressibility.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	(2)	Poor workability; stoniness.	Poor workability; stoniness.	High shrinkage; low bearing capacity; high compressibility; stoniness.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	Poor workability; stoniness.	Poor workability; stoniness.	High shrinkage; low bearing capacity; high compressibility; stoniness.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
High water table; moderate permeability; subject to flooding.	(3)	Wetness; high water table; subject to flooding.	High water table; wetness.	High water table; subject to flooding.	Severe: high water table; subject to flooding.
(2)	All features favorable, except slopes as much as 40 percent.	All features favorable, except slopes as much as 40 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	All features favorable, except slopes as much as 35 percent; bouldery.	All features favorable, except slopes as much as 35 percent; bouldery.	Slopes as much as 35 percent; bouldery.	Slopes as much as 35 percent; bouldery.	Severe: slopes generally more than 15 percent; bouldery.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Helemano: HLMG	Fair: 30 to 90 percent slopes.	Fair: 30 to 90 percent slopes.	Slopes of 30 to 90 percent.	Moderately rapid permeability; 30 to 90 percent slopes.	Slopes of 30 to 90 percent.
Hihimanu: HMMF	Fair: slopes of 40 to 70 percent; low fertility.	Fair: slopes of 40 to 70 percent.	Slopes of 40 to 70 percent.	Slopes of 40 to 70 percent; moderately rapid permeability.	Slopes of 40 to 70 percent. See also (4).
Holomua: HvA, HvB, HvB3, HvC, HvC3.	Good	Good	Bedrock as shallow as 4 feet in places.	Moderate permeability; bedrock as shallow as 4 feet in places.	Poor stability; piping hazard.
Honolua: HwC, HwD	Fair: low fertility.	Good	Slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	(4)
Honomanu: rHOD, rHR. For Amalu part of rHR, see Amalu series.	Fair: dehydrates irreversibly; low fertility.	Poor: poor workability; high compressibility; thixotropic; low compacted density.	High compressibility; low bearing capacity; slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	High seepage rate; high compressibility; thixotropic.
Honouliuli: HxA, HxB	Fair: very sticky and very plastic.	Poor: highly plastic; poor workability; high shrink-swell potential.	High shrink-swell potential; low shear strength.	Moderately slow permeability; high shrink-swell potential.	High shrink-swell potential; low shear strength.
Hoolehua: HyB3, HzA, HzB, HzC, HzE.	Good	Good	Slopes as much as 35 percent.	Moderate permeability; slopes as much as 35 percent.	High compacted density.
Hulua: HNUD, HNUF	Poor: always wet; low fertility.	Poor: poor workability; always wet.	Slopes as much as 70 percent; wetness; seepage.	Slopes as much as 70 percent; ironstone layer at a depth of about 15 inches.	Wetness; high organic-matter content to a depth of 15 inches; high compressibility.
Hydrandepts: rHT. For Tropaquods part of rHT, see Tropaquods.	Fair: dehydrates irreversibly; low fertility.	Poor: poor workability; high compressibility; low compacted density.	High compressibility; low bearing capacity; slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	High seepage rate; high compressibility.
Iao: IaA, IaB, IbB, IbC, IcB, IcC.	Fair: very sticky and very plastic.	Fair: moderate shrink-well potential.	Subject to local flooding.	Moderately slow permeability; moderate shrink-swell potential.	Moderate shrink-swell potential; clayey.
Io: ISD	Good to a depth of 20 inches; variable below 20 inches.	Fair: unstable material.	Slopes as much as 25 percent; unstable material.	Moderately rapid permeability; cinders at a depth of 20 to 40 inches; slopes as much as 25 percent.	Unstable material; high seepage rate; piping hazard.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	Slopes of 30 to 90 percent.	Slopes of 30 to 90 percent.	Slopes of 30 to 90 percent.	Slopes of 30 to 90 percent; susceptible to sliding.	Severe on slopes of 30 to 90 percent.
(2)	(2)	Slopes of 40 to 70 percent; moderately rapid permeability.	Slopes of 40 to 70 percent.	Slopes of 40 to 70 percent; susceptible to sliding.	Severe on slopes of 40 to 70 percent.
(2)	Erodible; slopes as much as 15 percent.	Susceptible to siltation.	Susceptible to siltation of channels; difficult to establish plants.	All features favorable, except where slopes are as much as 15 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Slopes as much as 25 percent.	Slopes as much as 25 percent; other features favorable.	(3)	Moderate shrink-swell potential; high shear strength; slopes as much as 25 percent.	Moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	Many stones below a depth of 3 feet; poor workability; low fertility.	Poor workability; low fertility.	High shrinkage; high compressibility; low shear strength.	Moderate on slopes of 5 to 15 percent; severe on slopes of more than 15 percent.
Moderately slow permeability.	Moderately slow permeability.	Poor workability	Difficult to establish plants; poor workability.	Low shear strength; high shrink-swell potential.	Severe: moderately slow permeability.
(2)	Slopes as much as 35 percent.	All features favorable on slopes not more than 20 percent.	Difficult to establish plants.	Slopes as much as 35 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
Ironstone layer at a depth of about 15 inches; wetness.	(2)	(2)	(2)	Poorly drained; slopes as much as 70 percent; low shear strength.	Severe: shallow to ironstone layers; steep and very steep slopes; always wet.
(2)	(2)	Many stones below a depth of 3 feet; poor workability; low fertility.	Poor workability; low fertility.	High shrinkage; high compressibility; low shear strength.	Moderate on slopes of 5 to 15 percent; severe on slopes of more than 15 percent.
(2)	Moderately slow permeability.	Poor workability	Poor workability; difficult to establish plants.	Moderate shrink-swell potential.	Severe: moderately slow permeability.
(2)	Slopes of 7 to 25 percent; high available water capacity; moderately rapid permeability.	Unstable material; cinders at a depth of 20 to 40 inches.	Cinders at a depth of 20 to 40 inches.	Slopes as much as 25 percent; cinders at a depth of 20 to 40 inches.	Severe: slopes generally more than 10 percent; rapid permeability in substratum.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Ioleau: IoB, IoC, IoD2, IoE2.	Fair: low fertility.	Good	Slopes as much as 35 percent.	Slopes as much as 35 percent; slow to moderately slow permeability.	(3)
Jaucas:					
JaC, JfB, JkB	Poor: low available water capacity.	Poor: unstable; highly erodible.	Unstable slopes; erodible.	Sandy pervious material.	Highly pervious; poor stability.
JcC	Poor: low available water capacity; saline.	Poor: unstable; highly erodible; high water table.	Unstable slopes; erodible; high water table.	Sandy pervious material; high water table.	Highly pervious; poor stability; high water table.
JL. For Blown-out part, see Blown-out land.	Fair: low fertility.	Good	Erodible where embankments are exposed.	Rapid permeability	Erodible; high compacted density.
Kaena: KaB, KaC, KaeB, KaeC, KaeD, KanE, KavB, KavC.	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential; poor workability; seepage.	High shrink-swell potential; seepage; poor workability; slopes as much as 35 percent.	Slow to moderately slow permeability; high shrink-swell potential; slopes as much as 35 percent.	Poor workability; high shrink-swell potential; poor compaction characteristics.
Kahana: KbB, KbC, KbD.	Good	Good	Slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	(3)
Kahanui: KASD, KATD	Poor: very low fertility.	Fair to good: wet in winter.	Local seepage; slopes as much as 20 percent.	Moderately rapid permeability; slopes as much as 20 percent; local seepage.	(4)
Kailua: KBID	Fair: dehydrates irreversibly; low fertility.	Poor: low shear strength; high compressibility; poor workability; thixotropic.	Low bearing capacity; high compressibility; poor workability; slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	Thixotropic; high compressibility; poor workability; low compacted density.
Kaimu: KCXD	Poor: extremely stony; fragmental Aa lava at a depth of less than 8 inches.	Good	Fragmental Aa lava; slopes as much as 25 percent.	Fragmental Aa lava; very rapid permeability.	Fragmental Aa lava; highly pervious.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	Moderate to severe erosion hazard where slopes are more than 20 percent; slow to moderately slow permeability.	Slopes as much as 35 percent.	Slopes as much as 35 percent.	Slopes as much as 35 percent.	Severe: moderately slow to slow permeability.
(2)	Low available water capacity; rapid intake rate.	Unstable embankments; sandy material; rapid permeability.	Highly erodible; low available water capacity; low fertility.	(3)	Slight: rapid permeability.
Rapid permeability; high water table.	Low available water capacity; rapid intake rate; high water table.	Unstable embankments; sandy material; rapid permeability; high water table.	Highly erodible; low available water capacity; low fertility; high water table.	High water table	Severe: high water table.
(2)	Slow intake rate	Susceptible to siltation.	Low fertility; difficult to establish plants.	(3)	Slight: rapid permeability.
Slow permeability; seepage.	Slow intake rate; poorly drained; slow permeability.	Poor workability; poorly drained; high shrink-swell potential.	Poorly drained; poor workability.	High shrink-swell potential; poorly drained; low shear strength; seepage.	Severe: slow permeability; seepage.
(2)	Slopes as much as 25 percent.	All features favorable where slopes are not more than 20 percent.	Slopes as much as 25 percent.	High shear strength; slopes as much as 25 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	Slopes as much as 20 percent; saprolite at a depth of 24 to 36 inches.	Very low fertility	Local seepage; slopes as much as 20 percent.	Slight on slopes of not more than 5 percent; severe on slopes of more than 5 percent; downslope seepage.
(2)	(2)	Poor workability	Poor workability	High shrinkage; low shear strength; high compressibility; slopes as much as 25 percent.	Slight on slopes of 0 to 5 percent; moderate on slopes of 5 to 10 percent; severe on slopes of more than 10 percent; moderately rapid permeability.
(2)	Rapid intake rate; very low available water capacity.	(2)	Extremely stony; poor workability.	Extremely stony; high bearing capacity; slopes as much as 25 percent.	Severe: lack of filter material.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Kaipoioi: KDIE	Good	Fair: high organic-matter content; low compacted density.	Slopes as much as 40 percent; moderate compressibility; unstable slopes.	Moderately rapid permeability; slopes as much as 40 percent.	Low compacted density; high organic-matter content.
KDVE	Good, except stony.	Fair: high organic-matter content: low compacted density; rocky.	Slopes as much as 40 percent; moderate compressibility; unstable slopes; rockiness.	Moderately rapid permeability; slopes as much as 40 percent; rockiness.	Low compacted density; high organic-matter content; rockiness.
Kalae: KcB, KcC, KcC3, KcD3, KcE3.	Fair: low fertility.	Good	Slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	(3)
Kalapa: KdD, KdE, KdF	Fair: low fertility.	Good	Slopes as much as 70 percent.	Moderately rapid permeability; slopes as much as 70 percent.	(4)
KEHF	Fair: low fertility; rocky.	Good, except rocky.	Slopes as much as 70 percent; rockiness.	Slopes as much as 70 percent; moderately rapid permeability; rockiness.	Rockiness. See also (4).
Kalaupapa: KFID	Poor: bedrock at a depth of less than 20 inches.	Poor: bedrock at a depth of less than 20 inches; rocky.	Slopes as much as 25 percent; rockiness; bedrock at a depth of less than 20 inches.	Bedrock at a depth of less than 20 inches; slopes as much as 25 percent; rockiness.	Limited volume of material; piping hazard; rockiness.
Kalihi: Ke	Poor: very sticky and very plastic; wet.	Poor: high shrink-swell potential; poor workability.	High shrink-swell potential; wetness; poor workability.	High water table; high shrink-swell potential; slow permeability.	High shrink-swell potential; low shear strength; poor compaction characteristics.
Kaloko: Kf, Kfa, Kfb	Poor: marl at a depth of less than 20 inches; high clay content.	Poor: high shrink-swell potential; poor workability.	High shrink-swell potential; wetness; poor workability.	Slow to moderately slow permeability; high shrink-swell potential.	Clayey; high shrink-swell potential; poor compaction characteristics; low shear strength.
Kamaole: KGKC, KGLC.	Poor: stony; less than 24 inches to fragmental Aa lava.	Good, except stony.	Fragmental Aa lava at a depth of less than 24 inches; stoniness.	Fragmental Aa lava at a depth of 16 to 24 inches; high seepage rate.	Limited volume of material; rapid seepage rate; stoniness.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	Rapid intake rate; slopes of 7 to 40 percent.	Slopes of 7 to 40 percent; erodible.	Erodible; slopes as much as 40 percent.	Slopes as much as 40 percent; moderate compressibility; low shear strength.	Severe: slopes generally more than 10 percent.
(2)	Rapid intake rate; slopes of 7 to 40 percent; rockiness.	Slopes of 7 to 40 percent; erodible; rockiness.	Erodible; slopes as much as 40 percent; rockiness.	Slopes as much as 40 percent; moderate compressibility; low shear strength; rockiness.	Severe: slopes generally more than 10 percent; rockiness.
(2)	Slopes as much as 40 percent; moderately rapid permeability.	All features favorable on slopes of not more than 20 percent.	Slopes as much as 40 percent.	High shear strength; slopes as much as 40 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 70 percent.	All features favorable on slopes of not more than 20 percent.	Slopes as much as 70 percent.	Moderate shrink-swell potential; high shear strength; slopes as much as 70 percent.	Moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 70 percent; rockiness.	Slopes of 40 to 70 percent; rockiness.	Slopes of 40 to 70 percent; rockiness.	Slopes of 40 to 70 percent; rockiness.	Severe: slopes of 40 to 70 percent; rockiness.
(2)	Bedrock at a depth of less than 20 inches; rockiness.	Bedrock at a depth of less than 20 inches; rockiness.	Bedrock at a depth of less than 20 inches; rockiness; slopes as much as 25 percent.	Bedrock at a depth of less than 20 inches; slopes as much as 25 percent; rockiness.	Severe: bedrock at a depth of less than 20 inches.
Slow permeability; high water table.	Slow intake rate; slow permeability.	Poor workability; wetness.	Wetness; poor workability.	High shrink-swell potential; poor drainage.	Severe: slow permeability; poor drainage.
Slow to moderately slow permeability; high water table.	Slow to moderately slow permeability.	Poor workability; wetness; marl layer at shallow depth.	Poor workability; wetness; shallow to marl.	High shrink-swell potential; wetness; low shear strength.	Severe: slow to moderately slow permeability; poorly drained.
(2)	Low available water capacity; fragmental Aa lava at a depth of 16 to 24 inches; stoniness.	Fragmental Aa lava at a depth of less than 24 inches; stoniness.	Highly erodible; fragmental Aa lava at a depth of less than 24 inches; stoniness; difficult to establish plants.	Stoniness; fragmental Aa lava at a depth of less than 24 inches.	Severe: lack of filter material.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Suitability as a source of— Road fill	Soil features affecting— Highway location	Soil features affecting— Farm ponds: Reservoir areas	Soil features affecting— Farm ponds: Embankments
Kaneohe: KgB, KgC, KHMC, KHME, KHMF, KHOF.	Fair: low fertility.	Good	Slopes as much as 65 percent.	Moderately rapid permeability; slopes as much as 65 percent.	(4)
Kanepuu: KhB, KhB2, KhC, KhC2.	Good	Good	(3)	Moderate permeability.	(3)
Kapaa: KkB, KkC, KkD, KkE, KlG.	Poor: very low fertility.	Good	Slopes as much as 100 percent.	Slopes as much as 100 percent; moderately rapid permeability.	(4)
Kapuhikani: KKTC	Poor: very sticky and very plastic; bedrock at a depth of 20 to 36 inches; stony.	Poor: very plastic; high shrink-swell potential; poor workability; stony.	High shrink-swell potential; poor workability; stoniness.	High shrink-swell potential; slow permeability; bedrock at a depth of 20 to 36 inches.	Clayey; high shrink-swell potential; poor compaction characteristics; stoniness.
Kaupo: KLUD, KLVD	Poor: stony; fragmental Aa lava at a depth of 20 to 40 inches.	Good, except stony.	Stoniness; slopes as much as 25 percent.	Stoniness; slopes as much as 25 percent; fragmental Aa lava at a depth of 20 to 40 inches; high seepage rate.	Stoniness; limited volume of soil material.
Kawaihapai: KlA, KlB, KlC, KlcB.	Good	Good	All features favorable, except occasional local flooding.	Moderate permeability.	(3)
KlbC, KlaA, KlaB	Good, except stony.	Good, except stony.	All features favorable, except occasional local flooding; stoniness.	Moderate permeability; stoniness.	Stoniness
Keaau: KmA, KmaB, KmbA.	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential; poor workability.	High shrink-swell potential; high water table.	High water table; high shrink-swell potential; slow permeability.	Clayey; high shrink-swell potential; poor compaction characteristics.
Keahua: KnB, KnC, KnaB, KnaC, KnaD, KncC, KnhC.	Good, except cobbly in places.	Good, except cobbly in places.	Slopes as much as 25 percent.	Moderate permeability; slopes as much 25 percent.	(3)
KnbD, KnsC	Good, except stony.	Good, except stony.	Slopes as much as 25 percent; stoniness.	Moderate permeability; slopes as much as 25 percent; stoniness.	Stoniness

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	(2)	All features favorable on slopes not more than 20 percent.	Slopes as much as 65 percent.	Slopes as much as 65 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 15 percent.	(3)	Difficult to establish plants.	Slopes as much as 15 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	(2)	Slopes as much as 100 percent.	Very low fertility; slopes as much as 100 percent.	Slopes as much as 100 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slow intake rate; stoniness.	Poor workability; stoniness; bedrock at a depth of 20 to 36 inches.	Poor workability; stoniness; bedrock at a depth of 20 to 36 inches; difficult to establish plants.	High shrink-swell potential; stoniness; bedrock at a depth of 20 to 36 inches.	Severe: slow permeability.
(2)	Fragmental Aa lava at a depth of 20 to 40 inches; stoniness.	Stoniness; fragmental Aa lava at a depth of 20 to 40 inches.	Stoniness; fragmental Aa lava at a depth of 20 to 40 inches.	Stoniness; slopes as much as 25 percent; fragmental Aa lava at a depth of 20 to 40 inches.	Severe: lack of filter material.
(2)	Slopes as much as 15 percent.	(3)	(3)	Slopes as much as 15 percent; high shear strength.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Slopes as much as 15 percent; stoniness.	Stoniness	Stoniness	Slopes as much as 15 percent; high shear strength; stoniness.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; stoniness.
Slow permeability; high water table.	Slow intake rate; slow permeability.	Poor workability; consolidated coral sand at a depth of 20 to 30 inches.	Poorly drained; poor workability; consolidated coral sand at a depth of 20 to 30 inches.	High shrink-swell potential; high water table; low shear strength.	Severe: slow permeability; high water table.
(2)	Slopes as much as 25 percent.	Susceptible to siltation.	Susceptible to siltation of channels; difficult to establish plants.	Slopes as much as 25 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 25 percent; stoniness.	Susceptible to siltation; stoniness.	Susceptible to siltation of channels; difficult to establish plants; stoniness.	Slopes as much as 25 percent; stoniness.	Moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Kealia: KMW	Poor: toxic salts; high water table.	Poor: high water table.	High water table; flooding hazard.	High water table; moderately rapid permeability.	Erodible: difficult to vegetate; piping hazard.
Keawakapu: KNXD	Poor: stony; 12 to 30 inches of soil material.	Fair: stony; limited volume of material.	Stoniness; slopes as much as 25 percent.	Fragmental Aa lava at a depth of 12 to 30 inches: moderate permeability.	Limited volume of material; stoniness.
Kekaha:					
KoA, KoB, KobA	Good	Good	(3)	Moderate permeability.	(3)
KOYE	Good, except stony.	Good, except stony.	Extremely stony; slopes as much as 35 percent.	Stoniness; slopes as much as 35 percent.	Stoniness
Kemoo: KpB, KpC, KpD, KpE, KpF, KPZ. For Badland part of KPZ, see Badland.	Good	Good	Slopes as much as 70 percent.	Moderate to moderately rapid permeability; slopes as much as 70 percent.	(3)
Koele:					
KrB, KrC, KrD	Good	Good	Slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	Pervious material below a depth of 3 feet.
KRX, KRL. For Badland part of KRL, see Badland.	Good, except rocky.	Good, except rocky.	Slopes as much as 60 percent; rockiness.	Slopes as much as 60 percent; rockiness.	Rockiness
Kokee: KSKE, KSKF	Fair: low fertility.	Good	Slopes as much as 70 percent.	Slopes as much as 70 percent; moderately rapid permeability.	(4)
Koko: KsB, KsC, KsD	Good	Fair: unstable slopes; erodible.	Erodible; slopes as much as 25 percent; unstable slopes.	Slopes as much as 25 percent; moderate permeability; tuff or cinders at a depth of 20 to 50 inches.	Low compacted density; tuff or cinders at a depth of 20 to 50 inches; subject to piping.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
Low, wet areas; high water table; flooding hazard; saline.	High water table; saline.	Subject to overflow from high tides; high water table.	High water table; saline; difficult to establish plants.	High water table; flooding hazard; subject to tidal action.	Severe: high water table; subject to tidal action.
(2)	Shallow soil; stoniness; slopes as much as 25 percent.	Fragmental Aa lava at a depth of 12 to 30 inches; stoniness.	Fragmental Aa lava at a depth of 12 to 30 inches; stoniness; difficult to establish plants.	Fragmental Aa lava at a depth of 12 to 30 inches; stoniness; slopes as much as 25 percent.	Severe: lack of filter material.
(2)	(3)	(3)	Difficult to establish plants unless irrigated.	(3)	Slight: moderate permeability.
(2)	Stoniness: slopes as much as 35 percent.	Stoniness: slopes as much as 35 percent.	Stoniness: slopes as much as 35 percent; difficult to establish plants unless irrigated.	Slopes as much as 35 percent; stoniness.	Moderate on slopes of 0 to 10 percent; severe on slopes of more than 10 percent.
(2)	Slopes as much as 70 percent.	All features favorable on slopes of not more than 20 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent; high bearing strength.	Slight on slopes of 2 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.
(2)	Slopes as much as 25 percent; moderately rapid permeability.	(3)	Difficult to establish plants unless irrigated.	Slopes as much as 25 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	Rockiness; uneven topography; slopes as much as 60 percent.	Rockiness; uneven topography; slopes as much as 60 percent.	Rockiness; slopes as much as 60 percent.	Slopes as much as 60 percent; rockiness.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent in other than rocky areas.
(2)	(2)	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent; low fertility.	Severe: slopes generally more than 10 percent.
(2)	Erodible; slopes as much as 25 percent; moderate permeability.	Erodible; tuff or cinders at a depth of 20 to 50 inches; slopes as much as 25 percent.	Erodible; difficult to establish plants unless irrigated.	Tuff or cinders at a depth of 20 to 50 inches; slopes as much as 25 percent.	Slight on slopes of 2 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Kokokahi:					
KtC	Poor: very sticky and very plastic.	Poor: very plastic; wet; poor workability; high shrink-swell potential.	High shrink-swell potential; poor workability; seepage.	High shrink-swell potential; seepage; slow to moderately slow permeability.	Poor workability; high shrink-swell potential; poor compaction characteristics.
KTKE	Poor: very sticky and very plastic.	Poor: very plastic; wet; poor workability; high shrink-swell potential; stoniness.	High shrink-swell potential; poor workability; seepage; slopes as much as 35 percent; stoniness.	High shrink-swell potential; seepage; slow to moderately slow permeability; stoniness.	Poor workability; high shrink-swell potential; poor compaction characteristics; stoniness.
Kolekole: KuB, KuC, KuD.	Good	Good	Slopes as much as 25 percent.	Slopes as much as 25 percent; moderate permeability.	Erodible
Koloa: KvB, KvC, KvD	Fair: soil material 20 to 40 inches deep over bedrock; stony.	Fair: 20 to 40 inches deep; stony.	Bedrock at a depth of 20 to 40 inches; slopes as much as 25 percent.	Bedrock at a depth of 20 to 40 inches; slopes as much as 25 percent; moderately rapid permeability.	Bedrock at a depth of 20 to 40 inches; high compacted density.
Kolokolo:					
Kw	Fair: low fertility.	Good	Subject to stream overflow.	Moderate permeability; subject to stream overflow.	(4)
KUL	Fair: stony; low fertility.	Poor: stony	Stoniness; subject to stream overflow.	Moderate permebility; subject to stream overflow; stoniness.	Stoniness. See also (4).
Koolau: KVSB, KVSE	Poor: always wet; low fertility.	Poor: low shear strength; always wet.	Wetness; low shear strength; poor workability.	Wetness; rapid permeability to a depth of 30 inches.	Wetness; poor workability; poor compaction characteristics.
Kula:					
KxC, KxD, KxaD	Good	Fair: unstable slopes; erodible.	Unstable slopes; erodible; slopes as much as 20 percent.	Moderately rapid permeability; slopes as much as 20 percent.	Poor stability; poor compaction characteristics; piping hazard.
KxbE	Good, except rocky.	Fair: unstable slopes; erodible; rocky.	Unstable slopes; erodible; rockiness; slopes as much as 40 percent.	Moderately rapid permeability; rockiness; slopes as much as 40 percent.	Poor stability; poor compaction characteristics; piping hazard; rockiness.
Kunia: KyA, KyB, KyC	Good	Good	(3)	Moderate permeability; slopes as much as 15 percent.	(3)

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
Slow to moderately slow permeability; seepage.	Slow intake rate; slow to moderately slow permeability.	High shrink-swell potential; poor workability.	Poor workability	High shrink-swell potential; low shear strength; seepage; susceptible to sliding.	Severe: slow and moderately slow permeability; seepage.
Slow to moderately slow permeability; seepage; stoniness.	Slow intake rate; slow to moderately slow permeability; slopes as much as 35 percent; stoniness.	High shrink-swell potential; poor workability; slopes as much as 35 percent; stoniness.	Poor workability; slopes as much as 35 percent; stoniness.	High shrink-swell potential; low shear strength; seepage; susceptible to sliding; slopes as much as 35 percent; stoniness.	Severe: slow to moderately slow permeability; seepage.
(2)	Thin panlike layer at a depth of 15 to 50 inches; slopes as much as 25 percent.	Slopes as much as 25 percent; thin panlike layer at a depth of 15 to 50 inches.	Thin panlike layer at a depth of 15 to 50 inches; slopes as much as 25 percent.	Slopes as much as 25 percent.	Slight on slopes of 1 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.
(2)	Stoniness; slopes as much as 25 percent; bedrock at a depth of 20 to 40 inches.	Stoniness; slopes as much as 25 percent; bedrock at a depth of 20 to 40 inches.	Stoniness; bedrock at a depth of 20 to 40 inches; slopes as much as 25 percent.	Bedrock at a depth of 20 to 40 inches; slopes as much as 25 percent.	Severe: bedrock at a depth of 20 to 40 inches.
(2)	(2)	Subject to stream overflow.	Subject to stream overflow and siltation.	Subject to stream overflow.	Severe: subject to stream overflow.
(2)	(2)	Subject to stream overflow; stoniness.	Subject to stream overflow; stoniness.	Subject to stream overflow; stoniness.	Severe: subject to stream overflow; stoniness.
High water table; moderately slow permeability in substratum.	(2)	Wetness; poor workability.	Poor workability; wetness.	Wetness; low shear strength; high compressibility.	Severe: poorly drained.
(2)	Moderately rapid permeability; erodible; slopes as much as 20 percent.	Susceptible to soil blowing and siltation; highly erodible.	Highly erodible; susceptible to siltation.	Moderate compressibility; piping hazard; slopes as much as 20 percent.	Moderate on slopes of 4 to 12 percent; severe on slopes o more than 12 percent.
(2)	Rockiness; slopes as much as 40 percent.	Susceptible to wind erosion and siltation; highly erodible; rockiness; slopes as much as 40 percent.	Highly erodible; susceptible to siltation of channels; rockiness; slopes as much as 40 percent.	Rockiness; slopes as much as 40 percent.	In other than rocky areas, moderate on slopes of 4 to 12 percent; severe on slopes of more than 12 percent.
(2)	Moderate permabiltiy; slopes as much as 15 percent.	(3)	Slopes as much as 15 percent.	Slopes as much as 15 percent.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Kunuweia: KZC	Poor: very low fertility.	Fair to good: wet in winter.	Slopes as much as 15 percent.	Moderately rapid permeability.	(4)
Lahaina: LaA, LaB, LaB3, LaC, LaC3, LaD, LaD3, LaE3.	Good	Good	Slopes as much as 40 percent.	Slopes as much as 40 percent; moderate permeability.	(3)
Laumaia: LME, LMF	Good	Fair: moderate compressibility; unstable slopes; low compacted density.	Moderate compressibility; moderate bearing capacity; unstable; slopes as much as 70 percent.	High seepage rate; slopes as much as 70 percent.	Low compacted density; high erodibility; subject to piping; unstable.
LNE	Good, except stony.	Fair: moderate compressibility; unstable slopes; low compacted density; stony.	Moderate compressibility; moderate bearing capacity; unstable slopes; slopes as much as 40 percent; stoniness.	Stoniness; slopes as much as 40 percent; high seepage rate.	Low compacted density; high erodibility; subject to piping; unstable; stoniness.
Lawai: LcB, LcC, LcD	Fair: low fertility.	Fair: subject to seepage.	Subject to seepage; slopes as much as 25 percent.	Moderate to moderately rapid permeability; slopes as much as 25 percent.	Poor workability. See also (4).
Leilehua: LeB, LeC	Fair: low fertility.	Good	(3)	Moderately rapid permeability.	(4)
Lihue: LhB, LhC, LhD, LhE2, LIB, LIC.	Good	Good	All features favorable, except slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	High shear strength; high compacted density.
Lolekaa: LoB, LoC, LoD, LoE, LoF.	Fair: low fertility.	Good	All features favorable, except slopes as much as 70 percent.	Moderately rapid permeability; slopes as much as 70 percent.	(4)

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	(2)	(3)	Very low fertility	Moderate bearing capacity; slopes as much as 15 percent.	Moderate: slopes generally more than 5 percent.
(2)	Moderate permeability; slopes as much as 40 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 70 percent.	Slopes as much as 70 percent; highly erodible.	Highly erodible; slopes as much as 70 percent.	Moderate bearing capacity; moderate compressibility; slopes as much as 70 percent.	Severe: slopes generally more than 10 percent.
(2)	Stoniness; slopes as much as 40 percent.	Highly erodible; stoniness; slopes as much as 40 percent.	Highly erodible; slopes as much as 40 percent; stoniness.	Moderate bearing capacity; moderate compressibility; stoniness; slopes as much as 40 percent.	Severe: slopes generally more than 10 percent.
Subject to seepage.	Slopes as much as 25 percent; subject to seepage.	Poor workability; subject to seepage; slopes as much as 25 percent.	Poor workability; slopes as much as 25 percent.	Subject to seepage; slopes as much as 25 percent.	Severe: subject to seepage; slopes as much as 25 percent.
(2)	Moderately rapid permeability; slopes as much as 12 percent.	(3)	Slopes as much as 12 percent.	Moderate shrink-swell potential; high shear strength; slopes as much as 12 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent.
(2)	Moderately rapid permeability; slopes as much as 40 percent.	All features favorable where slopes are not more than 20 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent; high shear strength.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Susceptible to sliding; slopes as much as 70 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Lualualei:					
LuA, LuB	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential.	Very plastic; high shrink-swell potential.	High shrink-swell potential; slow permeability.	Low shear strength; very plastic; high shrink-swell potential.
LvA, LvB, LPE	Poor: very sticky and very plastic; stony.	Poor: very plastic; high shrink-swell potential; stony.	Very plastic; high shrink-swell potential; stoniness; slopes as much as 35 percent.	High shrink-swell potential; slow permeability.	Low shear strength; very plastic; high shrink-swell potential; stoniness.
Mahana: MaC, MaD, MaD3, MaE, MaE3, McC2, McD2, McE2, MBL. For Badland part of MBL, see Badland.	Fair: low fertility.	Fair: erodible; unstable on steep slopes.	Slopes as much as 35 percent.	Moderately rapid permeability; slopes as much as 35 percent.	Poor stability; erodible; subject to piping.
Makaalae:					
MID, MWE	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential.	High shrink-swell potential; slopes as much as 40 percent.	High shrink-swell potential; slopes as much as 40 percent; moderate permeability.	High shrink-swell potential; poor workability; limited volume of material.
MJD	Poor: very sticky and very plastic; stony.	Poor: very plastic; high shrink-swell potential; stony.	High shrink-swell potential; slopes as much as 25 percent; stoniness.	High shrink-swell potential; slopes as much as 25 percent; moderate permeability.	High shrink-swell potential; poor workability; limited volume of material; stoniness.
Makalapa: MdB, MdC, MdD.	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential.	High shrink-swell potential; poor workability; slopes as much as 20 percent.	High shrink-swell potential; slopes as much as 20 percent; slow permeability.	High shrink-swell potential; low shear strength.
Makapili: MeB, MeC, MeD, MeE.	Fair: low fertility.	Good	All features favorable, except slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	([4])
Makawao: MfB, MfC	Fair: low fertility.	Fair to good: fair compaction characteristics.	([3])	Moderately rapid permeability.	Moderate compressibility; moderate shear strength.
Makaweli: MgB, MgC, MgD, MgE2, MhB, MhC, MhD, MhE.	Good, except stony in places.	Good, except stony in places.	Slopes as much as 35 percent.	Moderate permeability; slopes as much as 35 percent.	All features favorable, except stony in places.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Slow intake rate; high available water capacity.	Poor workability; high shrink-swell potential.	Poor workability; difficult to establish plants.	High shrink-swell potential; low shear strength.	Severe: slow permeability.
(2)	Slow intake rate; high available water capacity; slopes as much as 35 percent.	Poor workability; high shrink-swell potential; stoniness; slopes as much as 35 percent.	Poor workability; difficult to establish plants; stoniness; slopes as much as 35 percent.	High shrink-swell potential; low shear strength; stoniness; susceptible to sliding on slopes more than 15 percent.	Severe: slow permeability; slopes as much as 35 percent.
(2)	Slopes as much as 35 percent; erodible.	Slopes as much as 35 percent; erodible; susceptible to siltation.	Slopes as much as 35 percent; susceptible to siltation of channels.	Slopes as much as 35 percent.	Moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.
(2)	Slopes as much as 40 percent; moderate permeability.	Poor workability; slopes as much as 40 percent.	Poor workability; slopes as much as 40 percent.	High shrink-swell potential; slopes as much as 40 percent; low shear strength.	Severe: slopes generally more than 10 percent.
(2)	Slopes as much as 25 percent; stoniness.	Poor workability; slopes as much as 25 percent; stoniness.	Poor workability; stoniness; slopes as much as 25 percent.	High shrink-swell potential; slopes as much as 25 percent; stoniness.	Severe: slopes generally more than 10 percent.
(2)	Slow intake rate; slopes as much as 20 percent; high available water capacity.	Poor workability; high shrink-swell potential.	Poor workability; difficult to establish plants.	High shrink-swell potential; low shear strength; susceptible to sliding where slopes are more than 15 percent.	Severe: slow permeability.
(2)	(2)	Slopes as much as 40 percent.	Slopes as much as 40 percent; low fertility.	Slopes as much as 40 percent.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	High intake rate; moderately rapid permeability.	(3)	Slopes as much as 15 percent; low fertility.	Moderate shrink-swell potential; moderate shear strength.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Slopes as much as 35 percent; stony in places.	Susceptible to siltation; slopes as much as 35 percent; stony in places.	Susceptible to siltation of channels; difficult to establish plants; stony in places.	Slopes as much as 35 percent.	Slight on slopes of 0 to 6 percent; moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds: Reservoir areas	Farm ponds: Embankments
Makena: MXC	Good, except stony in places.	Fair: erodible; unstable slopes; stony in places.	Erodible; unstable slopes; stoniness.	Moderately rapid permeability.	Poor stability; poor compaction characteristics; erodible; piping hazard; stoniness in places.
Makiki: MkA, MlA	Fair: very sticky and very plastic; stony in places.	Fair: very sticky and very plastic; moderate shrink-swell potential; stony in places.	Very sticky and very plastic; moderate shrink-swell potential; stony in places.	Moderate shrink-swell potential; moderately rapid permeability; stony in places.	Moderate shrink-swell potential; fair compaction characteristics; stony in places.
Mala: MmA, MmB	Good	Good	Subject to flooding on 0 to 3 percent slopes.	Subject to flooding on 0 to 3 percent slopes; moderate permeability.	(3)
Malama: MYD	Poor: extremely stony; less than 10 inches to fragmental Aa lava.	Good: fragmental Aa lava at a depth of less than 10 inches.	Fragmental Aa lava.	Very rapidly permeable; fragmental Aa lava.	Fragmental Aa lava at a depth of less than 10 inches.
Mamala: MnC	Poor: coral below a depth of 8 to 20 inches.	Poor: less than 20 inches deep over coral; stony.	Coral at a depth of less than 20 inches; stoniness.	Coral at a depth of less than 20 inches; moderate permeability.	Limited volume of material; stoniness; coral at a depth of less than 20 inches.
Manana: MoB, MoC, MoD2, MpB, MpC, MpD, MpD2, MpE.	Good	Good	Slopes as much as 40 percent.	Slopes as much as 40 percent; moderate permeability.	Slopes as much as 40 percent.
Mokuleia: Mr, Ms, Mt, Mtb	Good to a depth of 20 inches; fair below 20 inches.	Good to a depth of 20 inches; fair below 20 inches; unstable; erodible.	Loose sand at a depth of 20 inches.	Rapid permeability below a depth of 20 inches.	Unstable; erodible material below a depth of 20 inches; subject to piping; poor compaction characteristics.
Mta	Fair: high water table.	Poor: high water table.	High water table	High water table	High water table; unstable; erodible material below a depth of 20 inches; poor compaction characteristics.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Complex slopes; stoniness; susceptible to wind erosion; erodible.	Stoniness in places; complex slopes; susceptible to wind erosion; erodible.	Highly erodible; stoniness in places; susceptible to siltation of channels; difficult to establish plants; slopes as much as 15 percent.	Stoniness in places; slopes as much as 15 percent.	Moderate on slopes of 3 to 15 percent; stoniness in places.
(2)	(2)	(2)	(2)	Moderate shrink-swell potential; moderate shear strength; stony in places.	Slight: moderately rapid permeability.
(2)	Slopes as much as 7 percent; moderate permeability.	Susceptible to siltation.	Susceptible to siltation of channels; difficult to establish plants.	Subject to flooding on 0 to 3 percent slopes; high shear strength.	Slight, except where subject to flooding.
(2)	Very high intake rate; very low available water capacity; extremely stony.	Fragmental Aa lava at a depth of less than 10 inches.	Fragmental Aa lava at a depth of less than 10 inches.	Extremely stony; fragmental Aa lava at a depth of less than 10 inches.	Severe: lack of filter material; may pollute underground water.
(2)	Coral at a depth of less than 20 inches; stoniness; slopes as much as 12 percent.	Coral at a depth of less than 20 inches; stoniness.	Coral at a depth of less than 20 inches; stoniness; slopes as much as 12 percent; difficult to establish plants.	Coral at a depth of less than 20 inches; slopes as much as 12 percent; stoniness.	Severe: coral at a depth of less than 20 inches.
(2)	Slopes as much as 40 percent; thin panlike layer at a depth of 15 to 50 inches.	All features favorable where slopes are not more than 20 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent; high shear strength.	Slight on slopes of 2 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Rapid permeability and low available water capacity below a depth of 20 inches.	Sand at a depth of less than 20 inches; erodible below a depth of 20 inches.	Sand at a depth of less than 20 inches; erodible below a depth of 20 inches.	Sand at a depth of less than 20 inches; low shrink-swell potential below a depth of 20 inches.	Slight: rapid permeability below a depth of 20 inches.
Low, wet areas; high water table.	High water table; needs drainage.	High water table; sand at a depth of less than 20 inches.	Sand at a depth of less than 20 inches; high water table.	High water table; sand at a depth of less than 20 inches.	Severe: poorly drained.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Suitability as a source of— Road fill	Soil features affecting— Highway location	Soil features affecting— Farm ponds: Reservoir areas	Soil features affecting— Farm ponds: Embankments
Molokai: MuA, MuB, MuB3, MuC, MuC3, MuD.	Good	Good	Slopes as much as 25 percent.	Slopes as much as 25 percent: moderate permeability.	(3)
MvD3	Poor: soft, weathered rock at a depth of 12 to 20 inches.	Good	Slopes of 15 to 25 percent.	Slopes of 15 to 25 percent; moderate permeability.	(3)
Naiwa: NAC, NAC3	Fair: low fertility.	Fair: erodible; unstable on steep slopes.	Slopes as much as 20 percent; unstable on moderately steep slopes; erodible.	Moderately rapid permeability; slopes as much as 20 percent.	Poor stability; erodible; subject to piping.
Niu: NcC, NcD, NcD2, NcE2.	Good	Good	Slopes as much as 35 percent.	Slopes as much as 35 percent; moderate permeability.	(3)
Niulii: NLE, NME	Fair: low fertility.	Poor: poor workability; low shear strength; low compacted density.	Slopes as much as 30 percent; low bearing capacity; high compressibility.	High seepage rate	Low compacted density; high compressibility; high shrinkage.
Nohili: Nh	Poor: very sticky and very plastic; 20 to 40 inches to high-lime layer.	Poor: high shrink-swell potential; poorly drained; poor workability; highly plastic.	High shrink-swell potential; poorly drained; low shear strength.	High shrink-swell potential; poorly drained; moderately slow permeability.	High shrink-swell potential; very plastic; poor workability; low shear strength.
Nonopahu: NnC	Poor: very sticky and very plastic.	Poor: highly plastic; high shrink-swell potential; poor workability.	High shrink-swell potential; low shear strength.	High shrink-swell potential; moderately slow permeability.	High shrink-swell potential; very plastic; poor workability; low shear strength.
NoC	Poor: very sticky and very plastic; stony.	Poor: highly plastic; high shrink-swell potential; poor workability; stony.	High shrink-swell potential; low shear strength; stoniness.	High shrink-swell potential; moderately slow permeability.	High shrink-swell potential; very plastic; poor workability; low shear strength; stoniness.
Oanapuka: OAD, OED	Poor: stony	Fair: erodible; unstable on steep slopes; slopes as much as 25 percent; stony.	Slopes as much as 25 percent; stoniness.	Slopes as much as 25 percent; moderately rapid permeability.	Poor compaction characteristics; piping hazard; stoniness.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	Slopes as much as 25 percent; moderate permeability.	Slopes as much as 25 percent; susceptible to siltation.	Susceptible to siltation of channels; slopes as much as 25 percent; difficult to establish plants.	Slopes as much as 25 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes of 15 to 25 percent; moderate permeability.	Slopes of 15 to 25 percent; susceptible to siltation.	Slopes of 15 to 25 percent; susceptible to siltation of channels; difficult to establish plants.	Slopes of 15 to 25 percent.	Severe: 15 to 25 percent slopes.
(2)	Slopes as much as 20 percent; erodible.	Slopes as much as 20 percent; erodible; subject to siltation.	Slopes as much as 20 percent; susceptible to siltation of channels.	Slopes as much as 20 percent.	Moderate: slopes generally 7 to 15 percent.
(2)	Moderate permeability; slopes as much as 35 percent.	Slopes as much as 35 percent.	Slopes as much as 35 percent.	Slopes as much as 35 percent.	Moderate on slopes of 6 to 12 percent; severe on slopes of more than 12 percent.
(2)	Slopes as much as 30 percent; moderately rapid permeability.	Slopes as much as 30 percent; poor workability.	Slopes as much as 30 percent; poor workability.	Low bearing capacity; high compressibility; susceptible to sliding on steep slopes; slopes as much as 30 percent.	Severe: slopes generally more than 10 percent.
Moderately slow permeability; high water table.	Moderately slow permeability; high water table; high available water capacity.	Poorly drained; poor workability; high shrink-swell potential.	Poorly drained; poor workability.	Poorly drained; high shrink-swell potential; low shear strength.	Severe: poorly drained.
Moderately slow permeability.	Moderately slow permeability; slopes as much as 10 percent.	Poor workability; high shrink-swell potential.	Poor workability; high shrink-swell potential.	High shrink-swell potential; low shear strength; moderately well drained; slopes as much as 10 percent.	Severe: moderately well drained; moderately slow permeability.
Moderately slow permeability.	Moderately slow permeability; stoniness; slopes as much as 12 percent.	Poor workability; high shrink-swell potential.	Poor workability; high shrink-swell potential; stoniness.	High shrink-swell potential; low shear strength; moderately well drained; stoniness; slopes as much as 12 percent.	Severe: moderately well drained; moderately slow permeability.
(2)	Stoniness; slopes as much as 25 percent; erodible.	Stoniness; slopes as much as 25 percent; erodible; susceptible to siltation.	Stoniness; slopes as much as 25 percent; susceptible to siltation of channels; difficult to establish plants.	Stoniness; slopes as much as 25 percent; moderate compressibility.	Severe: stoniness; slopes generally more than 10 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of— Topsoil	Suitability as a source of— Road fill	Soil features affecting— Highway location	Soil features affecting— Farm ponds: Reservoir areas	Soil features affecting— Farm ponds: Embankments
Oleło: OFC	Fair: low fertility.	Good: high shear strength; good compaction characteristics.	Slopes as much as 15 percent; high bearing capacity.	Slopes as much as 15 percent: moderately rapid permeability.	(1)
Oli: OID, OMB, OME, OMF.	Fair: low fertility.	Fair: erodible; unstable on steep slopes.	Slopes as much as 70 percent.	Slopes as much as 70 percent; moderately rapid permeability.	Poor stability; poor compaction characteristics; erodible; subject to piping.
Olinda: ONC, OND, ONE.	Good	Fair: high organic-matter content; fair compaction characteristics.	Slopes as much as 40 percent; low shear strength; moderate compressibility.	Slopes as much as 40 percent; moderately rapid permeability.	Low shear strength; low compacted density; moderate compressibility.
Olokui: OOE	Poor: always wet; very low fertility.	Poor: poor compaction.	Wetness; low bearing capacity; subject to seepage.	Wetness; high seepage rate.	Poor compaction characteristics; wetness; low shear strength.
Opihikao: OPD	Poor: bedrock at a depth of less than 10 inches; extremely rocky.	Poor: organic material; bedrock at a depth of less than 10 inches.	Bedrock at a depth of less than 10 inches.	Bedrock at a depth of less than 10 inches.	(2)
Paaiki: PGE, PGF	Fair: low fertility.	Fair: unstable on steep slopes; erodible.	Slopes as much as 70 percent.	Moderately rapid permeability; slopes as much as 70 percent.	Poor stability; erodible; subject to piping.
Paaloa: PaC, PbC	Fair: low fertility.	Good	(3)	Moderately rapid permeability; slopes as much as 12 percent.	(1)
Paia: PcB, PcC, PcC2	Good	Good	Slopes as much as 15 percent.	Moderate permeability; slopes as much as 15 percent.	(3)
Pakala:					
PdA, PdC	Good	Good	Subject to local flooding.	Moderate permeability; slopes as much as 10 percent.	Erodible where exposed.
PHXC	Good, except stony.	Good, except stony.	Subject to local flooding; stoniness.	Moderate permeability; stoniness.	Stoniness; erodible where exposed.
Pamoa: PID, PID2, PJD2.	Fair: very sticky and very plastic.	Poor: highly plastic; poor workability; high shrink-swell potential.	High shrink-swell potential; low shear strength; slopes as much as 20 percent.	High shrink-swell potential; moderately slow permeability.	High shrink-swell potential; low shear strength; poor workability.
Pane: PXD	Good	Fair: low compacted density; moderate compressibility.	Slopes as much as 25 percent; moderate compressibility.	Slopes as much as 25 percent; moderately rapid permeability.	Low compacted density; moderate shear strength.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	Degree and kind of limitations for septic tank filter fields
(2)	(2)	(3)	Slopes as much as 15 percent.	Slopes as much as 15 percent; high shear strength.	Moderate: slopes generally more than 7 percent.
(2)	Slopes as much as 70 percent; erodible.	Slopes as much as 70 percent; erodible; susceptible to siltation.	Slopes as much as 70 percent; susceptible to siltation of channels.	Slopes as much as 70 percent.	Moderate on slopes of 3 to 10 percent; severe on slopes of more than 10 percent.
(2)	Slopes as much as 40 percent; moderately rapid permeability.	Slopes as much as 40 percent; erodible.	Slopes as much as 40 percent; erodible.	Slopes as much as 40 percent; moderate compressibility; low shear strength.	Moderate on slopes of 4 to 12 percent; severe on slopes of more than 12 percent.
(2)	(2)	(2)	(2)	Low shear strength; wetness; moderate compressibility; subject to seepage.	Severe: always wet; poorly drained; subject to seepage.
(2)	Bedrock at a depth of less than 10 inches; organic material.	(2)	(2)	Bedrock at a depth of less than 10 inches.	Severe: less than 10 inches of soil material over bedrock.
(2)	Slopes as much as 70 percent; moderately rapid permeability.	Slopes as much as 70 percent; erodible.	Slopes as much as 70 percent.	Slopes as much as 70 percent; susceptible to sliding on steep slopes.	Severe: slopes generally more than 10 percent.
(2)	Moderately rapid permeability; slopes as much as 12 percent.	(3)	Slopes as much as 12 percent.	Slopes as much as 12 percent.	Moderate: slopes generally 5 to 10 percent.
(2)	Moderate permeability; slopes as much as 15 percent.	(3)	Slopes as much as 15 percent; difficult to establish plants.	Slopes as much as 15 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Slopes as much as 10 percent; moderate permeability.	(3)	Difficult to establish plants; slopes as much as 10 percent.	Subject to local flooding; high bearing capacity; slopes as much as 10 percent.	Slight on slopes of 0 to 2 percent; moderate on slopes of 2 to 10 percent.
(2)	Stoniness; slopes as much as 12 percent.	Stoniness	Stoniness; difficult to establish plants; slopes as much as 12 percent.	Stoniness; subject to local flooding; slopes as much as 12 percent.	Moderate: slopes generally more than 5 percent; stoniness.
(2)	Slopes as much as 20 percent; moderately slow permeability.	High shrink-swell potential; poor workability.	Poor workability; slopes as much as 20 percent; difficult to establish plants.	High shrink-swell potential; low shear strength; slopes as much as 20 percent.	Severe: moderately slow permeability in subsoil; slopes generally more than 10 percent.
(2)	Slopes as much as 25 percent; moderately rapid permeability; rapid intake rate.	Slopes as much as 25 percent.	Slopes as much as 25 percent.	Moderate compressibility; moderate shear strength; slopes as much as 25 percent.	Severe: slopes generally more than 10 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Papaa: PYD, PYE, PYF	Poor: very sticky and very plastic.	Poor: very plastic; high shrink-swell potential.	Very plastic; high shrink-swell potential; slopes as much as 70 percent.	High shrink-swell potential; slow permeability; slopes as much as 70 percent.	Low shear strength; very plastic; high shrink-swell potential.
Paumalu: PeB, PeC, PeD, PeE, PeF, PZ. For Badland part of PZ, see Badland.	Fair: low fertility.	Good	Slopes as much as 70 percent.	Moderately rapid permeability; slopes as much as 70 percent.	(4)
Pauwela: PfB, PfC, PfD	Fair: low fertility.	Good	Slopes as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	(4)
Pearl Harbor: Ph	Poor: wet; very sticky and very plastic.	Poor: very poorly drained; high shrink-swell potential; poor workability.	High shrink-swell potential; very poorly drained; low bearing capacity.	Very poorly drained; very slow permeability; high water table.	High shrink-swell potential; very poorly drained; poor workability.
Pohakupu: PkB, PkC	Good	Good	Slopes as much as 15 percent.	Moderately rapid permeability; slopes as much as 15 percent.	(3)
Pooku: PlB, PlD, PmB, PmC, PmD, PmE.	Poor: low fertility.	Good	Slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	(4)
Puhi: PnA, PnB, PnC, PnD, PnE.	Fair; low fertility	Good	Slopes as much as 40 percent.	Moderately rapid permeability; slopes as much as 40 percent.	High shear strength; high compacted density.
Pulehu: PoB, PpA, PpB, PrA, PrB, PsA, PtA, PtB, PuB.	Good	Good	Subject to flooding in low areas.	Moderate permeability; subject to to flooding in low areas.	Good compaction characteristics; high shear strength.
PoaB, PvC	Good, except stony.	Good, except stony.	Subject to flooding in low areas.	Moderate permeability; subject to flooding in low areas.	Good compaction characteristics; high shear strength; stoniness.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Slow intake rate; slopes as much as 70 percent.	Poor workability; high shrink-swell potential; slopes as much as 70 percent.	Poor workability; slopes as much as 70 percent.	High shrink-swell potential; low shear strength; slopes as much as 70 percent; susceptible to sliding where slopes are more than 15 percent.	Severe: slow permeability; slopes generally more than 10 percent.
(2)	Moderately rapid permeability; slopes as much as 70 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent; moderate shrink-swell potential in surface layer.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	Clayey; slopes as much as 25 percent.	Clayey; slopes as much as 25 percent.	Slopes as much as 25 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent: severe on slopes of more than 15 percent.
Very slow permeability; high water table.	High water table; very slow permeability.	High water table; high shrink-swell potential; poor workability.	High water table; poor workability; high shrink-swell potential.	High water table; high shrink-swell potential; low bearing capacity.	Severe: very poorly drained; very slow permeability.
(2)	Slopes as much as 15 percent; moderately rapid permeability.	(3)	Slopes as much as 15 percent.	High shear strength; slopes as much as 15 percent.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent.
(2)	(2)	Slopes as much as 40 percent; moderately rapid permeability; low fertility.	Slopes as much as 40 percent; low fertility.	Slopes as much as 40 percent.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 40 percent; moderately rapid permeability.	Slopes as much as 40 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Slopes as much as 7 percent; moderate permeability.	Subject to stream overflow in low areas.	Slopes as much as 7 percent.	High shear strength; subject to flooding in low areas.	Slight on slopes of 0 to 7 percent; moderate in low areas; subject to occasional flooding.
(2)	Slopes as much as 12 percent; stoniness.	Subject to stream overflow in low areas; stoniness.	Slopes as much as 12 percent; stoniness.	High shear strength; subject to flooding in low areas; stoniness.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 12 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Puuone: PZUE	Poor: low fertility; low available water capacity; cemented sand below a depth of 20 to 40 inches.	Poor: unstable on slopes erodible; cemented sand below a depth of 20 to 40 inches.	Slopes as much as 30 percent; unstable; erodible.	Slopes as much as 30 percent; shallow over cemented sand; rapid permeability above and below cemented sand.	Sandy material; rapid seepage rate; subject to piping; poor stability.
Puu Opae: PwC, PwD, PwE.	Fair: low fertility.	Good	Slopes as much as 40 percent.	Slopes as much as 40 percent; moderately rapid permeability.	(3)
Puu Pa: PZVE	Poor: stony; limited soil material.	Fair: erodible; unstable on steep slopes; slopes as much as 40 percent; stony.	Slopes as much as 40 percent; stoniness.	Slopes as much as 40 percent; moderately rapid permeability.	Poor compaction; piping hazard; stoniness.
Tantalus: TAE, TAF, TCC, TCE.	Fair to a depth of 15 inches: low fertility.	Fair: low compacted density; moderate compressibility.	Slopes as much as 70 percent; moderate compressibility; unstable on steep slopes.	Slopes as much as 70 percent; moderately rapid permeability.	Low compacted density; fine cinders below a depth of 15 to 36 inches.
Tropaquepts: TR	Poor: always wet.	Poor: always wet.	Wetness; poor workability.	High water table; slow permeability.	Poor workability; wetness.
Tropaquods: rTO	Poor: always wet.	Poor: always wet; accessibility is difficult.	Wetness; organic material.	Wetness; organic material.	(2)
Tropohumults: rTP. For Dystrandepts part of rTP, see Dystrandepts.	Good	Good	Slopes as much as 90 percent.	Slopes as much as 90 percent; moderately rapid permeability.	Slopes as much as 90 percent.
Ulupalakua: ULD	Good to a depth of 24 inches; poor below 24 inches.	Fair: moderate compressibility; low compacted density.	Slopes as much as 25 percent; moderate compressibility.	Slopes as much as 25 percent; moderately rapid permeability.	Low compacted density; fine gravel-size cinders at a depth of 24 to 40 inches.
Uma: UME, UMF, URD.	Fair: low available water capacity; erodible; unstable on steep slopes.	Unstable on steep slopes; erodible; moderate compacted density.	Slopes as much as 70 percent; unstable on steep slopes; erodible.	Very high seepage rate; slopes as much as 70 percent.	Unstable on slopes; high erodibility; poor compaction characteristics.
Uwala: UwB, UwC, UwC3.	Good	Good	Slopes as much as 15 percent.	Slopes as much as 15 percent; moderate permeability.	(3)

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Rapid intake rate; low available water capacity; slopes as much as 30 percent.	Sandy material; erodible; slopes as much as 30 percent.	Erodible; slopes as much as 30 percent; difficult to establish plants.	Slopes as much as 30 percent; cemented sand at a depth of 20 to 40 inches.	Severe: 20 to 40 inches to cemented sand; slopes generally more than 10 percent.
(2)	Slopes as much as 40 percent; moderately rapid permeability.	All features favorable where slopes are not more than 20 percent.	Slopes as much as 40 percent.	Slopes as much as 40 percent; high shear strength.	Moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Stoniness; slopes as much as 40 percent; erodible.	Stoniness; slopes as much as 40 percent; erodible; susceptible to siltation.	Stoniness; slopes as as much 40 percent; susceptible to siltation; difficult to establish plants.	Stoniness: slopes as much as 40 percent; moderate compressibility.	Severe: slopes generally more than 10 percent; stoniness.
(2)	Slopes as much as 70 percent; moderately rapid permeability; rapid intake rate.	Slopes as much as 70 percent; fine cinders below a depth of 15 to 36 inches.	Slopes as much as 70 percent; fine cinders below a depth of 15 to 36 inches.	Moderate compressibility; slopes as much as 70 percent; susceptible to sliding.	Severe: slopes generally more than 10 percent; lack of filter material.
Slow permeability; high water table.	Poorly drained; slow permeability; high water table.	Poor workability; high water table.	Poorly drained; high water table.	Slow permeability; high water table; low shear strength.	Severe: high water table.
(2)	(2)	(2)	(2)	Wetness; moderate to high compressibility.	Severe: always wet.
(2)	Slopes as much as 90 percent.	(2)	Slopes as much as 90 percent.	Slopes as much as 90 percent.	Severe: slopes more than 30 percent.
(2)	Slopes as much as 25 percent; moderately rapid permeability; rapid intake rate.	Slopes as much as 25 percent; fine gravel-size cinders at a depth of 24 to 40 inches.	Slopes as much as 25 percent; fine gravel-size cinders at a depth of 24 to 40 inches.	Moderate compressibility; moderate shear strength; slopes as much as 25 percent.	Severe: slopes generally more than 10 percent; lack of filter material.
(2)	Very high intake rate; rapid permeability; slopes as much as 70 percent; erodible.	Slopes as much as 70 percent; erodible; fine gravel-size cinders at a depth of less than 10 inches.	Slopes as much as 70 percent; fine gravel-size cinders at a depth of less than 10 inches; difficult to establish plants.	Unstable on slopes; erodible; slopes as much as 70 percent.	Severe: slopes more than 15 percent; lack of filter material.
(2)	Slopes as much as 15 percent; moderate permeability.	Slopes as much as 15 percent; susceptible to siltation.	Susceptible to siltation of channels; slopes as much as 15 percent; difficult to establish plants.	Slopes as much as 15 percent.	Slight on slopes of 2 to 7 percent; moderate on slopes of 7 to 15 percent.

TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Wahiawa: WaA, WaB, WaC, WaD2.	Good	Good	All features favorable, except where slopes are as much as 25 percent.	Moderately rapid permeability; slopes as much as 25 percent.	(3)
Wahikuli: WbB, WcB	Fair to good: stony in places; bedrock at a depth of 20 to 40 inches.	Fair to good: stony in places; bedrock at a depth of 20 to 40 inches.	Bedrock at a depth of 20 to 40 inches; slopes as much as 15 percent.	Moderate permeability; bedrock at a depth of 20 to 40 inches; slopes as much as 15 percent.	Bedrock at a depth of 20 to 40 inches; stoniness in places.
Waiakoa: WeB, WeC, WfB, WgB, WgC, WhB, WhC, WlD2.	Good, except cobbly or stony in places.	Good, except cobbly or stony in places.	Bedrock at a depth of 20 to 40 inches; slopes as much as 25 percent; cobbly or stony in places.	Moderate permeability; bedrock at a depth of 20 to 40 inches.	Poor stability; piping hazard; bedrock at a depth of 20 to 40 inches.
Waialeale: rWAF	Poor: always wet; saprolite below a depth of 10 to 22 inches.	Poor: always wet; low shear strength; low bearing capacity.	Wetness; low shear strength; slopes as much as 70 percent.	Slopes of 30 to 70 percent; high seepage rate.	Wetness; poor compaction characteristics; low shear strength.
Waialua: WkA, WkB, WlB, WlE, WmD, WnB.	Fair: very sticky and very plastic; stony in places.	Poor: very sticky and very plastic; moderate shrink-swell potential; stony in places.	Moderate shrink-swell potential; low shear strength; slopes as much as 30 percent; stony in places.	Moderate permeability; moderate shrink-swell potential; slopes as much as 30 percent.	Moderate shrink-swell potential; low shear strength; stoniness in places.
Waiawa: WJF	Very poor: very sticky and very plastic; rocky; less than 20 inches deep.	Very poor: very sticky and very plastic; rocky; bedrock at a depth of less than 20 inches.	Slopes 30 to 80 percent; bedrock at a depth of less than 20 inches; high shrink-swell potential; rockiness.	(2)	High shrink-swell potential; limited material; rockiness; low shear strength.
Waihuna: WoA, WoB, WoC, WoD, WohB.	Poor: very sticky and very plastic.	Poor: high shrink-swell potential; very sticky and very plastic.	High shrink-swell potential; slopes as much as 25 percent; low shear strength.	High shrink-swell potential; slopes as much as 25 percent; moderately slow permeability.	High shrink-swell potential; clayey; low shear strength.
Waikane: WpB, WpC, WpE, WpF, WpF2, WpaE.	Fair: low fertility; stony in places.	Good	Slopes as much as 70 percent; stony in places.	Slopes as much as 70 percent; moderately rapid permeability.	(4)

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Moderately rapid permeability; slopes as much as 25 percent.	All features favorable where slopes are less than 20 percent.	Slopes as much as 25 percent.	Slopes as much as 25 percent; high shear strength.	Slight on slopes of 0 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	Moderate permeability; slopes as much as 15 percent; stoniness in places.	Bedrock at a depth of 20 to 40 inches; stoniness in places.	Bedrock at a depth of 20 to 40 inches; slopes as much as 15 percent; stoniness in places.	Bedrock at a depth of 20 to 40 inches; slopes as much as 15 percent; stoniness in places.	Severe: bedrock at a depth of less than 40 inches.
(2)	Erodible; slopes as much as 25 percent; bedrock at a depth of 20 to 40 inches.	Susceptible to siltation; bedrock at a depth of 20 to 40 inches; cobbly or stony in places.	Susceptible to siltation of channels; difficult to establish plants; slopes as much as 25 percent; cobbly or stony in places.	Slopes as much as 25 percent; bedrock at a depth of 20 to 40 inches.	Severe: bedrock at a depth of 20 to 40 inches.
Wetness; saprolite at a depth of 10 to 22 inches.	(2)	Slopes of 30 to 70 percent; wetness.	Slopes of 30 to 70 percent; wetness.	Slopes of 30 to 70 percent; wetness; low shear strength; susceptible to sliding.	Severe: slopes 30 to 70 percent; always wet; saprolite at a depth of 10 to 22 inches.
Moderate permeability.	Moderate permeability; slopes as much as 30 percent; stoniness in places.	Moderate shrink-swell potential; clayey; stoniness in places.	Slopes as much as 30 percent; stoniness in places.	Moderate shrink-swell potential; low shear strength; stoniness in places.	Slight on slopes of 0 to 8 percent; moderate permeability. Moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.
(2)	(2)	(2)	(2)	High shrink-swell potential; susceptible to sliding; slopes of 30 to 80 percent; rockiness; low shear strength.	Severe: bedrock at a depth of less than 20 inches; slopes of 30 to 80 percent.
Moderately slow permeability.	Slow intake rate; slopes as much as 25 percent; moderately slow permeability.	Clayey; high shrink-swell potential; slopes as much as 25 percent.	Clayey; slopes as much as 25 percent.	High shrink-swell potential; low shear strength; slopes as much as 25 percent.	Severe: moderately slow permeability.
(2)	(2)	All features favorable where slopes are less than 20 percent.	Slopes as much as 70 percent.	Slopes as much as 70 percent.	Slight on slopes of 3 to 8 percent; moderate on slopes of 8 to 15 percent; severe on slopes of more than 15 percent.

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TABLE 3.—*Engineering*

Soil series and map symbols	Suitability as a source of—		Soil features affecting—		
	Topsoil	Road fill	Highway location	Farm ponds	
				Reservoir areas	Embankments
Waikapu: WrA, WrB, WrB3, WrC3.	Good	Good	Slopes as much as 15 percent.	Moderate permeability.	(3)
Waikomo: Ws, Wt, Wu	Poor: bedrock at a depth of less than 20 inches; stony and rocky.	Poor: bedrock at a depth of less than 20 inches; stony and rocky.	Bedrock at a depth of less than 20 inches; stoniness and rockiness.	Bedrock at a depth of less than 20 inches; moderate permeability.	Stoniness; rockiness; limited volume of material; bedrock at a depth of less than 20 inches.
Wailuku: WvB, WvC, WwC.	Good	Good	Slopes as much as 15 percent.	Slopes as much as 15 percent; moderate permeability.	(3)
Wainee: WxB, WxC, WyB, WyC.	Poor: stony; limited volume of soil material.	Poor: stony; limited volume of soil material.	Stoniness; slopes as much as 15 percent.	Stoniness; slopes as much as 15 percent; moderately rapid permeability.	Stoniness; limited volume of soil material.
Waipahu: WzA, WzB, WzC.	Fair: sticky and plastic.	Poor: high shrink-swell potential; poor workability; low shear strength.	High shrink-swell potential; low shear strength; slopes as much as 12 percent.	Moderately slow permeability; high shrink-swell potential.	High shrink-swell potential; low shear strength.

[1] Engineers and others should not apply specific values to the estimates given for bearing capacity of soils.
[2] Practice not applicable or not needed.

interpretations—Continued

Soil features affecting—Continued					Degree and kind of limitations for septic tank filter fields
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Foundations for low buildings [1]	
(2)	Slopes as much as 15 percent; moderate permeability.	Susceptible to siltation.	Susceptible to siltation of channels; difficult to establish plants; slopes as much as 15 percent.	Slopes as much as 15 percent.	Slight on slopes of 0 to 7 percent; moderate on slopes of 7 to 15 percent.
(2)	Bedrock at a depth of less than 20 inches; stoniness and rockiness.	Bedrock at a depth of less than 20 inches; stoniness and rockiness.	Bedrock at a depth of less than 20 inches; stoniness and rockiness.	Bedrock at a depth of less than 20 inches; stoniness and rockiness.	Severe: bedrock at a depth of less than 20 inches.
(2)	Moderate permeability; slopes as much as 15 percent.	Slopes as much as 15 percent.	Slopes as much as 15 percent.	Slopes as much as 15 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 8 to 15 percent.
(2)	Stoniness; slopes as much as 15 percent.	Stoniness; slopes as much as 15 percent.	Stoniness; slopes as much as 15 percent.	Stoniness; slopes as much as 15 percent.	Slight on slopes of 3 to 7 percent; moderate on slopes of 7 to 15 percent.
Moderately slow permeability.	Moderately slow permeability; slopes as much as 12 percent.	Clayey; slopes as much as 12 percent.	Difficult to establish plants; slopes as much as 12 percent.	Low shear strength; high shrink-swell potential; slopes as much as 12 percent.	Severe: moderately slow permeability; slopes as much as 12 percent.

[3] All features favorable.
[4] Under field conditions, it is difficult to reduce moisture content to that required for favorable compaction.

TABLE 4.—*Engineering test data*

[Tests were performed by the Bureau of Public Roads]

Soil name and location	Parent material	BPR report number	Depth	Mechanical analysis: Percentage passing sieve— No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	Percentage smaller than— 0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	Liquid limit	Plasticity index	Classification: AASHO	Unified
		S44-	In.								Pct.			
Lualualei clay: 0.08 mile west of entrance gate to Lualualei Naval Radio Station and southwest along fence, 100 feet north toward radio tower. Island of Oahu.	Alluvium from basic igneous rock.	790	1–10	-----	-----	99	97	91	81	73	60	30	A-7-6(20)	MH
		791	22–30	-----	-----	99	98	92	82	74	76	49	A-7-6(20)	CH
Molokai silty clay loam: One mile southwest of Kualapuu in block 4, 0.32 mile northeast of junction 47 and east of Highway 47. Island of Molokai.	Basic igneous rock.	784	0–11	100	100	92	89	80	62	52	44	16	A-7-6(11)	ML-CL
		785	37–63	100	97	85	80	62	41	33	46	16	A-7-5(12)	ML
Naiwa silty clay loam: 1.45 miles north of Waihee School, 0.2 mile west and 0.3 mile south on trail up side of hill. Island of Maui.	Basic igneous rock.	780	0–4	100	98	94	92	82	64	36	40	8	A-4(8)	ML
		781	14–26	100	99	97	97	96	96	83	36	7	A-4(8)	ML
Wahiawa silty clay: 0.5 mile southeast of Waipio. Island of Oahu.	Basic igneous rock.	798	0–16	100	98	92	91	89	86	81	62	24	A-7-5(18)	MH
		799	32–60	-----	-----	------	100	99	98	94	68	29	A-7-5(20)	MH

The USDA texture is the apparent field texture. By standards of mechanical analysis, most soils described in this survey are clay.

Permeability refers only to movement of water downward through undisturbed and uncompacted soil. It does not include lateral seepage. The estimates are based on soil structure, soil porosity, and data from a limited number of permeability tests made on undisturbed cores. Plowpans, surface crusts, and other properties resulting from use of the soils were not considered.

Estimated available water capacity is an estimate of the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The estimates are based on extensive laboratory tests, on field experience, and on soil properties.

Reaction is the degree of acidity or alkalinity of a soil, expressed as a pH value. The pH value and relative terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is an indication of the volume change to be expected of the soil material with changes in moisture content. A high shrink-swell potential indicates hazards to the maintenance of structures constructed in, on, or with such materials. Generally, soils classified CH have a high shrink-swell potential, and those classified ML or SP have a low shrink-swell potential. Many of the soils classified OH occur in high rainfall areas and are continuously wet throughout the year. These soils exhibit high shrinkage and low swell potential when placed in a dry environment.

Corrosivity, as used here, indicates the potential danger to uncoated metal or concrete structures through chemical action that dissolves or weakens the structural material. Structural material may corrode when buried in soil, and a given material corrodes in some kinds of soil more rapidly than in others. Extensive installations that intersect soil boundaries or soil horizons are more likely to be damaged by corrosion than are installations entirely in one kind of soil or soil horizon.

Engineering interpretations

Table 3 contains information useful to engineers and others who plan to use soil material in construction of highways, farm facilities, buildings, and sewage disposal systems. Detrimental or undesirable features are emphasized, but some of the important desirable features are also listed. The ratings and other interpretations in this table are based on estimated engineering properties shown in table 2, on available test data, and on field experience. Although the information applies only to the soil depths indicated in table 2, it is reasonably reliable to a depth of about 6 feet in most soils and several more for some.

The Jaucas and Puuone soils, the subsoil of the Mokuleia soils, Beaches, and Dune land are good sources of calcareous sand. Crushed hard rock or coral is the best source of gravel, but there are a few sources of gravel adjacent to intermittent streams associated with Kawaihapai and Pulehu soils.

Topsoil is used to designate a fertile soil or soil material, ordinarily rich in organic-matter content, used as a topdressing for lawns, gardens, and roadbanks. The ratings indicate suitability for such use. Soils that have low inherent fertility are rated according to their response to fertilization.

Road fill refers to material used to build embankments. The ratings indicate performance of soil material moved from borrow areas for these purposes.

Highway location is influenced by features of the undisturbed soil that affect construction and maintenance of highways. The soil features described, favorable as well as unfavorable, are the principal ones that affect location of highways.

Farm pond reservoir areas are affected mainly by loss of water through seepage, and the soil features described are those that influence such seepage.

Farm pond embankments serve as dams. The soil features given, of both subsoil and substratum, are those important in the use of the soils for constructing embankments.

Agricultural drainage is affected by permeability, texture, structure, depth to the water table, and other soil properties that affect the installation and performance of surface and subsurface drainage structures.

Irrigation is affected by texture, structure, permeability, available water capacity, slope, and other soil factors that influence suitability for irrigation.

Foundations for low buildings are affected chiefly by features of the undisturbed soil that influence the capacity of the soil to support low buildings that have a normal foundation load. Specific values of bearing strength are not given or implied.

Septic tank filter fields are affected mainly by permeability, depth to the water table, susceptibility to flooding, depth to bedrock, and slope. The degree and the principal kinds of limitations are given.

Engineering test data

Table 4 shows the results of engineering tests performed by the Bureau of Public Roads on important soils on the islands of Oahu, Maui, and Molokai. The table shows the specific location where samples were taken, the depth to which sampling was done, and the results of tests to determine particle-size distribution and other properties significant in soil engineering.

Mechanical analysis shows the percentages, by weight, of soil particles that pass sieves of specified sizes. Sand and other coarser materials do not pass through the No. 200 sieve, but silt and clay do. Silt is that material larger than 0.002 millimeter in diameter that passes through the No. 200 sieve, and clay is that fraction smaller than 0.002 millimeter in diameter that passes through the No. 200 sieve. The clay fraction was determined by the hydrometer method.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material passes from semisolid to plastic. The liquid limit is the moisture content at which the material changes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Classification, Genesis, and Morphology of the Soils [5]

In this survey 127 soil series are described. To understand why there should be so many, it is necessary to picture the pattern of soils on the landscape and to understand the similarities and differences among soils. The pattern of soils is a result of the interaction of the factors of soil genesis: climate, vegetation, parent material, relief, and drainage, over a period of time. The similarities and differences among soils and the reasons for them can be examined by classifying the soils into groups.

Soils are classified according to their observable and measurable properties. The properties chosen are primarily those that permit the grouping of soils that are genetically similar. Soil classification enables us to understand the pattern of soils and the ways in which they relate to each other.

The scheme of classification used in this survey was adopted for general use by the National Cooperative Soil Survey in 1965 and supplemented in September 1968 (*17*). It replaces a system that was adopted in 1938 and later revised (*15*, *14*). The system incorporates knowledge gained through research over the last 25 years and is much more precise and more complex than the older system. It is under continual study. Readers interested in the development of the system should refer to the latest literature available (*12*).

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 5 shows the classification of each soil series on the islands by family, by subgroup and great group, and by order, according to the current system. It also shows one category—the great soil group—of the 1938 system.

[5] By L. D. SWINDALE, associate director, Hawaii Agricultural Experiment Station, and professor of soil science, University of Hawaii, and members of the Soil Survey Correlation Staff.

TABLE 5.—*Classification of soil series by higher categories*

Series	Family	Subgroup and great group	Order	Great soil group (1938 classification)
Alae	Medial, isohyperthermic	Mollic Vitrandepts	Inceptisols	Alluvial soils.
Alaeloa	Clayey, oxidic, isohyperthermic	Orthoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Alakai	Clayey, kaolinitic, dysic, isomesic	Terric Troposaprists	Histosols	Bog soils.
Amalu	Fine, mixed, acid, isomesic	Histic Placaquepts	Inceptisols	Hydrol Humic Latosols.
Ewa	Fine, kaolinitic, isohyperthermic	Aridic Haplustolls	Mollisols	Low-Humic Latosols.
Haiku	Clayey, ferritic, isothermic	Humoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Halawa	Clayey, oxidic, isothermic	Orthoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Haleiwa	Fine, mixed, isohyperthermic	Typic Haplustolls	Mollisols	Alluvial soils.
Halii	Clayey, ferritic, isothermic	Typic Gibbsihumox	Oxisols	Humic Ferruginous Latosols.
Haliimaile	Fine, kaolinitic, isothermic	Ustoxic Humitropepts	Inceptisols	Low-Humic Latosols.
Hamakuapoko	Clayey, oxidic, isothermic	Orthoxic Tropohumults	Ultisols	Low-Humic Latosols.
Hana	Thixotropic, isohyperthermic	Typic Hydrandepts	Inceptisols	Humic Latosols.
Hanalei	Fine, mixed, nonacid, isohyperthermic.	Typic Tropaquepts	Inceptisols	Alluvial soils.
Hanamaulu	Fine, oxidic, isohyperthermic	Oxic Humitropepts	Inceptisols	Humic Latosols.
Helemano	Clayey, kaolinitic, isohyperthermic	Tropeptic Haplustox	Oxisols	Low-Humic Latosols.
Hihimanu	Fine, oxidic, isothermic	Ustoxic Humitropepts	Inceptisols	Humic Latosols.
Holomua	Clayey, kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Honolua	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Honomanu	Thixotropic, isothermic	Typic Hydrandepts	Inceptisols	Hydrol Humic Latosols.
Honouliuli	Very-fine, kaolinitic, isohyperthermic.	Typic Chromusterts	Vertisols	Gray Hydromorphic soils.
Hoolehua	Fine, kaolinitic, isohyperthermic	Aridic Haplustolls	Mollisols	Low-Humic Latosols.
Hulua	Fine, oxidic, acid, isothermic	Typic Placaquepts	Inceptisols	Gray Hydromorphic soils.
Iao	Fine, kaolinitic, isohyperthermic	Typic Haplustolls	Mollisols	Alluvial soils.
Io	Medial over cindery, isothermic	Typic Eutrandepts	Inceptisols	Reddish Prairie soils.
Ioleau	Clayey, oxidic, isohyperthermic	Orthoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Jaucas	Carbonatic, isohyperthermic	Typic Ustipsamments	Entisols	Regosols.
Kaena	Very-fine, montmorillonitic, isohyperthermic.	Typic Pelluderts	Vertisols	Gray Hydromorphic soils.
Kahana	Clayey, kaolinitic, isothermic	Tropeptic Haplustox	Oxisols	Low-Humic Latosols.
Kahanui	Clayey, ferritic, isothermic	Petroferric Acrohumox	Oxisols	Humic Ferruginous Latosols.
Kailua	Thixotropic, isothermic	Typic Hydrandepts	Inceptisols	Hydrol Humic Latosols.
Kaimu	Euic, isohyperthermic	Typic Tropofolists	Histosols	Lithosols.
Kaipoioi	Medial, isomesic	Typic Dystrandepts	Inceptisols	Latosolic Brown Forest soils.
Kalae	Clayey, oxidic, isothermic	Typic Rhodustults	Ultisols	Humic Ferruginous Latosols.
Kalapa	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Kalaupapa	Medial, isohyperthermic	Lithic Eutrandepts	Inceptisols	Reddish Prairie soils.
Kalihi	Very-fine, kaolinitic, nonacid, isohyperthermic.	Typic Tropaquepts	Inceptisols	Gray Hydromorphic soils.
Kaloko	Fine, carbonatic, isohyperthermic	Typic Haplaquolls	Mollisols	Gray Hydromorphic soils.
Kamaole	Clayey over fragmental, kaolinitic, isothermic.	Aridic Haplustolls	Mollisols	Reddish Brown soils.
Kaneohe	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Kanepuu	Fine, oxidic, isothermic	Oxic Paleustalfs	Alfisols	Humic Ferruginous Latosols.
Kapaa	Clayey, gibbsitic, isothermic	Typic Gibbsihumox	Oxisols	Humic Ferruginous Latosols.
Kapuhikani	Very-fine, montmorillonitic, isohyperthermic.	Mollic Torrerts	Vertisols	Dark Magnesium Clays.
Kaupo	Fine-silty over fragmental, mixed, isohyperthermic.	Pachic Haplustolls	Mollisols	Humic Latosols.
Kawaihapai	Fine, mixed, isohyperthermic	Cumulic Haplustolls	Mollisols	Alluvial soils.
Keaau	Very-fine, montmorillonitic, nonacid, isohyperthermic.	Typic Tropaquepts	Inceptisols	Gray Hydromorphic soils.
Keahua	Clayey kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Kealia	Coarse-loamy, mixed, isohyperthermic.	Typic Salorthids	Aridisols	Solonchak.
Keawakapu	Clayey over fragmental, kaolinitic, isohyperthermic.	Aridic Haplustolls	Mollisols	Reddish Brown soils.
Kekaha	Very-fine, mixed, isohyperthermic	Cumulic Haplustolls	Mollisols	Low-Humic Latosols.
Kemoo	Fine, oxidic, isothermic	Oxic Rhodustalfs	Alfisols	Humic Ferruginous Latosols.
Koele	Fine, kaolinitic, isothermic	Aridic Haplustolls	Mollisols	Alluvial soils.
Kokee	Clayey, oxidic, isomesic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Koko	Medial, isohyperthermic	Ustollic Eutrandepts	Inceptisols	Reddish Brown soils.
Kokokahi	Very-fine, montmorillonitic, isohyperthermic.	Udorthentic Pellusterts	Vertisols	Dark Magnesium Clays.
Kolekole	Fine, oxidic, isothermic	Ustoxic Humitropepts	Inceptisols	Humic Ferruginous Latosols.
Koloa	Clayey, kaolinitic, isohyperthermic, shallow.	Tropeptic Eutrustox	Oxisols	Low-Humic Latosols.
Kolokolo	Fine, mixed, isohyperthermic	Fluventic Humitropepts	Inceptisols	Alluvial soils.
Koolau	Fine, kaolinitic, acid, isothermic	Aeric Tropaquepts	Inceptisols	Gray Hydromorphic soils.

TABLE 5.—*Classification of soil series by higher categories*—Continued

Series	Family	Subgroup and great group	Order	Great soil group (1938 classification)
Kula	Medial, isothermic	Typic Eutrandepts	Inceptisols	Reddish Prairie soils.
Kunia	Fine, kaolinitic, isothermic	Ustoxic Humitropepts	Inceptisols	Low-Humic Latosols.
Kunuweia	Clayey, ferritic, isomesic	Plinthic Acrorthox	Oxisols	Humic Ferruginous Latosols.
Lahaina	Clayey, kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Laumaia	Medial, isomesic	Typic Dystrandepts	Inceptisols	Latosols Brown Forest soils.
Lawai	Very-fine, oxidic, isohyperthermic.	Oxic Humitropepts	Inceptisols	Humic Ferruginous Latosols.
Leilehua	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Lihue	Clayey, kaolinitic, isohyperthermic.	Tropeptic Eutrustox	Oxisols	Low-Humic Latosols.
Lolekaa	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Lualualei	Very-fine, montmorillonitic, isohyperthermic.	Typic Chromusterts	Vertisols	Dark Magnesium Clays.
Mahana	Medial, isothermic	Oxic Dystrandepts	Inceptisols	Humic Ferruginous Latosols.
Makaalae	Clayey-skeletal, mixed, isohyperthermic.	Ustic Humitropepts	Inceptisols	Humic Latosols.
Makalapa	Very-fine, montmorillonitic, isohyperthermic.	Typic Chromusterts	Vertisols	Dark Magnesium Clays.
Makapili	Clayey, ferritic, isothermic	Typic Acrohumox	Oxisols	Humic Ferruginous Latosols.
Makawao	Clayey,oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Makaweli	Clayey, kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Makena	Coarse-loamy, ashy, isohyperthermic.	Aridic Haplustolls	Mollisols	Red Desert soils.
Makiki	Fine, mixed, isohyperthermic	Andic Ustic Humitropepts	Inceptisols	Low-Humic Latosols.
Mala	Fine, kaolinitic, nonacid, isohyperthermic.	Typic Torrifluvents	Entisols	Alluvial soils.
Malama	Dysic, isohyperthermic	Typic Tropofolists	Histosols	Lithosols.
Mamala	Clayey, kaolinitic, isohyperthermic.	Lithic Haplustolls	Mollisols	Low-Humic Latosols.
Manana	Clayey, oxidic, isothermic	Orthoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Mokuleia	Sandy, carbonatic, isohyperthermic.	Entic Haplustolls	Mollisols	Alluvial soils.
Molokai	Clayey, kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Naiwa	Medial, isothermic	Oxic Dystrandepts	Inceptisols	Humic Ferruginous Latosols.
Niu	Clayey, kaolinitic, isohyperthermic.	Typic Torrox	Oxisols	Low-Humic Latosols.
Niulii	Thixotropic, isothermic	Hydric Dystrandepts	Inceptisols	Humic Latosols.
Nohili	Fine, montmorillonitic (calcareous), isohyperthermic.	Cumulic Haplaquolls	Mollisols	Gray Hydromorphic soils.
Nonopahu	Very-fine, kaolinitic, isohyperthermic.	Entic Chromusterts	Vertisols	Dark Magnesium Clays.
Oanapuka	Medial, isohyperthermic	Ustollic Eutrandepts	Inceptisols	Reddish Brown soils.
Olelo	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Oli	Medial, isothermic	Oxic Dystrandepts	Inceptisols	Reddish Prairie soils.
Olinda	Medial, isomesic	Entic Dystrandepts	Inceptisols	Latosolic Brown Forest soils.
Olokui	Fine, mixed, acid, isomesic	Typic Placaquepts	Inceptisols	Gray Hydromorphic soils.
Opihikao	Dysic, isohyperthermic	Lithic Tropofolists	Histosols	Lithosols.
Paaiki	Medial, isothermic	Typic Dystrandepts	Inceptisols	Humic Latosols.
Paaloa	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Paia	Fine, kaolinitic, isohyperthermic	Typic Haplustolls	Mollisols	Low-Humic Latosols.
Pakala	Fine, oxidic, isohyperthermic	Fluventic Ustropepts	Inceptisols	Alluvial soils.
Pamoa	Very-fine, kaolinitic, isohyperthermic.	Torrertic Haplustolls	Mollisols	Low-Humic Latosols.
Pane	Medial, isothermic	Typic Dystrandepts	Inceptisols	Reddish Prairie soils.
Papaa	Very-fine, montmorillonitic, isohyperthermic.	Udic Chromusterts	Vertisols	Dark Magnesium Clays.
Paumalu	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Pauwela	Clayey, ferritic, isothermic	Humoxic Tropohumults	Ultisols	Humic Ferruginous Latosols.
Pearl Harbor	Fine, montmorillonitic, nonacid, isohyperthermic.	Typic Tropaquepts	Inceptisols	Gray Hydromorphic soils.
Pohakupu	Fine, oxidic, isohyperthermic	Ustoxic Humitropepts	Inceptisols	Humic Latosols.
Pooku	Clayey, ferritic, isothermic	Typic Acrohumox	Oxisols	Humic Ferruginous Latosols.
Puhi	Clayey, oxidic, isohyperthermic	Typic Umbriorthox	Oxisols	Humic Ferruginous Latosols.
Pulehu	Fine-loamy, mixed, isohyperthermic.	Cumulic Haplustolls	Mollisols	Alluvial soils.
Puuone	Carbonatic, isohyperthermic	Typic Ustipsamments	Entisols	Regosols.
Puu Opae	Clayey, oxidic, isothermic	Typic Rhodustults	Ultisols	Humic Ferruginous Latosols.
Puu Pa	Medial over fragmental, isothermic	Ustollic Eutrandepts	Inceptisols	Reddish Brown soils.
Tantalus	Medial over cindery, isothermic	Typic Dystrandepts	Inceptisols	Latosolic Brown Forest soils.

TABLE 5.—*Classification of soil series by higher categories*—Continued

Series	Family	Subgroup and great group	Order	Great soil group (1938 classification)
Ulupalakua	Medial over cindery, isothermic	Typic Eutrandepts	Inceptisols	Reddish Prairie soils.
Uma	Cindery, isomesic	Typic Vitrandepts	Inceptisols	Regosols.
Uwala	Clayey, kaolinitic, isothermic	Typic Torrox	Oxisols	Low-Humic Latosols.
Wahiawa	Clayey, kaolinitic, isothermic	Tropeptic Eutrustox	Oxisols	Low-Humic Latosols.
Wahikuli	Clayey, kaolinitic, isohyperthermic	Typic Torrox	Oxisols	Low-Humic Latosols.
Waiakoa	Fine, kaolinitic, isohyperthermic	Aridic Haplustolls	Mollisols	Low-Humic Latosols.
Waialeale	Fine, oxidic, isomesic	Histic Lithic Tropaquods	Spodosols	Gray Hydromorphic soils.
Waialua	Very-fine, kaolinitic, isohyperthermic.	Typic Haplustolls	Mollisols	Low-Humic Latosols.
Waiawa	Clayey, montmorillonitic, isohyperthermic.	Lithic Vertic Haplustolls	Mollisols	Lithosols.
Waihuna	Very-fine, kaolinitic, isothermic	Typic Chromusterts	Vertisols	Low-Humic Latosols.
Waikane	Clayey, oxidic, isothermic	Humoxic Tropohumults	Ultisols	Humic Latosols.
Waikapu	Clayey, kaolinitic, isohyperthermic	Typic Torrox	Oxisols	Low-Humic Latosols.
Waikomo	Clayey, mixed, isohyperthermic	Lithic Haplustolls	Mollisols	Reddish Brown soils.
Wailuku	Clayey, kaolinitic, isohyperthermic	Tropeptic Haplustox	Oxisols	Low-Humic Latosols.
Wainee	Clayey-skeletal, kaolinitic, isohyperthermic.	Aridic Haplustolls	Mollisols	Low-Humic Latosols.
Waipahu	Very-fine, kaolinitic, isohyperthermic.	Torrertic Haplustolls	Mollisols	Low-Humic Latosols.

ORDER.—There are 10 orders: Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. All are represented on the islands.

An order represents the kind and the relative strength of the soil-forming process. Although it does not correspond exactly with any other category in any other classification system, each order is made up of certain well-recognized groups of soils.

Entisols, for example, are recent soils and very steep soils that lack distinctive horizons. *Vertisols* are dark-colored, clayey soils that swell and soils formerly classified as Tropical Black Earths. *Inceptisols* are soils that are on young but not recent land surfaces and have weakly developed horizons. *Aridisols* are soils that are generally dry. *Mollisols* are grassland soils, of subhumid regions, that have a deep, dark-colored, well-structured surface layer. *Spodosols* are Podzols and many hydromorphic soils. *Alfisols* are timbered soils, other than Podzols, of subhumid regions. *Ultisols* are timbered soils, other than Podzols, of humid regions. *Oxisols* are very strongly weathered soils and soils on very old tropical landscapes. *Histosols* are organic soils.

SUBORDER.—An order is so broad that the soils in it have similar morphology but little or no genetic relationship. Criteria used to divide orders into suborders have been chosen to produce categories of greater genetic homogeneity. For example, most orders contain well-drained soils and their associated poorly drained soils. The criteria for suborders reflect the absence or presence of wetness or differences in climate or vegetation.

GREAT GROUP.—Each suborder is divided into great groups on the basis of uniformity in kind and sequence of genetic horizons, on base saturation, or on properties related to climate. Each great group, therefore, is uniform in kind and arrangement of genetic horizons and features, and each is within a relatively narrow range of climate. Brief definitions of genetic horizons and such terms as "base saturation" are given in the Glossary.

SUBGROUP.—Each great group is divided into subgroups, one representing the central (typic) concept of the subgroup, and others, called intergrades, representing soils that have mostly the properties of one great group but also have one or more properties of another great group, suborder, or order. For example, if soils in a great group of the order Ultisols were considered to be intergrades toward the order Oxisols, they would be classified in an *Oxic* subgroup of the great group.

A few subgroups differ from the central, or typic, concept in having soils that have distinctive properties but indicate no intergradation toward other categories of the system. For example, some soils in a great group of the order Mollisols are subject to occasional flooding. Consequently, they accumulate soil material on the surface and have a distinctively thicker topsoil than the soils in the *Typic* subgroup. These aberrant soils would be classified in a *Cumulic* subgroup.

Several subgroups, particularly in the orders Inceptisols and Ultisols, correspond approximately to soil families according to the classification by Cline (*5*).

FAMILY.—Families are established within a subgroup on the basis of properties important to the growth of plants or the behavior of soils when they are used for engineering. Among the properties considered are texture, mineral composition, reaction, soil temperature, permeability, thickness of horizons, and consistence.

SERIES.—The series has the narrowest range of characteristics of the categories in the classification system. It is described fully in the section "How This Survey Was Made." Each soil series on the islands is described in detail in the section "Descriptions of the Soils."

Classification of the Soils on the Islands

The following pages tell how the soil series represented on the islands are classified by order and suborder.

Entisols

Entisols are recent soils that have little or no horizon development. The order includes almost all soils that are but little changed from the parent material in which they formed.

Two suborders of Entisols occur in Hawaii: Psamments and Fluvents. The prefix *Psamm*, derived from the Greek word for *sand*, indicates coarse texture. The prefix *Fluv* is derived from the Latin word *fluvius*, meaning *river*. It indicates the stratified nature of the soils. The suffix *ent* indicates the name of the order Entisols.

Psamments

Jaucas and Puuone soils are classified as Psamments. They formed in stabilized coral sand near beaches. They show very little soil development.

Jaucas and Puuone soils receive 10 to 40 inches of rainfall annually and have a mean annual soil temperature of about 75° F. They are sandy and excessively drained. The vegetation consists of bermudagrass, kiawe, koa haole, and lantana. The accumulation of organic matter accounts for the dark color of the calcareous sand in the surface soil. Because of the low rainfall, the high soil temperature, and the sandy texture, these soils are generally dry for 90 cumulative days or more, but for less than 6 months. Therefore, Jaucas and Puuone soils are placed in the great group of Ustipsamments; the prefix *Ust* indicates that the soils formed in a dry climate.

Jaucas and Puuone soils belong to the typic, or central, subgroup of this great group. Finally, they are placed in the carbonatic, isohyperthermic family. The first term in the family name applies to the mineralogy and the last to a mean annual soil temperature of more than 71.6° F.

Fluvents

Mala soils are classified as Fluvents. They receive 10 to 25 inches of rainfall annually and have a mean annual soil temperature of about 75° F. The A horizon is dark reddish-brown silty clay, and the C horizon stratified dark reddish-brown and very dark gray silty clay. The organic-matter content decreases irregularly within the profile. Because of low rainfall and high soil temperature, these soils are dry for more than 6 months in most years. Therefore, they belong in the typic, or central, subgroup. They are placed in the fine, kaolinitic, nonacid, isohyperthermic family of the Typic Torrifluvents because of the silty clay control section, the tabular halloysitic mineralogy, the slightly acid to mildly alkaline reaction, and the mean annual soil temperature of 74° F.

Vertisols

Vertisols are usually black or dark gray in color. They are high in clay, have poor structure, and develop large cracks when dry. The shrinking, cracking, and shearing make these soils difficult to manage for farming and for engineering and other nonfarm uses.

The order includes most of the Dark Magnesium soils and some of the Gray Hydromorphic soils, as classified by Cline (*5*).

In Hawaii, Vertisols occur along the coast in marine alluvium deposited when the sea stood much higher than it does now and in colluvium that consisted of fine clays and large stones. They occur on long fans that originate in the mountains and spill out over the coastal plains.

Vertisols contain a large amount of very fine clay, either the mineral montmorillonite or tabular halloysite. The clay shrinks and swells with changes in water content. The surface half inch of these soils is generally a layer of hard granules, which are evidence of excessive shrinkage of the clays in the sun's heat. The granules form a mineral mulch that protects the rest of the soil from the sun. Beneath the mulch the soil has poor structure and generally cracks into large, heavy clods. When the soil is dry, the cracks open up and the surface soil falls into them. When the soil is wet and swells, the cracks close and the subsoil material is pushed toward the surface. Thus, in the course of many years, the soil churns slowly over and over. Throughout the soil and particularly deep down where churning does not occur, there are aggregates and crystals of calcium carbonate, or calcite, and of calcium sulfate, or gypsum. These minerals are present because Vertisols occur in a dry or nearly dry climate and there is little leaching.

Although the soils are black or dark gray in color, they contain less organic matter than red soils do. The organic matter associated with montmorillonite may be naturally darker colored than that associated with the minerals in red soils. However, Raymundo [6] has found that the clay, silt, and sand fractions of these soils are gray in color, even when the organic matter is removed completely.

Three suborders of Vertisols occur in Hawaii: Torrerts, Uderts, and Usterts. Torrerts have cracks that remain open throughout the year in most years or are closed for less than 60 consecutive days at a period when the soil temperature at a depth of 50 centimeters (20 inches) is continuously more than 8° C. (46° F.). The prefix *Torr*, derived from the Latin word for *torrid*, indicates that the soils are usually dry. Uderts have cracks that open and close more than once each year but stay open for less than 90 cumulative days in most years. The prefix *Ud* indicates that the soils are in a humid climate. Usterts have cracks that open and close more than once each year and stay open for more than 90 cumulative days during the year in most years, but are closed for at least 60 consecutive days at a time when the soil temperature at a depth of 50 centimeters (20 inches) is continuously above 8° C. (46° F.). The prefix *Ust*, derived from the Latin word meaning *burnt*, indicates that summers are hot and dry. The suffix *ert* indicates the name of the order Vertisols.

Torrerts

Kapuhikani soils belong in the suborder Torrerts. They have deep, wide cracks that remain open throughout the year. They receive 10 to 15 inches of rainfall annually. The vegetation is sparse, and much of the surface is bare. A horizon high in content of calcium carbonate occurs at a depth of about 20 inches. Because of the dark-brown color in the surface layer, Kapuhikani soils are classified as Mollic Torrerts. They are dominated by montmorillonite clay minerals and have a mean annual soil temperature of 75° F. They are classified in the very-fine,

[6] RAYMUNDO, M. THE PROPERTIES OF THE BLACK EARTH OF HAWAII. 1965. [Unpublished Ph.D. dissertation. Copy on file University of Hawaii]

montmorillonitic, isohyperthermic family of Mollic Torrerts.

UDERTS

Kaena soils belong in the suborder Uderts. They are gently sloping to moderately steep and are on fans and steep colluvial slopes at an elevation of 50 to 150 feet. The mean annual rainfall is between 30 and 45 inches. The mean annual soil temperature is 74° F. Kaena soils are poorly drained. They are very sticky and very plastic and crack widely when dry. The cracks stay open for less than 90 days each year. Kaena soils have chromas of less than 1.5 when moist and are classified in the great group Pelluderts. They are Typic Pelluderts because of strongly mottled horizons. The prefix *Pell* is derived from a Greek word that indicates low chroma. Because of montmorillonite clay minerals and a mean annual soil temperature of 74°, Kaena soils are classified in the very-fine, montmorillonitic, isohyperthermic family of Typic Pelluderts.

USTERTS

Usterts that have chromas of 1.5 or more when moist are in the Chromusterts great group. Waihuna, Honouliuli, Lualualei, Makalapa, Nonopahu, and Papaa soils are classified as Chromusterts.

Waihuna soils are nearly level or gently sloping to moderately sloping and are in basins and on alluvial fans. The elevation ranges from 400 to 2,000 feet. The annual rainfall is 20 to 35 inches. Waihuna soils are very sticky and very plastic. They are dominated by tabular halloysitic minerals and have a mean annual soil temperature of 69° F. They are classified in the very-fine, kaolinitic, isothermic family of Typic Chromusterts.

Honouliuli soils are nearly level to gently sloping and are on lowlands. They are very sticky and very plastic and are dominated by tabular halloysitic minerals. They have a mean annual soil temperature of 74° F. and 18 to 30 inches of annual rainfall. They are classified in the very-fine, kaolinitic, isohyperthermic family of Typic Chromusterts.

Lualualei and Makalapa soils are dominated by montmorillonitic minerals and have a mean annual soil temperature of more than 71.6° F. They are gently sloping and are on marine alluvium and associated colluvial fans on the leeward side of the islands. They are classified in the very-fine, montmorillonitic, isohyperthermic family of Typic Chromusterts.

Nonopahu soils are classified as Entic Chromusterts because they grade to Entisols. They have a color value of more than 3.5 when moist. Because they are dominated by tabular halloysitic minerals and have a mean annual soil temperature of about 74° F., Nonopahu soils are classified in the very-fine, kaolinitic, isohyperthermic family of Entic Chromusterts.

Papaa soils are classified as Udic Chromusterts because they contain more moisture than the Typic Chromusterts. They have cracks that remain open from 90 to 150 cumulative days during the year. They are dominated by montmorillonitic minerals and have a mean annual soil temperature of 73° F. They are classified in the very-fine, montmorillonitic, isohyperthermic family of Udic Chromusterts.

Usterts that when moist have a chroma of less than 1.5 throughout the uppermost 12 inches are in the Pellusterts great soil group. Kokokahi soils are classified as Pellusterts. They have color values of more than 3.5 when moist and have cracks that remain open for less than 150 cumulative days during the year. They are therefore classified as Udorthentic Pellusterts, that is, soils that are moist (Udic) and are younger than typical. Kokokahi soils are dominated by montmorillonitic minerals and have a mean annual soil temperature of 74° F. They are classified in the very-fine, montmorillonitic, isohyperthermic family of Udorthentic Pellusterts.

Inceptisols

Inceptisols have weakly developed, natural soil horizons. Many of these soils are young but not recent. They are commonly older than Entisols. For example, in a river valley where there is a flood plain and an older terrace a few feet above the flood plain, Entisols are on the flood plain and Inceptisols generally on the older terrace.

The name of the order is derived from the Latin *inceptum*, meaning *beginning*. Recently, the order has been extended to include nearly all of the generally moist soils that have been little affected by those soil-forming processes that produce marked horizons in the soil profile. Thus, the order includes nearly all soils developed in volcanic ash and many strongly weathered soils in tropical zones, including Hawaii, that have been developing for many thousands of years but do not have oxic, spodic, or argillic horizons.

Three suborders of Inceptisols occur in the State of Hawaii: Andepts, which developed in volcanic ash; Aquepts, which show signs of wetness; and Tropepts, which developed in tropical climates and well-drained areas from strongly weathered alluvium or material weathered from basic rocks.

ANDEPTS

Andepts have a high content of allophane or volcanic ash, have bulk density of less than 0.85 grams per cubic centimeter, and lack characteristics associated with wetness. The prefix *And* is derived from Andosols, which is the name ordinarily applied to soils that developed in volcanic ash. The suffix *ept* indicates the name of the order Inceptisols. Andepts are divided into four great groups: Vitrandepts, Eutrandepts, Dystrandepts, and Hydrandepts. These groups correspond with significant differences in the soil properties that are associated with differences in rainfall, temperature, and age.

Uma and Alae soils developed under sparse vegetation in a semiarid climate. They are classified as Vitrandepts. The prefix *Vitr*, taken from the Latin word for *glass*, indicates that these soils are relatively unweathered volcanic ash and show little profile development. Because of low rainfall and sparse vegetation, they have high base saturation and a low organic-matter content.

Uma soils have an A horizon of black loamy coarse sand over black unweathered cinders. They have a mean annual soil temperature of 56° F. They are therefore classified in the cindery, isomesic family of Typic Vitrandepts.

Alae soils receive 12 to 20 inches of annual rainfall. This amount is not enough to leach the bases and, therefore, base saturation is greater than 50 percent. These soils have a mollic epipedon and are classified as Mollic Vitrandepts. Because of a dark-brown A horizon and a mean annual soil temperature of 74° F., Alae soils are classified in the medial, isohyperthermic family of Mollic Vitrandepts.

Eutrandepts formed in volcanic ash in a semiarid climate. Because of the low rainfall, there has been little leaching and base saturation is greater than 50 percent. The prefix *Eutr* is taken from the Greek word for *fertile*. In comparison with the soils classified as Vitrandepts, the soils in this great group show the effects of higher rainfall and increased vegetation in their darker colored, thicker surface layer and higher organic-matter content. They also have a higher clay content and a higher cation exchange capacity than Vitrandepts. Their base saturation is somewhat lower but exceeds 50 percent throughout the soil.

Kula, Io, and Ulupalakua soils on the island of Maui are classified as Typic Eutrandepts. Kula soils have an A horizon of dark reddish-brown loam that has weak structure. They have moderate structure in the upper part of the B horizon and strong structure in the lower part. Because they have a mean annual soil temperature of 66° F., Kula soils are classified in the medial, isothermic family of Typic Eutrandepts.

Io soils have a very dark-brown A horizon and a dark-brown to dark reddish-brown B horizon that has weak and moderate structure. They are underlain by black unweathered cinders at a depth of 20 to 40 inches. Ulupalakua soils have an A horizon of very dark-brown silt loam and a B horizon of dark reddish-brown silt loam and clay loam. They are underlain by black unweathered cinders at a depth of 24 to 40 inches. Because Io and Ulupalakua soils are underlain by cinders and have a mean annual soil temperature of between 65° and 69° F., they are classified in the medial over cindery, isothermic family of Typic Eutrandepts.

The Kalaupapa soils on the island of Molokai are classified in the subgroup Lithic Eutrandepts, which indicates that they are Eutrandepts that are truncated by hard rock and are shallow or are intermittent between rock outcrops. They have a dark-brown, strong granular A horizon and a dark yellowish-brown B horizon that rests on hard pahoehoe lava at a depth of about 14 inches. They have a mean annual soil temperature of 74° F. and are classified in the medial, isohyperthermic family of Lithic Eutrandepts.

Koko, Oanapuka, and Puu Pa soils formed under less rainfall than the soils classified as Typic Eutrandepts. They have a layer of soft, powdery, secondary lime and therefore are classified in an Ustollic subgroup. The prefix *Ust*, from the Latin word meaning *burnt*, indicates that the soils developed in a dry climate and that there is not enough rainfall to leach away entirely the calcium carbonate from the profile. The suffix *oll* indicates that the soils are considered intergrades to the Mollisol order.

Koko soils have an A horizon of dark reddish-brown granular silt loam and a dark reddish-brown B horizon that has weak to moderate structure. They occur on the slopes of Diamond Head, Koko Head, and Koko Crater, in a semiarid climate.

Oanapuka soils have an A horizon of very dark-brown and very dark grayish-brown silt loam. The B horizon is silt loam, has prismatic structure, and is weakly smeary. These soils occur on Maui. Koko and Oanapuka soils are weakly weathered and still contain much volcanic ash. They have a mean annual soil temperature of 73° F. They are classified in the medial, isohyperthermic family of Ustollic Eutrandepts.

Puu Pa soils have a very dark-brown A horizon and a very friable, massive C horizon. Because of a layer of fragmental Aa lava and a mean annual soil temperature of 70° F., Puu Pa soils are classified in the medial over fragmental, isothermic family of Ustollic Eutrandepts.

Andepts that formed in a humid climate belong to the Dystrandepts great group. The prefix *Dystr* is taken from the Greek word meaning *infertile*. Therefore, Dystrandepts are Andepts that have low base saturation because of higher rainfall and consequent leaching. They receive more rainfall than Eutrandepts but less than Hydrandepts. Annual rainfall ranges from 40 to about 100 inches. The organic-matter content is high, but base saturation is less than 50 percent.

Kaipoioi, Laumaia, Paaiki, Pane, and Tantalus are well-drained soils that do not have thixotropic properties. They are classified as Typic Dystrandepts.

Kaipoioi soils have a black A horizon that has strong structure and a silt loam and silty clay loam B horizon. Laumaia soils have a very dark-brown A horizon that has moderate structure. The upper part of the B horizon is dark-brown silt loam. These soils are underlain by a weakly cemented sandy layer. Their mean annual soil temperature is between 53° and 56° F. They are classified in the medial, isomesic family of Typic Dystrandepts.

Paaiki and Pane soils occur at the lower elevations on the island of Maui. Paaiki soils have a dark reddish-brown, granular A horizon and a brown B horizon that is silty clay loam in the upper part and silty clay in the lower part. Pane soils have a dark reddish-brown A horizon that has strong granular structure and a dark reddish-brown loamy B horizon that is weakly smeary. Paaiki and Pane soils have a mean annual soil temperature of between 60° and 66° F. They are classified in the medial, isothermic family of Typic Dystrandepts.

Tantalus soils have a very dark-brown A horizon over a dark reddish-brown very fine sandy loam B horizon. They have weak structure, are very friable, and are weakly weathered. Because these soils are underlain by cinders and have a mean annual soil temperature of 70° F., they are classified in the medial over cindery, isothermic family of Typic Dystrandepts.

Olinda soils have an A horizon of dark reddish-brown loam and a B horizon of silty clay loam that is weakly smeary. They do not have an umbric epipedon and therefore are not typic. They are classified as Entic Dystrandepts. They have a mean annual soil temperature of 57° F. and are classified in the medial, isomesic family of Entic Dystrandepts.

Niulii soils are similar to the soils classified as Typic Dystrandepts, but they have thixotropic properties and an umbric epipedon. Thus, they are classified as Hydric Dystrandepts to show that they intergrade to Hydrandepts. Niulii soils receive an average of 80 to 100 inches of rainfall annually, and their mean annual soil temperature is about 70° F. They have an A horizon of dark-brown silty clay loam that has strong structure and a

B horizon of dark-brown silty clay loam that is thixotropic. Niulii soils are classified in the thixotropic, isothermic family of Hydric Dystrandepts.

Mahana, Naiwa, and Oli soils formed in a subhumid, warm climate. They are strongly weathered and have practically no reserves of bases. Base saturation is low. Because of strong weathering, the surface soil contains many oxides and the soils are similar to those in the order Oxisols. Thus, they are placed in an Oxic subgroup where the cation exchange capacity is below 20 milliequivalents per 100 grams of soil. The low cation exchange capacity is caused by the high oxide content in the soil. Also, because of the strong weathering, the subsoil contains no volcanic ash but contains, instead, amorphous secondary minerals developed from the ash.

Mahana soils developed in old, strongly weathered volcanic ash in a subhumid, warm climate. They are nearly level to steep and are on uplands. Their A horizon is firm, dusky-red silty clay loam that has strong structure. It is underlain by dark-red silt loam that has weak structure. The A horizon contains an accumulation of iron and titanium oxides, which appear as small, dark-colored, shiny specks, and therefore has a much higher bulk density than is usual for soils derived from volcanic ash. The mean annual soil temperature is 67° F.

Naiwa soils have a dusky-red A horizon that has high bulk density and a red and dark reddish-brown silt loam B horizon that has weak to moderate structure. The A horizon and the upper part of the B horizon are more than 35 percent total iron oxides and more than 10 percent titanium oxide. The mean annual soil temperature is 70° F.

Oli soils have a dark-brown A horizon over a dark-brown B horizon that has weak structure. They are gently sloping to steep and are on dissected uplands. They developed in volcanic ash over basic igneous rock.

Because of a medial control section and a mean annual soil temperature of between 67° and 70° F., Mahana, Naiwa, and Oli soils are classified in the medial, isothermic family of Oxic Dystrandepts.

Andepts containing clays that dehydrate irreversibly into gravel-size aggregates are classified in the great group Hydrandepts. The prefix *Hydr* is taken from the Greek word meaning *water*. Hydrandepts occur in the wettest areas occupied by Andepts. They receive 80 to more than 300 inches of rainfall annually. They are the most strongly weathered of all the soils derived from volcanic ash. The cation exchange capacity is high, but base saturation is low. The organic-matter content is high. The moisture held by the soil at 15 atmospheres of tension often exceeds 200 percent. Water intake and transmission through the soil are rapid.

Honomanu, Kailua, and Hana soils are classified as Typic Hydrandepts. Honomanu soils have a very dark grayish-brown O1 horizon, a very dark-brown and dark yellowish-brown A horizon, and a dark yellowish-brown and brown B horizon. These soils are strongly smeary and dehydrate irreversibly into fine gravel-size aggregates. Kailua soils have an A horizon of dark-brown silty clay and a B horizon of dark-brown and dark reddish-brown silty clay. They are weakly or moderately smeary and dehydrate irreversibly into fine gravel-size aggregates. Because of thixotropic properties and a mean annual soil temperature of between 62° and 70° F., Honomanu and Kailua soils are placed in the thixotropic, isothermic family of Typic Hydrandepts.

Hana soils are similar to Honomanu and Kailua soils but have a mean annual soil temperature of more than 71.6° F. They have a very dark-brown A horizon and a dark-brown B horizon that is moderately smeary and dehydrates irreversibly into gravel-size aggregates. Because of a mean annual soil temperature of 73° F., Hana soils are classified in the thixotropic, isohyperthermic family of Typic Hydrandepts.

Aquepts

Eight soil series are classified in the suborder Aquepts. The prefix *Aqu*, derived from the Latin word meaning *water*, indicates the effect of wetness in the formation of these soils. Aquepts are mottled in the subsoil. The mottling indicates that the water table rises into the subsoil and periodically causes waterlogging and loss of oxygen. Consequently, the iron, which accounts largely for the bright color in soils and is insoluble when air is present, becomes dissolved in water and either moves out of the soil in drainage water or changes to gray or olive in color.

Amalu, Hulua, and Olokui soils are classified in the great group Placaquepts. The prefix *Plac*, taken from the Greek word *plax*, indicates the presence of a thin pan. Therefore, Placaquepts are Aquepts that have a thin black to reddish, cemented pan, presumably cemented with iron, that is called a placic horizon. Hulua and Olokui soils are placed in the typic, or central, subgroup.

Hulua soils have an A1 horizon of black gravelly silty clay over an acid A2 horizon that is shallow over a strongly cemented ironstone sheet. Elevations range from 400 to 2,400 feet. The annual rainfall is 100 to 200 inches. The mean annual soil temperature is about 66° F. Hulua soils are placed in the fine, oxidic, acid, isothermic family of Typic Placaquepts.

Olokui soils have an O horizon about 4 inches thick, an acid A2g horizon of mottled silty clay loam, and an ironstone sheet at a depth of about 12 inches. They occur at elevations of 1,500 to 4,000 feet and receive 75 to 150 inches of rainfall annually. The mean annual soil temperature is 58° F. Olokui soils are placed in the fine, mixed, acid, isomesic family of Typic Placaquepts.

Amalu soils are classified as Histic Placaquepts because they have a histic epipedon. They have a black peat surface layer 5 to 15 inches thick, an acid, gray clay A2 horizon, and an ironstone sheet 8 to 15 inches below the base of the peaty surface layer. They occur at elevations of 2,000 to 5,500 feet. The annual rainfall is 75 to 400 inches. The mean annual soil temperature is about 58° F. Amalu soils are placed in the fine, mixed, acid, isomesic family of Histic Placaquepts.

Aquepts that have a difference of less than 9° F. between the mean summer and mean winter temperatures are placed in the great group Tropaquepts. The prefix *Trop* means *tropical*.

Hanalei soils have a dark-gray to dark grayish-brown A horizon and a mottled dark-gray or dark grayish-brown silty clay loam B horizon. The water table is above a depth of 26 inches most of the time. Because these soils have a fine silty texture in the control section, have mixed mineralogy, mostly kaolin and montmorillonite, are nonacid in the control section, and have a mean annual temperature of 74° F., they are placed in the fine, mixed nonacid, isohyperthermic family of Typic Tropaquepts. Pearl Harbor soils differ from Hanalei soils in containing a large amount of montmorillonite clay. They are therefore classified in the fine, montmorillonitic, nonacid, isohyperthermic family of Typic Tropaquepts. Pearl Harbor soils also have a layer of muck and peat that occurs at too great a depth to be significant for purposes of classification.

Keaau soils have an A horizon of very dark grayish-brown clay and a mottled dark-brown B horizon. They are underlain by coral limestone. Because of the clayey A horizon, the montmorillonitic mineralogy, a nonacid control section, and a mean annual soil temperature of 73° F., Keaau soils are classified in the very-fine, montmorillonitic, nonacid, isohyperthermic family of Typic Tropaquepts.

Kalihi soils have a dark-brown, clayey A horizon and a mottled very dark gray, very sticky and very plastic B horizon. The pH ranges from 6.4 to 7 throughout the solum. The dominant clay mineral is tabular halloysite. Kalihi soils are nearly level and occur on bottom land at elevations of 50 to 100 feet. They were formerly classified as Gray Hydromorphic soils by Cline (*5*). Because of the clay texture, the tabular halloysitic mineralogy, a nonacid control section, and a mean annual soil temperature of 74° F., Kalihi soils are classified in the very-fine, kaolinitic, nonacid, isohyperthermic family of Typic Tropaquepts.

Koolau soils are similar to Typic Tropaquepts but have mottles of more than 2 chroma. This fact indicates that they are slightly better drained. They are therefore classified as Aeric Tropaquepts. They are gently sloping to steep and are on uplands at elevations ranging from 750 to 5,200 feet. The annual rainfall is 120 to 200 inches. Koolau soils have a mottled light brownish-gray, clayey A1 horizon and a mottled gray to pale-yellow B horizon that is very strongly acid. The mottling indicates poor aeration. The soil material is very porous and is easily penetrated by water. Because of the clay texture, the tabular halloysitic mineralogy, an acid subsoil, and a mean annual soil temperature of 64° F., Koolau soils are classified in the fine, kaolinitic, acid, isothermic family of Aeric Tropaquepts.

Tropepts

Tropepts are Inceptisols that have a difference of less than 9° F. between the mean summer and mean winter soil temperatures. They include soils in tropical areas that are strongly weathered and have been developing for thousands of years but do not have an oxic, spodic, or argillic horizon. Tropepts are subdivided into two great groups: Humitropepts and Ustropepts. The groupings are based on differences in rainfall and temperature and on the relative amounts of organic matter in a unit of volume of 1 meter (40 inches) square to a depth of 1 meter.

Makaalae, Makiki, Haliimaile, Hihimanu, Kolekole, Kunia, Pohakupu, and Kolokolo soils are classified in the great group Humitropepts because they have high mean annual rainfall or high humus content. The prefix *Hum*, derived from the Latin word *humus*, meaning *earth*, indicates the presence of a relatively large amount of organic matter. These soils occur on bottom lands, uplands, and alluvial fans at elevations that range from sea level to 12,000 feet. The mean annual rainfall ranges from 35 to 150 inches but is generally between 80 and 140 inches.

Hanamaulu and Lawai soils have higher mean annual rainfall than most other Tropepts. They are always moist. They have a base saturation of less than 50 percent and a mean annual soil temperature of more than 71.6° F. Hanamaulu soils have a cation exchange capacity of less than 20 milliequivalents per 100 grams of clay and are therefore classified in an Oxic subgroup. They have a very dark grayish-brown A horizon and moderate and strong structure in the B2 horizon. Because the control section is fine textured, Hanamaulu soils are classified in the fine, oxidic, isohyperthermic family of Oxid Humitropepts. The Lawai soils are similar to the Hanamaulu soils except that they have a very fine texture in the control section. Lawai soils are classified in the very-fine oxidic, isohyperthermic family of Oxic Humitropepts.

Makaalae soils have a very dark brown A horizon that has strong subangular blocky structure and a very dark grayish-brown silty clay C horizon that is 35 to 70 percent coarse fragments. These soils are 24 to 48 inches deep over fragmental Aa lava. They are dry in some horizons for more than 90 cumulative days in most years. They are therefore classified as Ustic Humitropepts. Makaalae soils have mixed mineralogy and a mean annual soil temperature of about 73° F. They are classified in the clayey-skeletal, mixed, isohyperthermic family of Ustic Humitropepts.

Makiki soils have a dry period similar to that of Makaalae soils, but are influenced by volcanic ash. They are classified as Andic Ustic Humitropepts. They occur in Manoa Valley and along the base of Punchbowl and Round Top. Their subsoil is dark-brown clay loam of moderate structure. It is underlain by volcanic ash and cinders. Because of the clay loam texture, the mixed clay minerals, and a mean annual soil temperature of 73° F., Makiki soils are classified in the fine, mixed, isohyperthermic family of Andic Ustic Humitropepts.

Haliimaile, Hihimanu, Kolekole, Kunia, and Pohakupu soils are classified as Ustoxic Humitropepts because they are as dry as the soils classified as Ustic Humitropepts and have a cation exchange capacity that is less than 24 milliequivalents per 100 grams of clay. Kolekole and Hihimanu soils occur on the uplands of the island of Oahu and on the very steep parts of the island of Kauai.

Kolekole soils have an A horizon of dark reddish-brown silty clay loam that has high bulk density over a subsoil that is similar in color and texture but has low bulk density. The subsoil is underlain by very compact older alluvium that is capped by a thin panlike layer that restricts root and water movement. Kolekole soils have oxidic mineralogy and a mean annual soil temperature of about 71° F. Hihimanu soils have an A horizon of dark-brown silty clay loam and a dark-brown to reddish-brown B horizon. They are similar to Kolekole soils. Both soils are classified in the fine, oxidic, isothermic family of Ustoxic Humitropepts.

Haliimaile and Kunia soils are also similar to Kolekole soils, but they have tabular kaolinitic mineralogy. The

A and B horizons are dark reddish-brown silty clay. The mean annual soil temperature is 71° F. Because of the silty clay texture and tabular kaolinitic mineralogy, these two soils are classified in the fine, kaolinitic, isothermic family of Ustoxic Humitropepts.

Pohakupu soils are similar to Kunia soils, but they have oxidic mineralogy. Therefore, they are classified in the fine, oxidic, isohyperthermic family of Ustoxic Humitropepts.

Kolokolo soils occur on bottom lands along small and large streams on the eastern and northern sides of the island of Kauai. They are associated with Fluvents and intergrade toward those soils. They have a very dark brown, subangular blocky A horizon and a stratified C horizon that has an irregularly decreasing organic-matter content. The mineralogy is mixed. The mean annual soil temperature is about 73° F. Kolokolo soils are classified in the fine, mixed, isohyperthermic family of Fluventic Humitropepts.

Pakala soils are classified in the great group Ustropepts. They have the least mean annual rainfall of the Tropepts. The prefix *Ust* is from the Latin word *ustus*, meaning *burnt*. It indicates a dry climate. These soils are dry for 90 cumulative days or more in most years; they receive 25 to 40 inches of rainfall. They are nearly level and occur on alluvial fans and flood plains. The A horizon is dark reddish-brown clay loam. The C horizon is stratified silty clay loam to silt loam and has an irregularly decreasing organic-matter content. Pakala soils have a mean annual soil temperature of 74° F. Their cation exchange capacity is less than 24 milliequivalents per 100 grams of clay, and they are high in oxides. They are placed in the fine, oxidic, isohyperthermic family of Fluventic Ustropepts.

Aridisols

Aridisols are primarily soils of dry places. They have an ochric epipedon and one or more additional diagnostic horizons. The order includes most soils formerly called Desert soils, Red Desert soils, Sierozems, Reddish Brown soils, and Solonchak soils (*15*). It also includes some of the Regosols and Lithosols of dry climates and some Brown soils and Solonetz soils.

The Aridisols that have no argillic or natric horizon but have a salic horizon and are saturated with water within 40 inches of the surface for 1 month or more are placed in the suborder Orthids. The suffix *id* indicates the order Aridisols.

Orthids

The only soil on the five islands in the Aridisol order and Orthid suborder is Kealia silt loam. Within the suborder, the Kealia soil is placed in the great group Salorthids. The prefix *Sal*, derived from the Latin base for *salt*, indicates that the soil is saline. Within this great group, the Kealia soil is placed in the typic, or central, subgroup.

The Kealia soil has a dark reddish-brown Asa horizon over a stratified, dark reddish-brown and black Csa horizon. The stratified material was laid down by streams along the coastal flats. This soil has a fluctuating salt water table at a depth of 12 to 40 inches, and as a result, is saline and poorly drained. The annual rainfall is 10 to 25 inches. The mean annual soil temperature is 75° F. The Kealia soil is classified in the coarse-loamy, mixed, isohyperthermic family of Typic Salorthids.

Mollisols

Mollisols have a mollic epipedon that has high base saturation and generally has moderate to strong granular structure. The order includes most soils formerly classified as Prairie soils, Chernozems, and Chestnut soils (*15*), and most soils that have a dark-colored surface layer and developed over limestone. Mollisols generally develop under grass vegetation where the grass is dense enough to form a sod. A few developed under sedges and water-tolerant plants and under hardwood forest.

Two suborders of Mollisols occur in the State of Hawaii: Aquolls and Ustolls. Aquolls show signs of wetness and, unless drained, are saturated with water for 1 month or more during most years. Ustolls are dry soils that have high base saturation. The prefix *Ust*, derived from the Latin word *ustus*, meaning *burnt*, indicates that the soils developed in an area that has dry, hot summers. The suffix *oll* indicates the name of the order Mollisols.

Aquolls

Nohili and Kaloko soils are classified in the suborder Aquolls because they are saturated with water at some period during the year. Nohili soils have a clayey A horizon; a slightly calcareous, clayey B2 horizon, or mollic epipedon, more than 24 inches thick; and a strongly calcareous, massive C horizon. The rainfall is 20 to 40 inches annually. The mean annual soil temperature is about 75° F. Nohili soils do not have a duripan, a natric horizon, a calcic horizon, or an argillic horizon, and are therefore classified as Haplaquolls. *Hapla* is a prefix meaning *simple*. Nohili soils are further classified in the fine, montmorillonitic (calcareous), isohyperthermic family of Cumulic Haplaquolls.

Kaloko soils are poorly drained and have mottles in the mollic epipedon. They occur at elevations that range from 0 to 20 feet. The annual rainfall is 20 to 25 inches, and the mean annual soil temperature is about 73° F. These soils have clay over marl at a depth of 12 to 20 inches. They are classified in the fine, carbonatic, isohyperthermic family of Typic Haplaquolls.

Twenty-one soils have been classified in the suborder Ustolls. This suborder includes soils that are dry for 90 cumulative days but not continuously dry for 60 consecutive days. They are further classified in the great group Haplustolls (*Hapla* means *simple*) because they do not have an argillic horizon, a calcic horizon, a duripan, or a natric horizon.

Some soils previously classified as Low-Humic Latosols by Cline (*5*) are now classified in the suborder Ustolls. The prefix *Ust* indicates that the soils are often dry and consequently have high base saturation.

Haleiwa, Iao, Paia, and Waialua soils are classified as Typic Haplustolls. They are nearly level to moderately sloping and occur on alluvial fans and uplands at elevations that range from sea level to 1,000 feet. The mean annual rainfall is 25 to 60 inches.

Haleiwa soils have a dark-brown A horizon and a weak subangular blocky B horizon that is silty clay in texture. Mineralogy is mixed. The mean annual soil temperature is about 73° F. Haleiwa soils are classified in the fine, mixed, isohyperthermic family of Typic Haplustolls.

Iao soils have a dark-brown, massive A horizon and a very dark brown and dark-brown, subangular blocky B horizon. Both horizons are clay in texture. Paia soils have a dark reddish-brown, granular and subangular blocky A horizon and a dark reddish-brown clay B horizon. Both soils have tabular halloysitic mineralogy and a mean annual soil temperature of 73° or 74° F. Both are classified in the fine, kaolinitic, isohyperthermic family of Typic Haplustolls.

Waialua soils have a dark reddish-brown, subangular blocky A horizon and a subangular blocky B horizon. Mineralogy is dominated by tabular halloysite. The mean annual soil temperature is about 73° F. These soils are classified in the very-fine, kaolinitic, isohyperthermic family of Typic Haplustolls.

Aridic Haplustolls are Haplustolls that intergrade to Aridisols, that is, soils that are usually dry. The mean annual rainfall is generally between 10 and 25 inches but can be as high as 35 inches. Ewa, Hoolehua, and Waiakoa soils have a mean annual soil temperature of more than 71.6° F. Their mineralogy is dominated by tabular halloysite. Ewa soils have a dark reddish-brown A horizon and a dark reddish-brown to dark-red B horizon. Hoolehua soils have a dark reddish-brown A horizon and a dark reddish-brown B horizon. Both horizons are silty clay in texture. Waiakoa soils have a dark reddish-brown A horizon and are 20 to 40 inches deep over bedrock. All three soils are classified in the fine, kaolinitic, isohyperthermic family of Aridic Haplustolls. Koele soils differ mainly in having a mean annual soil temperature of about 69° F. They are classified in the fine, kaolinitic, isothermic family of Aridic Haplustolls.

Kamaole soils have a dark-brown and dark reddish-brown A horizon and a dark reddish-brown B horizon over fragmental Aa lava at a depth of 16 to 24 inches. They have a mean annual soil temperature of 69° F. and are classified in the clayey over fragmental, kaolinitic, isothermic family of Aridic Haplustolls. Keawakapu soils differ from Kamaole soils mainly in having an annual soil temperature of more than 71.6° F. and are classified in the clayey over fragmental, kaolinitic, isohyperthermic family of Aridic Haplustolls.

Makena soils have a very dark brown and very dark grayish-brown, mildly alkaline A horizon. The lower part of the B horizon and the C horizon are dark yellowish brown and contain a considerable amount of volcanic ash. Some lime has accumulated in the Cca horizon as a result of low rainfall and limited leaching. Makena soils have a mean annual soil temperature of about 75° F. and receive 10 to 20 inches of annual rainfall. They are classified in the coarse-loamy, ashy, isohyperthermic family of Aridic Haplustolls.

Wainee soils have dark reddish-brown A and B horizons. The control section is gravelly, cobbly, and stony silty clay. The mineralogy is dominated by tabular halloysite. The mean annual soil temperature is about 75° F. Wainee soils are classified in the clayey-skeletal, kaolinitic, isohyperthermic family of Aridic Haplustolls.

Kawaihapai, Kekaha, and Pulehu soils are classified as Cumulic Haplustolls because they have a mollic epipedon more than 20 inches thick and an irregularly decreasing organic-matter content. Kawaihapai soils have a dark-brown A horizon 22 inches thick over an unconformable dark-brown, massive IIC horizon. The mean annual soil temperature is about 74° F. The mineralogy is mixed. Kawaihapai soils are classified in the fine, mixed, isohyperthermic family of Cumulic Haplustolls.

Kekaha soils have a dark reddish-brown, granular and subangular blocky A horizon 21 inches thick and a dark reddish-brown B horizon that is silty clay and clay in texture. The mean annual soil temperature is about 74° F. The mineralogy is mixed. Kekaha soils are classified in the very-fine, mixed, isohyperthermic family of Cumulic Haplustolls.

Pulehu soils have a dark-brown A horizon that is 21 inches thick and is clay loam in texture, and a stratified C horizon. The mineralogy is mixed. The mean annual soil temperature is about 74° F. Pulehu soils are classified in the fine-loamy, mixed, isohyperthermic family of Cumulic Haplustolls.

Mokuleia soils are classified as Entic Haplustolls because they have a calcareous mollic epipedon and do not have a cambic horizon. Mokuleia soils occur at elevations that range from near sea level to about 100 feet and receive 15 to 40 inches of rainfall annually. They have a dark-colored A horizon and a loamy sand or sand C horizon. The sand fraction is coral sand. Mokuleia soils are classified in the sandy, carbonatic, isohyperthermic family of Entic Haplustolls.

Waikomo and Mamala soils are classified as Lithic Haplustolls because they are less than 20 inches deep over bedrock. Waikomo soils have a very dark grayish-brown silty clay A horizon. The B horizon is reddish-brown silty clay loam. These soils overlie pahoehoe lava. They have mixed mineralogy and a mean annual soil temperature of 74° F. They are classified in the clayey, mixed, isohyperthermic family of Lithic Haplustolls.

Mamala soils have coral limestone at a depth of 8 to 20 inches. They are nearly level to gently sloping and occur on coastal plains. The elevation ranges from sea level to 100 feet. The annual rainfall is 18 to 25 inches, and the mean annual soil temperature is about 74° F. Mamala soils are classified in the clayey, kaolinitic isohyperthermic family of Lithic Haplustolls.

Kaupo soils are classified as Pachic Haplustolls (*Pachic* means *thick*) because they have a mollic epipedon more than 20 inches thick. The mollic epipedon is very dark brown and very dark grayish brown. The organic-matter content decreases gradually to the fragmental Aa lava, which is at a depth of 20 to 40 inches. The B horizon is silty clay loam in texture and is more than 40 percent gravel and cobblestones. Kaupo soils have mixed mineralogy and a mean annual soil temperature of about 74° F. They are classified in the fine-silty over fragmental, mixed, isohyperthermic family of Pachic Haplustolls.

Haplustolls that intergrade to Torrerts, that is, Vertisols that are usually dry, are classified as Torrertic Haplustolls. These soils are very sticky and very plastic clays that crack when dry and remain open throughout the year in most years. Pamoa and Waipahu soils are dominated by tabular halloysite mineralogy and have a mean annual soil temperature greater than 71.6° F. Pamoa soils have a solum of dark reddish-brown silty clay to clay. They have a thin, strong, granular surface mulch and deep wide cracks when dry. Waipahu soils have a dark grayish-brown A horizon and a dark-brown B horizon. They have prominent, very fine nodules of manganese oxide throughout. Both soils are classified in the very-fine, kaolinitic, isohyperthermic family of Torrertic Haplustolls.

Waiawa soils are classified as Lithic Vertic Haplustolls because they are less than 20 inches deep over bedrock and are very sticky and very plastic clays that crack when dry. Waiawa soils have a dark reddish-brown, clayey solum. They have montmorillonitic mineralogy and a mean annual soil temperature of 74° F. They are placed in the clayey, montmorillonitic, isohyperthermic family of Lithic Vertic Haplustolls.

Spodosols

Spodosols have a spodic horizon in which active amorphous material consisting of organic matter and, in places, aluminum have accumulated. Spodic horizons occur only in humid environments. They form in soils that have a shallow, fluctuating, ground-water level, but ordinarily do not form in soils that are permanently saturated.

Waialeale soils belong in the suborder Aquods. The prefix *Aqu*, derived from the Latin word for *water*, indicates that the soil has characteristics associated with wetness. The suffix *od* indicates the order Spodosols.

Aquods

Within the suborder Aquods, Waialeale soils are placed in the great group Tropaquods. The prefix *Trop* is taken from the Greek word meaning *tropical*. Tropaquods are Aquods that occur in a tropical climate that has less than 9° F. difference between the mean summer and mean winter temperatures.

Waialeale soils are classified as Histic Lithic Tropaquods because they have a histic epipedon and are 9 to 22 inches deep over weathered rock. These soils have a thin O1 horizon over an albic horizon. The albic horizon overlies a strong-brown spodic horizon. Elevations range from 3,500 to 4,800 feet. The annual rainfall ranges from 100 to 450 inches. The mean annual soil temperature is about 57° F. Waialeale soils are placed in the fine, oxidic, isomesic family of Histic Lithic Tropaquods.

Alfisols

Alfisols are generally moist and contain an argillic horizon, that is, a subsoil horizon in which clay has accumulated. This horizon of clay accumulation forms because clay particles are washed from upper horizons and deposited in lower ones. Alfisols characteristically have a relatively low base saturation and a slightly to medium acid reaction in the surface layer and a relatively high base saturation and slightly acid to neutral reaction in the argillic horizon.

Alfisols are defined as soils that have an argillic horizon in which base saturation is more than 35 percent, and which, in moist climates, generally rests on calcareous parent material. Alfisols develop either in calcareous parent material in a humid climate or in strongly weathered parent material in a subhumid climate where the rain does not penetrate deep enough into the soil to leach out the exchangeable cations. In some subhumid areas, the effectiveness of the rain in leaching the soil is reduced by salt spray.

Only the suborder Ustalfs is represented on the islands.

Ustalfs

Kanepuu and Kemoo soils are placed in the suborder Ustalfs because some of their horizons are dry for more than 90 cumulative days in most years, but are continuously moist in some part for 90 or more consecutive days.

Kanepuu soils are classified as Paleustalfs because they have an argillic horizon in which the clay distribution is such that the percentage of clay does not decrease from its maximum by as much as 20 percent of that maximum to a depth of 60 inches. Also, throughout the major part of the horizon, hues are 7.5YR or redder and values are less than 4 moist and less than 5 dry. Kanepuu soils occur at elevations of 1,500 to 2,000 feet and receive 20 to 25 inches of rainfall annually. The mean annual soil temperature is about 70° F. Kanepuu soils have a dark reddish-brown, slightly acid to neutral solum. Their B horizon is silty clay that has strong subangular blocky structure. Within the great group Paleustalfs, Kanepuu soils are placed in the Oxic subgroup because they have a cation exchange capacity of less than 24 milliequivalents per 100 grams of clay. Finally, this soil is classified in the fine, oxidic, isothermic family of Oxic Paleustalfs.

Kemoo soils are placed in the great group Rhodustalfs because they have an argillic horizon that has hues redder than 5YR and color values less than 4 moist and no more than 5 dry. The A horizon is very dusky red to dark reddish brown. The B horizon is dark reddish-brown to dusky-red silty clay. The mean annual soil temperature is 69° F. Kemoo soils are further classified as Oxic Rhodustalfs because they have a cation exchange capacity of less than 24 milliequivalents per 100 grams of clay, or because the cation retention from ammonium chloride is less than 12 milliequivalents per 100 grams of clay. Finally, these soils are placed in the fine, oxidic, isothermic family of Oxic Rhodustalfs.

Ultisols

Ultisols, like Alfisols, have an argillic horizon in the subsoil. They formed either in a wetter climate than Alfisols or in more strongly weathered parent material. Leaching has removed most of the exchangeable cations from the soil profile. As a result, the soils are strongly to extremely acid throughout. In contrast with Alfisols, Ultisols have less than 35 percent base saturation in the lower part of the argillic horizon.

The order includes most of the soils that were classified as Humic Latosols and Humic Ferruginous Latosols by Cline (*5*).

Most of the Ultisols in Hawaii are classified in the suborder Humults, which are those Ultisols that have 1.5 percent or more organic matter in the upper part of the argillic horizon. Humults are further classified in the great group Tropohumults because of their tropical climate. The difference between the mean summer and mean winter temperatures is less than 9° F.

Humults

Thirteen soil series are classified in the subgroup Humoxic Tropohumults. These Tropohumults have a cation exchange capacity of less than 24 milliequivalents per 100 grams of clay and a mean annual soil temperature below 71.6° F.

Haiku soils have a dark-brown A horizon that has high bulk density and a B horizon that contains gibbsite nodules or sheets. They are gently sloping and are on uplands at elevations that range from near sea level to 1,200 feet. The average annual rainfall is between 50 and 80 inches. The mean annual soil temperature is 70° F. Haiku soils are clay and silty clay in texture and are high in iron oxides. Pauwela soils are clayey and have high bulk density in the A horizon. They have a high iron oxide content, a well-developed argillic horizon, and a mean annual soil temperature of 70° F. Haiku and Pauwela soils are classified in the clayey, ferritic, isothermic family of Humoxic Tropohumults.

Kokee soils have an A horizon of dark-brown silty clay loam over a B horizon of strong-brown and dark-brown heavy silty clay loam and silty clay. They occur at elevations of 3,400 to 4,200 feet. The average annual rainfall is 60 to 70 inches. The mean annual soil temperature is about 59° F. These soils are classified in the clayey, oxidic, isomesic family of Humoxic Tropohumults.

Honolua, Kalapa, Kaneohe, Leilehua, Lolekaa, Makawao, Olelo, Paaloa, Paumalu, and Waikane soils occur at elevations that range from near sea level to 3,500 feet. They have an average annual rainfall of between 40 and 100 inches. The mean annual soil temperature is between 63° and 71° F. All of these soils are silty clay or clay in texture in the upper part of the B horizon and are high in iron oxides. They are classified in the clayey, oxidic, isothermic family of Humoxic Tropohumults.

Halawa, Hamakuapoko, Manana, Alaeloa, and Ioleau soils are classified in the subgroup Orthoxic Tropohumults. This subgroup indicates that the soils are Tropohumults that have a cation exchange capacity below 24 milliequivalents per 100 grams of clay and are either dry in part of the profile for 60 consecutive days or more, or the mean annual soil temperature is 72° F. or higher.

Halawa soils occur at elevations that range from 500 to 3,000 feet. The annual rainfall is 30 to 60 inches. The mean annual soil temperature is 69° F. These soils have a dark reddish-brown surface layer that has high bulk density. The upper part of this layer has strong structure, but the lower part is structureless. The subsoil is reddish brown and dark reddish brown and has strong and moderate structure. Halawa soils are strongly acid to very strongly acid and have a strongly developed argillic horizon.

Hamakuapoko soils developed in residuum weathered from basic igneous rock. They occur at elevations of 500 to 1,200 feet. The annual rainfall is 40 to 60 inches. The mean annual soil temperature is 71° F. Hamakuapoko soils have an A horizon of dark-brown silty clay that has high bulk density. The B horizon has nearly continuous clay films on ped faces.

Manana soils developed in old alluvium and residuum at elevations of 500 to 1,200 feet. The annual rainfall is 40 to 60 inches. The mean annual soil temperature is about 70° F. These soils have a dark reddish-brown A horizon that has moderate structure and high bulk density over a dusky-red and dark reddish-gray, firm B horizon that has strong structure. A very compact layer occurs at a depth of 15 to 50 inches. Manana soils are strongly acid throughout and have a strongly developed argillic horizon.

Halawa, Hamakuapoko, and Manana soils are silty clay in texture and are high in iron oxides. Their mean annual soil temperature is between 69° and 71° F. They are, therefore, classified in the clayey, oxidic, isothermic family of Orthoxic Tropohumults.

Alaeloa soils developed in material weathered from basic igneous rock. They are at elevations of 100 to 1,750 feet. The average annual rainfall is 35 to 60 inches. The mean annual soil temperature is about 72° F. The A horizon is dark reddish brown and has strong structure. The argillic horizon has strong structure and continuous, thick clay films in the lower part.

Ioleau soils also developed in residuum from basic igneous rock. They occur at elevations of 100 to 750 feet. The average annual rainfall is 40 to 70 inches. The mean annual soil temperature is 72° F. These soils have a dark-brown A horizon over a compact, clayey B horizon.

Alaeloa and Ioleau soils are both silty clay to silty clay loam in texture, are high in iron oxides, and have a mean annual soil temperature of more than 71.6° F. They are classified in the clayey, oxide, isohyperthermic family of Orthoxic Tropohumults.

USTULTS

Two soils are classified in the suborder Ustults. These are Ultisols that are never saturated and are dry for 90 cumulative days but not continuously dry for 60 consecutive days. They are further classified in the great group Rhodustults because they have a epipedon that when moist has a color value of less than 4 and an argillic horizon that when dry has a value of less than 5 in all subhorizons.

Kalae and Puu Opae soils are classified in the subgroup Typic Rhodustults. Kalae soils developed in residuum and old alluvium influenced by volcanic ash. They occur at elevations that range from 750 to 2,200 feet. The annual rainfall is 30 to 50 inches. The mean annual soil temperature is 70° F. The A horizon is dark reddish brown and has moderately high bulk density. The B horizon is red and dark-red silty clay that has strong subangular blocky structure and continuous clay films.

Puu Opae soils occur in climatic and physiographic positions similar to those of the Kalae soils. They have a dusky-red A horizon and a reddish-brown silty clay argillic horizon.

Kalae and Puu Opae soils are silty clay in texture, are high in iron oxides, and have a mean annual temperature of about 70° F. They are classified in the clayey, oxidic, isothermic family of Typic Rhodustults.

Oxisols

Oxisols are generally reddish in color and have a rather featureless profile similar to that of the strongly weathered, tropical Mollisols and Inceptisols, which they closely resemble. In contrast with the Mollisols and Inceptisols they have a low cation exchange capacity and consist almost entirely of kaolin minerals and crystalline oxides of silica, iron, aluminum, and titanium, all of which are resistant to weathering. Oxisols characteristically occur in tropical regions where weathering is intense.

The order includes many of the Low-Humic Latosols and the Humic Ferruginous Latosols as classified by Cline (*5*).

Most of the Oxisols in Hawaii developed on low uplands in a semiarid to humid climate. They occur on the older islands of Kauai, Oahu, Maui, Molokai, and Lanai where factors are favorable for nearly complete weathering of primary minerals.

Four suborders of Oxisols occur in Hawaii: Humox, Orthox, Ustox, and Torrox. Humox soils have a relatively high organic-matter content, a mean annual soil temperature of less than 72° F., and less than 35 percent base saturation in the Oxic horizon. The prefix *Hum* indicates that the soils have a high organic-matter content. Orthox soils have a mean annual soil temperature of more than 72° F. or lack enough organic carbon to qualify as Humox. They are not dry for as long as 60 consecutive days in all parts of the moisture control section. The prefix *Orth* is derived from the Greek word meaning *true* or *common.* Ustox soils are dry in some or all parts of the moisture control section for more than 90 cumulative days in most years, but are continuously moist in some part for 90 consecutive days. The prefix *Ust*, derived from the Latin word meaning *burnt*, indicates a dry climate. Torrox soils are dry more than half the time in most years. The prefix *Torr*, derived from the Latin word meaning *hot* and *dry*, indicates a hot, dry climate. The suffix *ox* is derived from the order Oxisols.

Humox

Makapili, Pooku, Kahanui, Halii, and Kapaa soils are classified in the suborder Humox. They occur in areas where annual rainfall ranges from 60 to 200 inches. The high rainfall keeps the soils moist and accounts for the abundant vegetative cover, the high organic-matter content, and the strong structure in the A horizon. The base saturation is less than 35 percent. The bases are leached out of the soil and replaced by hydrogen cations. As a result, fertility is low.

Makapili and Pooku soils are placed in the great group Acrohumox. The prefix *Acr*, derived from the Greek word *akros*, indicates extreme weathering. Makapili and Pooku soils are classified in the typic subgroup of Acrohumox.

Makapili soils have a brown A horizon that has strong structure and a very strongly acid B2 horizon. Pooku soils have an A horizon of dark-brown silty clay that contains ironstone-gibbsite concretions. The B horizon is dark reddish brown. Because of clay loam or silty clay texture in the control section, a high iron oxide content, and a mean annual soil temperature of 71° F., Makapili and Pooku soils are classified in the clayey, ferritic, isothermic family of Typic Acrohumox.

Kahanui soils occur on uplands on the islands of Molokai and Lanai. They belong to the subgroup Petroferric Acrohumox because they have a petroferric (ironstone) contact within 50 inches of the surface. Kahanui soils have an A horizon of dark-brown, gravelly silty clay and a B horizon of dark yellowish-brown silty clay. The A horizon is gravelly because it contains many ironstone fragments. A discontinuous ironstone sheet occurs in the B horizon. Because of clay texture in the control section, a high iron oxide content, and a mean annual soil temperature of 62° F., Kahanui soils are classified in the clayey, ferritic, isothermic family of Petroferric Acrohumox.

Halii and Kapaa soils are classified in the great group Gibbsihumox because they have cemented sheets or 20 percent or more gravel-size aggregates that are 30 percent or more gibbsite. They are in the typic subgroup.

Halii soils receive 100 to 200 inches of rainfall annually. Vegetation is abundant. The A horizon is very dark grayish-brown gravelly silty clay loam, and the B horizon dark reddish-brown silty clay. The gravelly material consists of hardened, smooth ironstone pebbles. Because of silty clay texture in the control section, a high iron oxide content, and a mean annual soil temperature of about 71° F., Halii soils are classified in the clayey, ferritic, isothermic family of Typic Gibbsihumox.

Kapaa soils receive 80 to 120 inches of rainfall. They have weak structure throughout, lack smooth ironstone pebbles, are less than 40 percent free iron oxides in the control section, and have a mean annual soil temperature of 71° F. They are classified in the clayey, gibbsitic, isothermic family of Typic Gibbsihumox.

Orthox

Kunuweia and Puhi soils belong in the suborder Orthox. Puhi soils have a mean annual soil temperature of 72° F. or more and receive 40 to 150 inches of rainfall annually. Kunuweia soils have less than 20 kilograms of organic carbon per square meter within the upper meter (40 inches). Neither soil is dry below the surface 7 inches for 60 consecutive days or more in most years, nor is either saturated. Neither has plinthite that forms a continuous phase within 12 inches of the surface if saturated at this depth.

Soils in the Orthox suborder that have a cation retention capacity of 1 milliequivalent or less and contain no gravel-size aggregates that are 30 percent or more gibbsite are placed in the great group Acrorthoxs. Soils in this great group are extremely weathered. Kunuweia soils have plinthite and, therefore, are classified as Plinthic Acrorthox. They have a dark-brown, very gravelly A horizon. The B horizon contains discontinuous bands of plinthite. Because of clay loam texture in the control section, ferritic mineralogy, and a mean annual soil temperature of 58° F., Kunuweia soils are classified in the clayey, ferritic, isomesic family of Plinthic Acrorthox.

Puhi soils belong in the great group Umbriorthox. They are wetter than Lihue soils but drier than Kapaa soils. They are 1.8 percent humus in all horizons to a depth of 30 inches or more, have base saturation of less than 35 percent, have no sheets of gibbsite, and have a cation retention of more than 1 milliequivalent per 100 grams of clay. They are classified in the great group of Umbriorthox, and in the typic subgroup. Puhi soils have a silty clay loam control section, have more than 10 percent silicon dioxide in the whole soil, have no nodules or sheets that are more than 30 percent gibbsite, and have a mean annual temperature of 73° F. They are, therefore, classified in the clayey, oxidic, isohyperthermic family of Typic Umbriorthox.

Torrox

Oxisols that are dry for more than half the time (cumulative) in most years and have a mean annual soil temperature of 72° F. or more are placed in the suborder Torrox. The prefix *Torr* indicates that these soils are usually dry. Unless irrigated, they are too dry to cultivate. They are probably relicts preserved from some former pluvial period. The nine soil series in the suborder Torrox are so similar that no subdivisions seem justified at the great group or subgroup level. They are dominantly red in color, contain little organic matter, and have relatively high base saturation. They are classified as Typic Torrox.

Holomua, Keahua, Lahaina, Makaweli, Molokai, Niu, Uwala, Waikapu, and Wahikuli soils formed in residuum and alluvium derived from basic igneous rock. They are gently sloping to very steep and occur on uplands and alluvial fans where the rainfall is 15 to 40 inches annually.

Holomua soils have a dark reddish-brown, granular and subangular blocky A horizon and a dark reddish-brown silty clay loam B horizon.

Keahua soils have a dark reddish-brown, weak granular A horizon and a silty clay loam B horizon that has nearly continuous pressure cutans in the lower part.

Lahaina soils have an A horizon of dark reddish-brown silty clay, a dusky-red and dark reddish-brown B horizon, and black concretions throughout the solum that effervesce with hydrogen peroxide.

Makaweli soils have a dusky-red A horizon that has weak structure and a dusky-red B horizon that has weak prismatic structure.

Molokai soils have a dark reddish-brown A horizon that has weak granular and subangular blocky structure and is silty clay loam in texture. The B horizon is dark reddish brown and has weak prismatic structure in the upper part. These soils have black concretions that effervesce with hydrogen peroxide.

Niu soils have a dark reddish-brown A horizon that is silty clay loam in texture and a B horizon that has nearly continuous coatings on ped faces.

Waikapu soils have a dark reddish-brown, granular and subangular blocky A horizon that is silty clay loam in texture. The B horizon has subangular blocky structure and contains common fine black concretions.

Wahikuli soils are gently to moderately sloping and occur on uplands on the island of Maui. They have an A horizon that is silty clay in texture and a B horizon that has patchy pressure cutans on ped faces.

Uwala soils have a dark reddish-brown A horizon that has subangular blocky structure and a dark reddish-brown B horizon that has pressure cutans in the lower part.

All of these soils are clayey in the control section and have mineralogy dominated by tabular halloysite. All but Uwala soils have a mean annual soil temperature of more than 72° F. Therefore, all but Uwala soils are classified in the clayey, kaolinitic, isohyperthermic family of Typic Torrox. Uwala soils have a mean annual soil temperature of about 70° F. They are classified in the clayey, kaolinitic, isothermic family of Typic Torrox.

Ustox

Oxisols that are dry for 60 consecutive days or more in most years and have a mean annual soil temperature of 59° F. or more are placed in the suborder Ustox. The prefix *Ust* indicates a dry climate. Six soil series in this suborder are represented on the islands. They are further classified in the great groups Eutrustox and Haplustox because they have a cation retention capacity of more than 1 milliequivalent per 100 grams of clay. Soils in the Eutrustox great group have base saturation of 50 percent or more in the oxic horizon. Those in the Haplustox great group have base saturation of less than 50 percent in the oxic horizon. The prefix *Eutr*, derived from the Greek word *eutrophic*, indicates high base saturation. The prefix *Hapl*, derived from the Greek word *haplous*, indicates minimum horizon.

Because these Eutrustox and Haplustox soils either have no structure in the oxic horizon, or have an oxic horizon that extends to a depth of 50 inches or more, they are classified as Tropeptic Eutrustox and Tropeptic Haplustox respectively.

Koloa, Lihue, and Wahiawa soils are classified as Tropeptic Eutrustox. Koloa and Lihue soils have a mean annual soil temperature of 59° F. or more and receive 40 to 60 inches of rainfall annually.

Koloa soils have a dark reddish-brown A horizon that contains stones and a dark reddish-brown and dark-red B horizon. They are 20 to 40 inches deep over pahoehoe bedrock. Because they have silty clay texture in the control section, tabular halloysitic mineralogy, a mean annual soil temperature of 74° F., and are 20 to 40 inches deep, Koloa soils are classified in the clayey, kaolinitic, isohyperthermic, shallow family of Tropeptic Eutrustox.

Lihue soils occur on low uplands on the island of Kauai. They are similar to Koloa soils but are very deep. They have an A horizon of dusky-red silty clay and a dark reddish-brown to dark-red, very compact B horizon. Because they have clay texture in the control section, tabular halloysitic mineraligy, and a mean annual soil temperature of 73° F., Lihue soils are classified in the clayey, kaolinitic, isohyperthermic family of Tropeptic Eutrustox.

Wahiawa soils occur on broad, smooth uplands on the Wahiawa Plateau on the island of Oahu. They have an A horizon of very dusky red silty clay and a compact B horizon that has moderate or strong structure. Manganese compounds are common throughout the soil. Because of silty clay texture in the control section that is dominated by halloysite, and a mean annual soil temperature of 71° F., Wahiawa soils are classified in the clayey, kaolinitic, isothermic family of Tropeptic Eutrustox.

Helemano, Kahana, and Wailuku soils have base saturation of less than 50 percent in some part of the oxic horizon. They receive 20 to 60 inches of rainfall.

Helemano soils formed in colluvium and alluvium derived from basic igneous rocks. They occur on steep side slopes of drainageways on the island of Oahu. They have an A horizon of dark reddish-brown silty clay and a silty clay B horizon that has moderate structure. Wailuku soils have an A horizon of dark-brown silty clay loam and a very sticky and very plastic silty clay B2 horizon. Both Helemano and Wailuku soils are more than 35 percent clay in the control section, have tabular halloysitic mineralogy, and have a mean annual soil temperature of more than 72° F. Therefore, they are classified in the clayey, kaolinitic, isohyperthermic family of Tropeptic Haplustox.

Kahana soils have a dark reddish-brown A horizon that has moderate structure and a dark reddish-brown silty clay B horizon that has continuous pressure faces on peds. Because of a clayey control section that is dominated by tabular halloysite, and a mean annual soil temperature of 70° F., Kahana soils are classified in the clayey, kaolinitic, isothermic family of Tropeptic Haplustox.

Histosols

The Histosols in Hawaii are placed in the suborders Folists and Saprists.

Folists are organic soils that are never saturated with water or are saturated for only a few days at a time. They have a litter of leaves, twigs, and branches in varying stages of decomposition, ranging from fresh leaves to nearly completely humified material. In addition, they have a lithic contact less than 40 inches from the surface, or fragmental material in which the interstices are filled with organic material, or both. They do not have a mineral layer more than 4 inches thick above a lithic contact, and the organic material is more than twice the thickness of the mineral layer.

Saprists are bog soils that contain highly decomposed organic material. They occur in closed depressions where the ground water level tends to fluctuate within the soil allowing periodic aerobic decomposition. These soils have the least amount of plant fiber, the highest bulk density value, and the lowest water content at saturation of any of the three basic kinds of organic material on a dry weight basis.

Folists

Kaimu, Malama, and Opihikao soils are classified in the suborder Folists and in the great group Tropofolists. The prefix *Trop* is taken from the Greek word meaning tropical. Kaimu and Malama soils are further classified as Typic Tropofolists because they have fragmental material in which the interstices are filled with organic material in half or more of each pedon.

Kaimu soils have a thin, very dark-brown O2 horizon underlain by fragmental Aa lava. They are nonsmeary. Field moisture is less than 100 percent. Because of a neutral pH and a mean annual soil temperature of 73° F., Kaimu soils are classified as a member of the euic, isohyperthermic family of Typic Tropofolists.

Malama soils have a thin, very dark-brown O2 horizon underlain by fragmental Aa lava. They are weakly smeary. Field moisture is 130 to 175 percent. These soils have a pH of 5.4 and a mean annual soil temperature of 72° F. Therefore, they are classified as a member of the dysic, isohyperthermic family of Typic Tropofolists.

Folists that are underlain by pahoehoe lava within a depth of 40 inches are classified as Lithic Tropofolists. Opihikao soils are similar to the Malama soils but are underlain by pahoehoe lava bedrock within a depth of 20 inches. For this reason and also because they have a pH of 5.4 and a mean annual soil temperature of 72° F., Opihikao soils are classified in the dysic, isohyperthermic family of Lithic Tropofolists.

TABLE 6.—*Chemical and*

[Analyses made by Soil Survey Laboratories, SCS, Lincoln, Neb., and Riverside, Calif.,

Soil, sample number, and location	Depth	Organic carbon	Nitrogen	Free iron oxide (Fe_2O_3)	Bulk density [1]	Moisture retention [1]		Reaction		Cation exchange capacity (NH_4OAc)	Extractable bases			
						1/3 atmos.	15 atmos.	1:5 (H_2O)	1:5 (KCL)		Ca	Mg	Na	K
	In.	*Pct.*	*Pct.*	*Pct.*	*Gm./cc.*	*Pct.*	*Pct.*	*pH*	*pH*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*
Haiku clay:[3]	0–7	3.08	0.263	35.5	1.10	34.7	25.5	5.1	4.1	15.9	0.0	0.6	0.1	0.3
S62 Ha-4-2 (1–7),	7–13	2.79	.232	34.2	1.13	30.4	24.4	5.0	4.0	14.3	.0	.6	.1	.2
lat. 20°54′08″ N.,	13–18	1.98	.161	31.5	1.12	44.2	38.4	4.9	4.1	15.5	.2	.8	.2	.1
long. 156°17′42″ W.	18–28	1.78	.128	35.6	1.06	44.4	39.0	5.2	4.4	12.2	.6	.7	.4	.1
	28–39	1.08	.080	22.9	1.10	40.4	33.2	5.1	4.0	12.7	1.0	.8	1.0	.1
	39–62	.91	.059	19.9	1.10	43.2	33.5	5.0	4.0	12.0	.6	.2	.8	.1
	62–70	.74	.045	19.2	------	36.2	24.9	4.9	4.0	12.4	.4	.3	.8	.1
Hanalei silty clay:	0–6	2.30	.239	8.9	.75	63.5	43.8	4.8	3.9	33.9	12.5	14.4	.6	.2
S62 Ha-2-1 (1–6),	6–10	1.96	.173	8.9	.96	62.8	41.2	5.3	4.1	34.7	12.9	16.0	.5	.1
lat. 22°12′37.8″ N.,	10–13	1.46	.133	9.2	1.01	57.4	39.5	6.5	5.2	30.7	12.2	15.5	.5	(4)
long. 159°28′47″ W.	13–18	.84	.095	11.4	.87	63.3	42.8	6.6	5.3	35.7	12.6	17.2	1.0	.1
	18–26	.54	.067	15.3	.82	70.1	47.7	6.7	5.2	39.9	12.5	17.0	1.0	.1
	26–36	.42	------	13.7	.81	67.8	------	6.4	4.9	38.0	12.3	17.2	1.0	.1
Honouliuli clay:	0–15	.74	.073	10.7	1.30	30.2	22.3	7.1	5.8	27.0	12.2	12.5	1.4	.5
S62 Ha-7-5 (1–5)	15–26	.21	.039	11.0	1.49	28.1	20.9	7.5	6.2	24.9	12.5	11.5	1.9	.1
lat. 21°20′56″ N.,	26–36	.20	.029	11.3	1.48	27.7	21.5	8.0	7.0	25.5	17.0	11.3	2.1	.1
long. 158°02′23″ W.	36–48	.08	------	10.9	1.49	27.6	21.6	8.2	7.5	25.3	17.4	10.9	2.3	.1
	48–68	.02	------	11.0	------	27.2	21.6	8.2	7.2	24.6	18.1	11.2	2.4	.1

See footnotes at end of table.

Saprists

Saprists that occur in a climate in which there is a difference of less than 9° F. between the mean summer and mean winter temperatures are classified in the great group Troposaprists.

Alakai soils are on high ridges and in depressional areas atop Mt. Waialeale on the island of Kauai. They have a layer of decomposed debris and are underlain by gray mottled massive clay. Because of this inorganic layer, Alakai soils are placed in the subgroup Terric Troposaprists. They have a clayey subsoil, mixed mineralogy, a pH of less than 4.0, and a mean annual soil temperature of 56° F. Therefore, they are placed in the clayey, kaolinitic, dysic, isomesic family of Terric Troposaprists.

Laboratory Analysis of Selected Soils

Table 6 gives analytical data for 19 representative soil series in the survey area. All samples were collected from carefully selected pits. Soil fragments larger than 1 inch were discarded in the field. Fragments larger than 2 millimeters were discarded in the laboratory. Soil samples were kept moist, but all capacity measurements are reported on oven-dry basis.

The content of organic carbon was determined by the Walkley-Black wet-combustion method (1 milliequivalent $K_2Cr_2O_7$ equivalent to 3.9 milligrams carbon) (*9*).

Total nitrogen was determined by the Kjeldahl method modified by A.O.A.C. (*3*).

Free iron oxide was determined by dithionite-citrate extraction and orthophenanthroline colorimetry (*1*), modified by shaking overnight instead of heating.

Bulk density was determined from core samples oven dried at 105° C. Two samples were taken at each 3-inch increment to a depth of 60 inches. The reported values are averages for the horizons.

Moisture retention was determined at ⅓ atmosphere and 15 atmospheres using the Richards pressure membrane apparatus (*10*).

The pH was determined by glass electrode, using soil-water and soil-potassium chloride ratios of 1:5 for all except Io and Waiakoa soils, for which the ratios were 1:1 (*9*).

Cation exchange capacity was determined by direct distillation of adsorbed ammonia after saturation with ammonium acetate (*9*).

Extractable calcium, magnesium, sodium, and potassium were determined by extraction with neutral normal ammonium acetate (*9*). Calcium and magnesium were separated with alcohol and determined by EDTA titration (*4*). Sodium and potassium were determined on original extracts by using flame photometry (*6*).

Extractable aluminum was determined by extraction with neutral normal potassium chloride and fluoride titration (*19*).

Extractable sulfate was determined by extraction with neutral normal ammonium acetate and precipitation with barium sulfate by using a modification of the method devised by Richards (*11*).

Total analysis was determined by standard methods used by the Hawaii Agricultural Experiment Station of the University of Hawaii.

physical data of selected soils

except as otherwise indicated in footnotes. Dashes indicate data were not determined]

KCl extractable Al	NH_4OAc extractable SO_4	Base saturation (NH_4OAc)	Total analysis [2]											
			SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Loss on ignition	H_2O
Meq./100 gm.	*Meq./100 gm.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
0. 5	1. 7	6	15. 9	11. 0	7. 22	43. 8	0. 14	0. 92	0	0. 06	1. 09	0. 52	14. 7	5. 42
. 5	1. 6	6	16. 0	10. 7	10. 6	40. 9	. 11	. 73	0	. 07	1. 17	. 49	14. 8	4. 85
. 4	1. 3	8	12. 8	7. 16	13. 8	38. 7	. 06	. 06	0	0	. 90	. 52	16. 0	9. 31
. 2	1. 4	15	10. 3	5. 65	20. 1	32. 0	. 08	. 68	0	. 02	. 56	. 45	16. 7	13. 3
. 8	2. 0	23	17. 1	4. 74	24. 8	25. 7	. 11	. 89	0	0	. 28	. 35	16. 5	9. 64
1. 1	4. 4	14	15. 8	5. 15	27. 5	24. 1	. 11	1. 48	0	0	. 10	. 38	16. 1	8. 66
. 8	4. 1	13	15. 7	4. 76	30. 4	22. 8	. 14	1. 42	0	0	0	. 30	16. 6	7. 65
. 2	0	82	33. 4	4. 09	19. 1	15. 9	. 10	2. 94	1. 54	. 57	. 14	. 61	13. 1	8. 66
. 1	0	85	33. 4	4. 27	20. 0	16. 0	. 09	2. 89	2. 08	. 57	. 14	. 46	12. 2	8. 01
--------	0	92	34. 3	4. 10	20. 3	16. 1	. 12	2. 84	2. 12	. 53	. 09	. 48	11. 7	8. 03
--------	0	86	32. 1	4. 11	21. 0	18. 1	. 10	2. 45	1. 69	. 52	. 13	. 48	11. 3	8. 26
--------	0	77	30. 8	4. 15	20. 3	19. 5	. 09	2. 90	1. 46	. 52	. 08	. 50	10. 6	9. 34
--------	0	80	30. 2	3. 88	19. 8	21. 1	. 11	2. 61	1. 58	. 57	. 09	. 54	10. 3	9. 27
--------	. 2	98	33. 4	4. 75	21. 7	23. 7	. 79	. 21	. 10	. 22	. 04	. 29	11. 6	6. 01
--------	. 6	100	32. 1	3. 20	20. 5	25. 7	. 71	. 13	. 10	. 21	. 03	. 24	11. 5	5. 77
--------	. 4	100	33. 5	4. 47	19. 8	23. 1	. 35	. 18	. 07	. 22	. 04	. 31	11. 6	5. 67
--------	. 5	100	30. 7	5. 40	22. 4	21. 1	. 25	1. 41	. 91	. 29	. 04	. 59	10. 8	6. 22
--------	. 5	100	30. 8	5. 07	22. 6	21. 2	. 22	1. 34	1. 33	. 33	. 04	. 58	10. 7	6. 27

TABLE 6.—*Chemical and*

Soil, sample number, and location	Depth	Organic carbon	Nitrogen	Free iron oxide (Fe_2O_3)	Bulk density[1]	Moisture retention[1]		Reaction		Cation exchange capacity (NH_4OAc)	Extractable bases			
						1/3 atmos.	15 atmos.	1:5 (H_2O)	1:5 (KCL)		Ca	Mg	Na	K
	In.	*Pct.*	*Pct.*	*Pct.*	*Gm./cc.*	*Pct.*	*Pct.*	*pH*	*pH*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm*
Hoolehua silty clay:	0–9	1. 30	. 154	12. 0	1. 19	29. 2	21. 4	4. 0	3. 5	15. 6	1. 9	0. 9	0. 1	0. 8
S63 Ha–5–3 (1–6),	9–15	. 88	. 128	12. 7	1. 18	26. 2	23. 0	5. 1	4. 4	14. 6	6. 0	1. 8	. 1	. 7
lat. 21°09′34′′ N.,	15–21	. 44	. 085	12. 3	1. 19	26. 1	22. 4	6. 6	5. 6	11. 2	7. 8	1. 8	. 2	. 6
long. 157°03′08′′ W.	21–27	. 08	------	11. 9	1. 24	24. 2	21. 7	6. 8	5. 8	10. 4	7. 2	2. 5	. 2	. 6
	27–49	. 06	------	11. 9	1. 41	24. 1	20. 8	6. 8	5. 8	10. 1	5. 2	2. 9	. 2	. 6
	49–64	. 12	------	12. 6	1. 49	24. 5	20. 2	6. 2	5. 4	9. 8	3. 9	2. 9	. 1	. 6
Io silt loam:[3]	0–9	5. 81	. 455	12. 4	. 87	49. 9	35. 2	[5] 6. 7	[5] 5. 8	61. 1	35. 8	11. 7	. 4	6. 1
S65 Ha–4–22 (1–5)	9–16	2. 55	. 207	15. 2	. 88	50. 0	38. 1	[5] 7. 4	[5] 6. 5	65. 5	55. 5	22. 3	1. 7	4. 2
lat. 20°40′00′′ N.,	16–25	2. 58	. 201	13. 7	. 75	55. 7	43. 2	[5] 7. 4	[5] 6. 4	63. 1	42. 7	12. 3	6. 0	. 3
long. 156°24′10′′ W.	25–30	2. 92	. 010	3. 1	. 77	17. 7	14. 1	[5] 7. 8	[5] 6. 4	54. 3	34. 9	11. 7	2. 2	. 9
	30–39	. 79	. 072	15. 2	. 76	58. 1	51. 3	[5] 7. 5	[5] 6. 5	56. 7	39. 9	13. 7	6. 0	. 2
Kalae silty clay:	0–9	3. 35	. 363	23. 7	1. 25	29. 8	19. 3	6. 3	5. 3	17. 6	5. 6	2. 2	. 1	. 6
S63 Ha–5–1 (1–7),	9–15	. 61	. 134	26. 7	1. 54	20. 2	16. 1	6. 5	5. 5	7. 9	2. 6	1. 5	. 1	. 6
lat. 21°10′28′′ N.,	15–26	. 58	. 100	32. 5	1. 53	27. 9	23. 4	6. 6	5. 5	11. 7	3. 3	3. 1	. 5	1. 2
long. 157°02′37′′ W.	26–41	. 87	. 110	28. 6	1. 25	32. 3	28. 6	5. 4	4. 3	14. 8	2. 0	3. 1	. 6	1. 3
	41–53	1. 52	. 112	16. 6	1. 12	47. 2	38. 9	4. 7	4. 0	21. 1	. 7	1. 6	. 7	. 9
	53–62	1. 07	. 071	11. 3	1. 15	40. 6	33. 9	4. 5	3. 7	15. 6	. 5	1. 1	1. 1	. 3
	62–67	. 62	. 044	7. 4	------	34. 7	28. 1	4. 5	3. 4	13. 8	. 6	1. 1	1. 5	. 2
Kapaa silty clay:[3]	0–12	3. 92	. 217	34. 5	1. 13	36. 3	30. 0	5. 0	4. 5	15. 9	. 7	. 4	. 2	. 4
S65 Ha–2–5 (1–6),	12–16	1. 46	. 065	33. 3	1. 07	40. 1	35. 6	5. 5	5. 7	3. 7	. 2	(4)	. 1	. 2
lat. 22°01′34′′ N.,	16–25	1. 09	. 044	30. 5	1. 05	37. 3	30. 5	5. 5	5. 7	2. 6	. 4	. 1	. 2	. 1
long. 159°23′50′′ W.	25–36	. 64	. 023	26. 5	1. 12	38. 4	32. 1	5. 8	5. 7	1. 9	. 1	. 1	. 2	. 1
	36–49	. 46	. 019	24. 5	1. 16	38. 9	31. 7	5. 3	5. 4	3. 7	. 8	. 1	. 2	. 1
	49–60	. 48	. 019	24. 6	------	40. 5	34. 8	5. 5	4. 9	6. 1	1. 0	. 1	. 3	. 1
Keahua silty clay loam:	0–5	1. 09	. 138	12. 3	1. 12	26. 7	22. 2	5. 6	4. 7	15. 6	6. 2	2. 6	. 2	. 5
S63 Ha–4–4 (1–6A,	5–10	1. 10	. 129	13. 9	1. 14	25. 8	22. 1	5. 7	4. 8	14. 3	6. 4	2. 7	. 2	. 2
6B, 7), lat.	10–15	. 58	. 094	14. 2	1. 23	27. 5	22. 3	6. 3	5. 4	10. 2	5. 1	1. 8	. 1	(4)
20°49′56′′ N., long.	15–24	. 45	. 080	13. 9	1. 27	28. 9	22. 1	6. 4	5. 6	8. 8	4. 2	1. 7	. 2	(4)
156°23′50′ W.	24–33	. 28	------	12. 6	1. 35	28. 0	23. 6	6. 7	5. 8	10. 2	4. 6	2. 2	. 5	(4)
	33–48	. 17	------	9. 0	1. 32	29. 3	25. 1	6. 7	5. 5	14. 4	5. 1	2. 8	2. 0	(4)
	48–62	. 23	------	6. 7	1. 25	------	------	6. 3	5. 4	13. 7	4. 3	3. 2	2. 6	(4)
	0–11	3. 00	. 236	20. 4	. 94	49. 6	36. 0	4. 3	3. 8	15. 6	0	. 6	. 1	. 1
Lawai silty clay:[3]	11–22	1. 91	. 166	24. 2	. 93	63. 6	48. 6	4. 8	4. 1	13. 7	0	1. 0	. 1	. 1
S63 Ha–2–5 (1–5),	22–39	1. 18	. 106	24. 2	. 91	64. 9	51. 3	4. 9	4. 1	15. 9	. 8	1. 4	. 2	. 1
lat. 21°58′15′′ N.,	39–58	. 83	. 773	26. 3	. 93	68. 1	51. 7	4. 9	3. 9	15. 6	. 8	1. 4	. 4	. 1
long. 159°30′21′′ W.	58–64	. 58	. 048	22. 2	------	55. 0	39. 7	4. 8	3. 8	14. 1	. 7	1. 1	. 7	. 1
Lihue silty clay:	0–6	2. 66	. 273	18. 6	. 96	46. 1	33. 8	5. 5	5. 0	19. 1	6. 8	4. 4	. 2	. 8
S62 Ha–2–7 (1–6),	6–12	2. 00	. 213	18. 4	1. 03	46. 0	33. 6	5. 5	4. 9	17. 3	5. 3	3. 3	. 1	. 3
lat. 21°59′06.7′′ N.,	12–21	. 45	. 086	20. 6	1. 13	39. 7	32. 3	6. 3	6. 0	7. 9	3. 0	1. 9	. 2	. 2
long. 159°21′50′′ W.	21–27	. 37	------	21. 2	1. 21	38. 4	33. 0	6. 6	6. 2	7. 3	2. 7	1. 5	. 1	. 1
	27–48	. 42	------	22. 6	1. 21	39. 6	34. 2	6. 6	6. 2	7. 4	3. 0	1. 2	. 2	. 1
	48–60	. 44	------	23. 2	1. 19	40. 3	35. 0	6. 6	6. 2	8. 3	3. 6	1. 7	. 4	. 1
Lualualei clay:	0–1	. 66	. 082	10. 4	1. 29	31. 8	22. 0	7. 1	5. 9	34. 1	17. 1	15. 2	. 8	1. 4
S62 Ha–7–1 (1–6),	1–10	. 42	. 060	10. 0	1. 40	30. 0	22. 1	7. 2	5. 4	32. 9	15. 1	15. 1	1. 3	. 4
lat. 21°25′10′′ N.,	10–22	. 21	. 054	10. 7	1. 54	28. 4	22. 7	7. 2	5. 4	32. 9	14. 6	13. 4	2. 5	. 2
long. 158°09′00′′ W.	22–30	. 17	. 044	10. 4	1. 55	27. 8	21. 4	6. 8	5. 2	32. 1	16. 0	10. 5	3. 9	. 2
	30–49	. 17	------	9. 4	1. 54	28. 4	22. 3	5. 6	4. 9	29. 8	73. 1	9. 3	7. 2	. 2
	49–54	. 16	------	8. 6	1. 42	34. 5	25. 3	5. 8	5. 0	30. 6	73. 8	10. 7	8. 4	. 3
Mahana silty clay loam:	0–7	6. 15	. 413	31. 0	1. 22	41. 7	36. 7	5. 6	4. 7	27. 1	6. 1	2. 8	. 2	1. 0
S65 Ha–2–2 (1–6),	7–11	5. 18	. 289	27. 3	. 94	48. 5	38. 9	5. 4	4. 7	22. 6	1. 1	. 6	. 2	. 4
lat. 22°01′30′′ N.,	11–20	5. 40	. 267	25. 6	. 73	58. 3	42. 6	5. 2	4. 8	19. 4	. 2	. 1	. 2	. 2
long. 159°41′11′′ W.	20–35	3. 78	. 198	17. 1	. 70	65. 6	44. 6	4. 7	4. 7	17. 3	0	(4)	. 1	. 1
	35–48	2. 04	. 109	16. 0	. 98	49. 8	39. 4	4. 9	4. 6	15. 4	0	(4)	. 1	. 1
	48–61	. 94	. 052	16. 6	------	39. 1	35. 1	5. 0	4. 3	15. 5	. 2	. 3	. 2	. 1

See footnotes at end of table.

physical data of selected soils—Continued

KCl extractable Al	NH_4OAc extractable SO_4	Base saturation (NH_4OAc)	Total analysis [2]											
			SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	KO_2	P_2O_5	Loss on ignition	H_2O
Meq./100 gm.	*Meq./100 gm.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
2. 2	4. 7	24	25. 0	4. 49	25. 8	19. 9	1. 43	1. 54	. 62	0. 15	1. 09	2. 70	13. 1	4. 53
. 2	1. 9	59												
--------	1. 0	93	25. 8	4. 37	26. 4	20. 4	1. 26	1. 68	. 70	. 14	1. 05	2. 42	11. 8	4. 40
--------	1. 4	100												
--------	1. 5	88	26. 8	3. 98	27. 4	19. 6	. 71	1. 62	1. 06	. 16	1. 03	2. 98	11. 1	4. 40
--------	1. 7	76												
--------	0	88	25. 5	3. 60	18. 2	15. 6	. 28	4. 08	2. 20	. 41	. 50	. 65	16. 6	12. 9
--------	0	100	25. 4	3. 70	18. 4	16. 4	. 28	4. 06	2. 11	. 39	. 34	. 60	14. 4	14. 9
--------	0	97	24. 2	3. 78	18. 4	16. 3	. 23	3. 51	1. 66	. 38	. 19	. 50	13. 0	18. 2
--------	0	92	38. 2	3. 77	14. 8	14. 3	. 21	7. 32	7. 29	1. 71	. 59	. 47	4. 82	7. 30
--------	0	100	27. 3	4. 05	19. 6	17. 9	. 20	4. 21	1. 25	. 28	. 11	. 23	10. 7	14. 8
--------	. 3	48	16. 0	10. 8	10. 9	40. 0	. 38	2. 35	(4)	. 07	1. 23	. 85	12. 0	5. 81
--------	. 3	61	15. 7	11. 3	14. 2	44. 7	. 34	2. 10	(4)	. 05	1. 34	. 74	7. 51	2. 82
--------	. 3	69	19. 5	6. 78	17. 9	35. 8	. 14	1. 13	(4)	. 07	1. 25	. 90	10. 8	6. 19
. 2	1. 5	47	20. 3	3. 90	23. 4	27. 9	. 08	. 85	(4)	. 05	. 95	. 85	13. 9	8. 07
1. 6	2. 8	18	19. 7	3. 47	26. 2	18. 6	. 08	. 58	0	. 04	. 47	. 83	17. 0	12. 9
2. 2	3. 3	19	21. 3	4. 01	29. 0	17. 0	. 14	. 82	0	. 03	. 22	. 55	16. 6	10. 2
2. 4	2. 4	25	25. 6	3. 71	30. 6	13. 9	. 13	. 62	0	0	0	. 53	15. 3	9. 46
. 6	1. 8	11	6. 08	6. 71	21. 8	34. 2	. 05	. 28	(4)	. 03	. 25	. 56	19. 2	11. 5
--------	4. 7	14	3. 94	6. 39	24. 9	34. 7	. 08	. 22	0	. 03	. 10	. 49	17. 6	11. 6
--------	7. 6	31	3. 70	7. 19	25. 7	34. 5	. 07	. 07	0	. 03	. 06	. 52	17. 6	10. 7
--------	12. 0	26	3. 94	6. 76	29. 8	31. 1	. 15	. 12	0	. 03	. 06	. 57	18. 1	9. 32
. 1	4. 4	32	6. 48	6. 84	28. 1	32. 0	. 14	. 10	0	. 03	. 06	. 52	17. 2	8. 96
--------	11. 6	24	11. 6	7. 36	21. 7	32. 2	. 13	. 33	(4)	. 03	. 06	. 53	13. 6	12. 4
. 1	. 1	61	28. 3	5. 08	27. 9	20. 2	. 47	1. 15	. 02	. 18	. 35	. 41	11. 6	4. 25
0	(4)	66	28. 8	5. 09	28. 0	20. 2	. 49	. 95	. 03	. 16	. 30	. 44	11. 9	4. 20
--------	. 1	69	28. 0	5. 03	28. 8	20. 9	. 45	1. 14	. 03	. 16	. 29	. 27	11. 1	3. 99
--------	. 2	69	27. 7	5. 23	29. 0	20. 9	. 36	1. 09	. 02	. 17	. 28	. 41	11. 0	4. 39
--------	. 4	72	27. 4	5. 26	28. 7	21. 0	. 32	1. 14	. 02	. 15	. 20	. 33	10. 7	5. 35
--------	. 3	69	29. 2	6. 42	24. 3	20. 7	. 28	1. 06	. 02	. 15	. 05	. 19	10. 4	7. 44
--------	. 3	74	28. 2	6. 09	25. 5	20. 3	. 26	1. 24	. 01	. 17	. 06	. 22	10. 2	7. 75
2. 2	2. 8	5	18. 3	7. 90	22. 5	28. 9	. 07	. 74	0	. 07	. 99	. 29	15. 4	5. 94
. 6	2. 1	9	17. 3	5. 58	25. 0	28. 8	. 09	. 62	. 06	. 07	. 78	. 26	16. 1	5. 48
1. 2	2. 8	10	18. 2	4. 30	26. 4	27. 8	. 10	. 60	0	. 04	. 47	. 26	15. 5	6. 12
3. 6	4. 5	17	20. 9	3. 75	25. 4	26. 4	. 07	. 58	(4)	. 04	. 28	. 23	15. 1	7. 10
4. 9	6. 1	18	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------
(4)	. 3	64	21. 1	4. 20	28. 5	20. 8	1. 16	. 95	. 08	. 18	1. 11	. 56	17. 0	4. 20
--------	. 1	52	20. 8	4. 00	29. 7	19. 9	1. 35	1. 04	(4)	. 16	1. 11	. 60	16. 3	4. 72
--------	1. 0	67	23. 8	4. 40	30. 7	21. 8	. 50	. 56	(4)	. 21	1. 09	. 32	13. 5	3. 78
--------	. 9	60	22. 8	4. 75	29. 1	22. 9	. 23	. 62	(4)	. 19	1. 08	. 37	13. 2	3. 80
--------	. 9	61	24. 2	5. 38	28. 0	24. 0	. 15	. 45	(4)	. 18	. 78	. 37	12. 5	3. 84
--------	. 8	70	23. 1	5. 75	27. 2	25. 5	. 12	. 07	(4)	. 15	. 51	. 40	12. 4	4. 68
--------	. 9	100	28. 5	7. 20	18. 0	24. 5	. 28	1. 40	1. 47	. 24	. 07	. 47	10. 9	7. 05
--------	. 1	97	29. 6	7. 08	19. 0	24. 1	. 31	1. 39	1. 60	. 26	. 07	. 45	10. 1	7. 27
--------	. 1	93	31. 8	7. 04	17. 8	24. 6	. 42	1. 47	. 58	. 27	. 05	. 48	10. 2	6. 79
--------	1. 3	95	31. 3	7. 09	18. 3	24. 1	. 40	1. 61	. 32	. 35	. 06	. 34	9. 84	7. 10
--------	61. 2	----------	22. 0	5. 74	18. 6	22. 5	. 31	1. 47	2. 38	. 41	. 04	. 35	10. 6	7. 68
--------	63. 7	----------	29. 1	6. 06	18. 8	20. 6	. 35	1. 38	4. 05	. 45	. 06	. 27	10. 7	8. 38
. 3	. 2	37	16. 1	6. 97	15. 2	35. 6	. 10	. 76	. 10	. 04	. 36	. 50	16. 7	7. 58
. 9	. 2	10	14. 2	4. 74	19. 7	26. 4	. 03	. 47	(4)	. 04	. 28	. 37	16. 8	17. 0
1. 0	0	4	14. 9	4. 12	20. 6	23. 4	. 05	. 46	(4)	. 04	. 23	. 37	19. 6	16. 4
. 8	. 7	1	19. 1	3. 70	24. 0	18. 2	. 07	. 36	(4)	. 03	. 11	. 32	18. 5	16. 1
1. 3	. 7	1	23. 1	3. 41	26. 2	19. 1	. 07	. 44	. 04	. 03	. 07	. 33	16. 5	10. 9
5. 6	. 7	5	26. 6	2. 32	26. 6	21. 0	. 05	. 48	(4)	. 04	. 06	. 27	13. 4	8. 14

TABLE 6.—*Chemical and*

Soil, sample number, and location	Depth	Organic carbon	Nitrogen	Free iron oxide (Fe_2O_3)	Bulk density [1]	Moisture retention [1] 1/3 atmos.	Moisture retention [1] 15 atmos.	Reaction 1:5 (H_2O)	Reaction 1:5 (KCL)	Cation exchange capacity (NH_4OAc)	Extractable bases Ca	Extractable bases Mg	Extractable bases Na	Extractable bases K
	In.	*Pct.*	*Pct.*	*Pct.*	*Gm./cc.*	*Pct.*	*Pct.*	*pH*	*pH*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*	*Meq./100 gm.*
Makapili silty clay:	0–12	4. 90	. 387	31. 7	1. 01	41. 5	31. 8	5. 9	4. 5	21. 0	1. 5	2. 3	0. 3	0. 3
S63 Ha–2–4 (1–6),	12–14	2. 60	. 166	38. 9	1. 09	------	------	5. 1	4. 4	15. 3	. 5	. 9	. 2	. 1
lat. 22°13′14″ N.,	14–22	2. 51	. 147	40. 2	1. 00	39. 2	34. 8	5. 1	4. 5	14. 2	. 6	. 8	. 2	. 1
long. 159°28′46.9″	22–28	2. 11	. 118	43. 2	1. 13	40. 4	33. 7	5. 3	4. 9	12. 3	. 4	. 8	. 2	([4])
W.	28–44	. 98	------	35. 2	1. 29	32. 7	24. 6	4. 9	5. 3	5. 8	------	. 4	. 1	([4])
	44–60	. 78	------	38. 6	1. 19	34. 4	30. 1	4. 5	4. 8	3. 7	------	. 2	. 1	([4])
Nohili clay: [3]	0–14	1. 42	. 142	8. 3	1. 09	44. 6	34. 9	8. 7	7. 4	40. 7	29. 3	28. 0	1. 7	. 3
S63 Ha–2–8 (1–7),	14–22	. 91	. 102	10. 2	1. 08	42. 2	33. 6	8. 5	7. 3	44. 8	22. 8	24. 6	2. 0	. 2
lat. 21°22′42″ N.,	22–31	1. 33	. 128	4. 9	. 99	64. 1	43. 9	8. 8	7. 4	54. 6	36. 8	40. 8	3. 0	. 3
long. 159°45′18″ W.	31–37	. 59	. 065	2. 4	------	58. 6	38. 9	8. 8	7. 5	48. 8	37. 0	39. 8	2. 4	. 2
	37–46	. 27	------	1. 1	------	38. 4	26. 7	8. 9	7. 6	28. 2	33. 5	27. 9	1. 4	. 2
	46–55	. 17	------	. 9	------	------	------	8. 9	7. 7	30. 0	34. 1	28. 5	1. 6	. 2
	55–60	. 14	------	1. 4	------	------	------	8. 8	7. 5	42. 4	40. 2	35. 4	3. 0	. 4
Paaloa silty clay:	0–17	2. 43	. 166	25. 9	1. 27	32. 4	26. 4	4. 8	4. 4	14. 2	2. 0	. 2	. 2	. 2
S65 Ha–7–1 (1–5),	17–25	. 95	. 045	20. 0	1. 29	30. 5	25. 5	4. 7	4. 4	7. 6	0	0	. 2	. 1
lat. 21°36′02″ N.,	25–36	. 75	. 032	17. 4	1. 21	36. 1	30. 5	4. 8	4. 3	6. 2	. 2	([4])	. 2	. 1
long. 158°01′30″	36–45	. 78	------	19. 3	1. 15	36. 1	31. 3	4. 6	4. 3	7. 2	. 7	. 1	. 2	. 1
W.	45–60	. 79	------	20. 9	1. 08	39. 1	33. 4	4. 7	4. 3	14. 6	. 8	. 4	. 4	. 1
Pane silt loam:	0–8	8. 87	. 686	16. 3	. 70	64. 6	41. 0	6. 2	5. 4	53. 7	17. 5	6. 3	. 3	1. 7
S65 Ha–4–23 (1–6),	8–16	3. 51	. 299	14. 3	. 64	67. 1	49. 1	6. 6	5. 8	40. 6	11. 8	5. 4	. 4	1. 8
lat. 20°49′30″ N.	16–29	2. 57	. 211	14. 2	. 84	50. 6	40. 6	7. 1	5. 8	36. 6	7. 8	4. 7	. 7	. 9
long. 156°18′40″	29–39	1. 57	. 133	10. 7	. 94	51. 5	38. 6	6. 1	5. 4	25. 6	6. 1	2. 4	1. 5	. 5
W.	39–57	. 86	. 072	8. 6	------	41. 2	34. 9	6. 2	5. 2	29. 8	3. 0	3. 6	2. 2	1. 6
	57–65	. 29	------	5. 1	------	38. 6	28. 7	6. 2	5. 2	20. 3	. 2	4. 3	1. 4	4. 0
Puhi silty clay loam: [3]	0–9	4. 39	. 370	23. 6	. 91	46. 3	34. 2	5. 9	4. 9	19. 8	2. 2	2. 0	. 2	. 8
S63 Ha–2–2 (1–6),	9–21	1. 72	. 140	28. 0	. 92	50. 5	40. 3	5. 4	5. 4	9. 4	1. 0	. 6	. 2	. 2
lat. 22°03′30″ N.,	21–30	1. 27	. 084	29. 5	. 98	49. 2	42. 2	5. 8	5. 8	10. 8	1. 1	. 6	. 6	. 1
long. 159°22′30″	30–39	. 62	------	26. 3	1. 10	44. 1	38. 8	6. 0	5. 9	7. 2	. 9	. 8	. 9	. 1
W.	39–48	. 52	------	26. 2	1. 14	41. 1	34. 5	5. 8	5. 7	5. 9	. 9	. 9	1. 0	. 1
	48–60	. 41	------	24. 9	1. 15	44. 1	33. 2	5. 6	5. 3	6. 8	1. 0	. 8	1. 3	. 1
Waiakoa silty clay loam:	0–2	1. 59	. 130	11. 4	1. 30	27. 2	20. 9	[5] 6. 1	[5] 5. 3	16. 0	7. 8	4. 0	. 2	2. 5
S65 Ha–4–2b (1–5),	2–8	. 82	. 066	10. 7	1. 21	25. 6	19. 4	[5] 6. 2	[5] 5. 2	14. 7	6. 6	3. 1	. 3	2. 3
lat. 20°47′20″ N.,	8–16	. 80	. 066	10. 6	1. 14	26. 4	20. 2	[5] 6. 1	[5] 5. 2	13. 8	6. 1	2. 9	. 5	. 9
long. 156°24′30″	16–25	. 57	. 053	7. 4	1. 08	34. 2	23. 2	[5] 6. 6	[5] 5. 2	14. 7	5. 6	2. 8	1. 3	. 2
W.	25–33	. 28	------	5. 1	------	40. 6	23. 3	[5] 7. 1	[5] 5. 8	19. 2	8. 2	3. 9	2. 5	. 1
Waihuna clay: [3]	0–4	1. 11	. 132	13. 0	------	34. 3	26. 6	5. 0	4. 0	20. 0	8. 9	3. 7	. 2	. 6
S62 Ha–3–1 (1–6),	4–17	1. 51	. 168	13. 0	------	35. 6	28. 9	4. 5	3. 6	22. 8	6. 4	2. 4	. 1	. 5
lat. 20°49′39″ N.,	17–23	. 40	. 080	13. 4	------	35. 5	29. 4	5. 9	5. 0	20. 4	9. 5	4. 9	. 2	1. 3
long. 156°55′41″	23–37	. 29	------	13. 9	------	36. 5	30. 8	6. 0	5. 1	19. 8	8. 3	7. 6	. 4	1. 0
W.	37–54	. 16	------	14. 2	------	36. 9	31. 4	4. 7	3. 6	18. 0	3. 6	7. 8	. 5	. 3
	54–64	. 22	------	13. 6	------	35. 5	30. 2	4. 8	3. 7	19. 4	5. 3	8. 6	. 5	. 4

[1] Bulk density and moisture retention values were determined by Hawaii Sugar Planters Association, Honolulu.
[2] Total analysis was determined by Hawaii Agricultural Experiment Station, Univ. of Hawaii, Honolulu.
[3] Data is for the paired sample of the soil profile described in the section "Descriptions of the Soils."

physical data of selected soils—Continued

KCl extractable Al	NH₄OAc extractable SO₄	Base saturation (NH₄OAc)	Total analysis [3]											
			SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	Loss on ignition	H_2O
Meq./100 gm.	*Meq./100 gm.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
0.2	0.6	21	10.9	6.59	22.0	31.8	0.08	0.64	0.03	0.09	1.04	0.57	20.5	7.14
.2	1.2	11	----	----	----	----	----	----	----	----	----	----	----	----
.1	1.6	12	7.30	5.56	18.2	41.8	.05	.36	(4)	.08	.76	.57	18.0	9.34
(4)	2.8	11	4.14	5.93	21.8	40.3	.05	.28	(4)	.07	.56	.54	18.7	7.56
(4)	9.4	9	1.88	5.89	28.5	37.4	.09	.30	(4)	.05	.24	.56	20.2	5.00
(4)	16.2	8	----	----	----	----	----	----	----	----	----	----	----	----
----	.2	100	33.7	3.50	18.9	17.9	.23	2.68	1.78	.28	.18	.29	12.1	8.68
----	.2	100	33.7	3.55	20.5	19.6	.26	2.64	1.22	.30	.16	.29	11.2	7.16
----	.4	100	34.9	2.82	16.9	14.2	.09	3.48	3.82	.25	.14	.24	14.3	9.94
----	.5	100	----	----	----	----	----	----	----	----	----	----	----	----
----	.3	100	----	----	----	----	----	----	----	----	----	----	----	----
----	0	100	----	----	----	----	----	----	----	----	----	----	----	----
----	.6	100	----	----	----	----	----	----	----	----	----	----	----	----
.8	.3	18	19.3	9.52	21.2	28.3	.09	.80	(4)	.11	1.58	.34	13.9	5.06
1.8	1.0	4	13.1	5.71	33.2	24.4	.08	.32	(4)	.04	.38	.23	18.9	3.32
1.3	13.9	8	12.5	5.36	35.4	23.7	.10	.28	(4)	.06	.22	.27	18.9	3.24
1.2	3.4	15	15.5	5.71	32.6	24.5	.08	.37	0	.03	.19	.32	17.6	3.06
1.2	1.6	12	16.4	5.72	29.8	27.0	.06	.35	0	.03	.16	.33	16.7	3.46
.2	0	48	17.3	3.88	20.2	17.8	.54	1.16	.63	.08	.59	.95	23.2	14.1
----	0	23	16.9	3.67	24.9	16.0	.41	.94	.32	.06	.46	.74	17.8	18.2
----	0	38	17.5	3.06	25.7	16.3	.41	.98	.15	.06	.39	.76	16.5	18.4
----	0	41	20.4	3.22	26.8	16.6	.34	.92	.20	.22	.29	.61	15.3	15.5
----	.2	35	24.9	3.28	29.1	15.3	.30	1.16	.04	.13	.25	.49	14.3	11.2
----	.4	49	----	----	----	----	----	----	----	----	----	----	----	----
.2	.8	26	16.4	4.23	31.2	28.1	.17	1.92	(4)	.10	.71	.60	12.3	5.81
.1	2.8	21	17.4	4.69	31.9	32.0	.08	1.52	(4)	.08	.50	.49	80.5	2.55
----	1.6	22	20.8	5.40	21.1	32.5	.09	1.32	0	.10	.31	.54	11.4	5.70
----	3.4	38	20.3	5.01	19.5	31.2	.10	.45	0	.10	.14	.44	14.6	7.58
----	5.6	49	15.2	4.78	27.5	30.4	.09	.56	0	.12	.10	.48	15.8	5.33
----	7.6	47	17.4	4.48	25.5	30.8	.13	.47	0	.08	.08	.58	14.7	5.98
----	0	91	26.8	5.07	28.7	20.2	.28	1.22	.27	.14	.33	.37	12.6	4.38
----	0	84	26.2	4.96	29.9	20.1	.28	1.11	.18	.14	.33	.34	11.9	4.72
----	0	75	26.3	5.36	29.0	20.8	.28	1.13	0	.14	.25	.34	12.3	4.38
----	0	67	26.2	4.41	29.6	20.4	.24	1.32	0	.18	.03	.44	12.4	5.24
----	0	76	----	----	----	----	----	----	----	----	----	----	----	----
.2	1.6	67	28.7	3.84	24.7	21.3	.77	.80	.82	.13	.05	.19	13.2	6.78
1.9	1.9	41	28.5	3.77	24.0	21.2	.81	.66	.96	.14	.04	.24	13.9	7.32
.1	1.2	78	28.8	3.66	22.6	22.6	1.20	.88	1.20	.12	.04	.22	12.5	7.04
(4)	1.7	87	28.6	3.58	23.4	22.5	.91	.85	1.17	.08	.06	.22	11.8	7.49
1.4	3.7	68	30.2	3.64	23.1	22.2	.62	.83	.84	.07	.03	.19	12.0	7.02
.6	4.6	76	30.1	3.91	23.6	23.2	.42	.66	.49	.06	.04	.17	11.5	6.71

[4] Trace.
[5] Determined in 1:1 ratio of soil to water and soil to potassium chloride.

General Nature of the Islands

This section contains general information about the history of the islands, the geology and physiography, the climate, the population, the transportation, the tourist industry, and the farms and ranches.

History

Little is known about the Hawaiian Islands before 1778 when Captain James Cook first sighted Oahu and Kauai. At the time of Cook's visit, the islands were divided into four kingdoms. Kamehameha, a chief, was rising to power on the island of Hawaii. By 1810, he had united all the islands into one kingdom.

Missionaries arrived from New England in 1820. They transcribed the spoken Hawaiian language into writing, translated hymns and parts of the Bible into Hawaiian, and taught the natives to read and write.

In 1835, the sugar industry was established at Koloa, Kauai. With increasing acreage and production, the need for additional labor increased. In 1852, Chinese immigrants arrived to work in the sugar fields. They were the first of a long list of immigrants, including Chinese, Japanese, Portugese, Koreans, Germans, and Filipinos.

The pineapple industry was established near the turn of the century in Wahiawa, Oahu.

In 1900, Hawaii became a territory of the United States, and in 1959, it officially became the 50th State.

Geology and Physiography

The area surveyed consists of five of the eight major islands in the State of Hawaii. These five islands form a chain that extends in a northwest-southeast direction. They are the summits of volcanic domes built up from the ocean floor through countless eruptions. In general, the volcanic activity moved from northwest to southeast. Kauai, on the northwest, is therefore the oldest island in the survey area, and the eastern part of Maui on the southeast is the youngest.

The islands formed primarily in thin-bedded pahoehoe and Aa lava flows. The rocks are mostly basaltic; the basalt is about 50 percent silica. Andesitic rocks as well as volcanic ash and cinders occur in a few places. Adjacent to the ocean is a small amount of coral limestone and coral sand.

The relief of the islands varies. The once smooth volcanic domes have been weathered and eroded. The older islands are deeply dissected; their surface is one of ridges, valleys, and alluvial fans. In contrast, the eastern part of Maui is relatively smooth, and the original shape of the volcano is still apparent.

Climate [7]

The climate of Hawaii is unusually pleasant for the tropics. Its outstanding features are the remarkable differences in rainfall over short distances, the mild temperatures, and the persistence of the northeasterly trade winds.

The major climatic influences in this region are the latitude—the State lies well within the geographic tropics; the surrounding ocean, which has a moderating influence on temperature; and the Pacific anticyclone, from which the trade winds flow. Between about October and April, storms that migrate eastward across the Pacific north of Hawaii, or the storms that form nearby, occasionally bring in spells of bad weather and widespread heavy rains.

The most important influence on all the weather elements is Hawaii's topography. Elevations range from sea level along the coastal plains to heights of about 5,170 feet on Kauai, 4,025 feet on Oahu, 10,025 feet on Maui, 4,970 feet on Molokai, and 3,370 feet on Lanai. More important than mere elevation, moreover, is the ruggedness of the terrain, in which each valley bottom, slope, and steep-sided ridge has its own local climate.

Rainfall.—Over the open sea in the Hawaiian area, rainfall averages between 25 and 30 inches a year. Yet the State itself receives more than 10 times this amount in some places, and less than half in others. Except for Lanai, where maximum rainfall is about 50 inches, each of the major islands has regions in which the mean annual rainfall approaches or exceeds 300 inches. Mt. Waialeale, on the island of Kauai, which has 486 inches of rain a year and is known as the wettest spot on earth, is only 15 miles from Barking Sands, which receives less than 20 inches annually. Table 7 gives precipitation data for six selected stations.

The principal cause of this remarkable variability is the orographic, or mountain-caused, rain that forms within the moist air from trade winds as it ascends and traverses the steep and high terrain of the islands. The resulting rainfall distribution, in the mean, closely resembles the topographic contours. The amount is greatest over windward slopes and crests and is least toward the leeward lowlands.

The lowlands obtain moisture chiefly from a few winter storms, and only negligibly from trade-wind showers. Thus, rainfall in the normally dry areas is strongly seasonal. Summers are arid. Seasonal differences are much smaller in the wetter areas, where rainfall is derived from both the winter storms and the year-round, trade-wind showers. For example, at Kaunakakai, a very dry station where the mean annual rainfall 12.5 inches, June and July together account on the average for less than 1 percent of the annual rainfall; but in Wahiawa where rainfall measures 50 inches a year, June and July account for 10 percent, and in Kahana where it measures 240 inches a year, they account for 17 percent. No data from the Kahana station are given in table 7.

The number of rainy days a year also varies widely from place to place; the number is greatest in areas where the mean annual rainfall is higher. Kaunakakai, for example, receives 0.1 inch or more of rainfall on an average of 15 days a year and 0.5 inch or more on only 6 days. In contrast, Wahiawa receives 0.1 inch or more on an average of 81 days a year and 0.5 inch or more on 25 days. Kahana receives 0.1 inch or more on an average of 200 days a year and 0.5 inch or more on 65 days.

Another source of rainfall is the deep cumulus clouds that build up over mountains and interiors on clear calm afternoons. Although such convective showers may be

[7] By Saul Price, regional climatologist, National Weather Service, U.S. Department of Commerce.

TABLE 7.—*Precipitation data for selected stations*

[Dashes indicate no data available for specified amount of precipitation]

Month	Percent frequency of indicated amount							Mean monthly
	0.50 inch or less	0.51–1 inch	1.01–3 inches	3.01–5 inches	5.01–10 inches	10.01–20 inches	More than 20 inches	
KILAUEA FIELD 17, KAUAI NO. 1135 [Period of record 1931–67. Mean annual precipitation 93.14 inches]								
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*In.*
January	0	0	16	14	38	27	5	10.09
February	0	0	7	22	51	14	5	8.18
March	0	0	5	11	43	32	7	9.88
April	0	0	7	27	38	19	7	7.81
May	0	0	11	5	70	7	5	7.59
June	0	3	22	35	35	5	0	5.05
July	0	0	5	27	59	7	0	6.71
August	0	0	3	16	65	16	0	7.69
September	0	3	27	24	41	5	0	5.28
October	0	3	5	24	46	22	0	7.07
November	0	0	5	19	43	27	5	8.28
December	0	0	0	11	51	35	3	9.51
KANEOHE (MAUKA), OAHU NO. 781 [Period of record 1931–60. Mean annual precipitation 65.09 inches]								
January	0	0	20	20	37	23	0	7.30
February	0	0	10	33	43	7	7	7.22
March	0	0	20	33	23	23	0	7.26
April	0	0	30	23	33	13	0	5.53
May	0	0	40	33	20	7	0	4.55
June	0	7	50	37	3	3	0	2.94
July	0	3	40	23	27	7	0	4.31
August	0	3	27	37	33	0	0	4.29
September	0	3	43	27	27	0	0	3.81
October	0	3	37	17	30	13	0	5.75
November	0	0	30	20	43	7	0	5.28
December	0	0	10	27	47	17	0	6.85
WAHIAWA, OAHU NO. 872 [Period of record 1931–60. Mean annual precipitation 51.5 inches]								
January	3	7	20	23	30	10	7	6.47
February	0	3	17	20	47	10	3	6.42
March	0	0	23	36	20	17	3	6.29
April	0	3	57	23	13	0	3	3.57
May	7	7	60	17	10	0	0	2.49
June	0	10	70	17	3	0	0	2.49
July	0	3	63	23	10	0	0	2.75
August	3	3	47	20	27	0	0	3.59
September	7	3	73	17	0	0	0	2.24
October	3	3	57	13	10	13	0	4.15
November	3	3	27	27	30	10	0	4.84
December	0	0	33	13	36	17	0	6.17

See footnotes at end of table.

TABLE 7.—*Precipitation data for selected stations*—Continued

WAIAWA, OAHU NO. 836 [1]

[Period of record 1931–60. Mean annual precipitation 138.79 inches]

Month	Percent frequency of indicated amount							Mean monthly
	0.50 inch or less	0.51–1 inch	1.01–3 inches	3.01–5 inches	5.01–10 inches	10.01–20 inches	More than 20 inches	
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*In.*
January	----------	----------	----------	23	23	40	13	11. 64
February	----------	----------	----------	10	50	27	[2] 10	12. 94
March	----------	----------	----------	13	10	63	13	13. 84
April	----------	----------	----------	7	37	50	7	11. 40
May	----------	----------	----------	10	33	50	7	11. 84
June	----------	----------	----------	7	33	57	3	10. 84
July	----------	----------	----------	0	20	67	13	13. 30
August	----------	----------	----------	0	27	60	13	4. 41
September	----------	----------	----------	13	40	43	3	9. 97
October	----------	----------	----------	13	33	43	10	11. 02
November	----------	----------	----------	13	27	53	7	12. 10
December	----------	----------	----------	3	30	43	23	15. 49

KAUNAKAKAI, MOLOKAI NO. 536

[Period of record 1933–62. Mean annual precipitation 12.5 inches]

Month	0.50 inch or less	0.51–1 inch	1.01–3 inches	3.01–5 inches	5.01–10 inches	10.01–20 inches	More than 20 inches	Mean monthly
January	23	10	33	10	23	0	----------	2. 58
February	40	13	27	17	3	0	----------	1. 74
March	37	10	30	13	7	3	----------	1. 99
April	70	13	7	7	3	0	----------	. 74
May	77	7	13	3	0	0	----------	. 40
June	97	3	0	0	0	0	----------	. 03
July	97	0	3	0	0	0	----------	. 07
August	80	10	10	0	0	0	----------	. 22
September	83	13	3	0	0	0	----------	. 14
October	63	3	20	7	7	0	----------	1. 22
November	50	10	27	7	3	3	----------	1. 57
December	30	20	30	13	7	0	----------	1. 75

MAUNALOA, MOLOKAI NO. 511

[Period of record 1933–62. Mean annual precipitation 27.84 inches]

Month	0.50 inch or less	0.51–1 inch	1.01–3 inches	3.01–5 inches	5.01–10 inches	10.01–20 inches	More than 20 inches	Mean monthly
January	7	13	33	10	27	10	----------	4. 27
February	7	10	40	23	17	3	----------	3. 08
March	3	20	27	33	10	7	----------	3. 77
April	17	13	53	7	3	7	----------	2. 31
May	10	43	37	10	0	0	----------	1. 47
June	67	17	13	3	0	0	----------	. 75
July	27	30	37	3	3	0	----------	1. 26
August	27	33	33	3	3	0	----------	1. 20
September	33	23	37	7	0	0	----------	1. 11
October	23	10	50	7	3	7	----------	2. 37
November	7	17	47	13	13	3	----------	2. 75
December	0	7	43	30	20	0	----------	3. 50

[1] Percentage figures in column headed "3.01–5 inches" based on 5 inches or less of rainfall. Percentage figures in column headed "More than 20 inches" based on 20.01 to 40 inches of rainfall.

[2] Percentage figure based on more than 40 inches of rainfall.

intense, they are usually too brief and localized to contribute significantly to the total water supply.

Hawaii's heaviest rains are brought by winter storms. Although the effects of terrain are not so obvious as in trade-wind showers, large differences in rainfall over small distances do occur, because of the topography and the path and structure of the rain clouds. Frequently, the most copious storm rains do not occur in localities that have the greatest average rainfall; nor is it uncommon during such storms for relatively dry areas to receive within a single day, or even a few hours, half or more of their mean annual rainfall. For example, downtown Honolulu has an average yearly rainfall of only 24 inches, but it has received more than 17 inches in a single day.

Intensities of 2 inches of rain an hour are not infrequent, and even the dry regions on Oahu have an average recurrence interval of only 5 years or less. In many of the farming areas, hourly intensities of 2.5 inches can be expected, and over the island as a whole, 3 inches an hour is by no means rare. Hawaii's heaviest rain was the more than 40 inches recorded at Kilauea Plantation, Kauai, in a 24-hour period in January 1956. Of this, 6 inches fell in 30 minutes and more than 11 inches in a single hour. Flash flooding is a recurrent problem and results in frequent damage to fields, crops, and other property.

Another important, but often neglected, source of water is that directly extracted from passing clouds by vegetation and by the soil in areas where an elevation of 2,500 feet or more brings them into the cloud belt. For example, at Lanaihale, the contribution of what is locally called "fog drip" to soil moisture appears to be about equal to that of rainfall.

At the opposite extreme, neither is *drought* uncommon in Hawaii, although it rarely affects more than part of even a single island at one time. Drought occurs when either the winter storms or the trade winds fail. If the winter storms fail, the leeward areas, which receive little rain from trade winds, are hardest hit. A dry winter between two normally dry summers can have very serious consequences. The failure of the trades most affects mountain and upland regions, including many of the sources of irrigation water. The probability of serious drought somewhere in Hawaii during any given 10-year period exceeds 90 percent.

TEMPERATURE.—Mean annual temperatures in Hawaii vary between about 72° and 75° F., near sea level, decrease by about 3° for each 1,000 feet of elevation, and tend to be higher in sunny dry areas. They are higher, for example, in the leeward lowlands, than in those areas that are cloudier, wetter, and more directly exposed to the trades. The average annual temperature at Mountain View, Hawaii (1,530 feet) is 67°; at Haleakala Branch Experiment Station (2,100 feet) 66°; at Kula Sanatorium (3,004 feet), 64°; at Hawaii National Park (3,971 feet) 61°; at Haleakala Ranger Station (7,030 feet) 54°; and at Mauna Loa Observatory (11,150 feet), 45°. Table 8 gives the average daily maximum and minimum temperature at six selected stations.

The average difference between daily high and low temperatures is between 10° and 20°; the higher readings occur in areas that are lower, drier, and less open to the wind. For example, on Oahu the daily range is 19° at Ewa Plantation, 13° at Kahuku, and only 8° at Makapuu Point. Lanai City, under its orographic cloud cap, is kept cooler during the day and warmer at night than Lanai Airport, which is less than 4 miles away, and the city has a mean daily range of 13° as compared with 17° at the airport.

August and September are the warmest months of the year, and January and February are the coolest. The seasonal range of temperature is only 6° to 8°, which is far below the daily range. Hence, throughout the State, the temperature varies more in the course of an average day than it does from season to season. In addition, the average nighttime temperature during most of the year is below the average temperature of the coolest months.

Almost everywhere at low elevations, the highest temperatures of the year are in the low 90's and the lowest temperatures near 50°. The warmest days are usually during Kona weather, when the trade winds, which come from cooler latitudes, fail and air stagnates over the heated islands.

As an example of the role of afternoon cloudiness in holding down the maximum temperatures, Maunaloa, at an elevation of 1,100 feet in dry West Molokai, has registered 90° or above in May through November, and 96° in September, while Lanai City only a few hundred feet higher, but shielded from the afternoon sun by an orographic cloud cap, has had no temperature higher than 88°.

WIND.—The prevailing wind throughout the year is the east-northeasterly trade. The trades vary greatly in frequency they are virtually absent for long periods at some times and blow for weeks on end at others. On the average, however, the trade winds are more persistent in summer than in winter. At Honolulu they range from a minimum of about 45 percent in January to a maximum of more than 90 percent in July, for an annual frequency of about 70 percent.

In well-exposed areas, the trades average somewhat under 15 miles an hour. They are slightly stronger in summer than in winter. A speed of 31 miles an hour is exceeded only about 2 percent of the time by the trades and 3 percent by winds from other directions.

The strongest and most damaging winds are not ordinarily the trade winds but the winds that accompany winter storms and the infrequent hurricanes. High winds are most likely between November and March and blow from almost any direction. The strongest of recent years was a gust of 103 miles an hour at Kilauea Point, Kauai, in August 1959, during Hurricane DOT, but gusts exceeding 80 miles an hour have occurred twice at Honolulu Airport since 1951 and occasionally elsewhere.

The effect of topography on the local wind is varied and profound, ranging from a complete sheltering from winds from certain directions to deflections and accelerations, that is, through passes and narrow valleys and over crests, that can transform a moderate wind into a strong and gusty one. Thus, the Hoolehua plains, the windward side of west Molokai, and the north end of Lanai are subject to severe wind erosion and occasional crop damage by strong trades funnelling between the highlands of east and west Molokai or through the channel between Molokai and Lanai. At Molokai Airport, in the central saddle, winds exceed 15 miles an hour nearly

Table 8.—*Average daily maximum and minimum temperatures at selected stations*

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
° F.	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*	*° F.*
Kilauea Field 17, Kauai No. 1135											
75.6	74.9	75.5	76.4	78.2	80.3	80.9	81.9	81.9	80.2	78.2	75.7
60.5	59.7	61.3	62.8	64.8	67.0	68.1	68.8	68.0	66.5	65.6	63.0
Kaneohe (Mauka), Oahu No. 781											
77.4	77.2	77.3	78.2	79.6	81.5	82.0	82.4	82.8	81.9	80.0	77.9
64.9	64.8	65.1	66.7	68.2	69.7	70.7	71.2	70.3	69.7	68.2	66.2
Wheeler Field, Oahu No. 810											
75.9	76.0	76.1	76.6	79.0	81.0	81.7	82.4	82.6	81.7	78.8	76.3
60.0	60.0	60.9	62.3	63.9	65.7	67.0	67.4	66.6	65.6	63.9	62.2
Kailua, Maui No. 446											
75.5	74.7	75.1	75.7	76.4	78.1	79.0	79.4	80.4	79.8	77.5	75.0
61.5	61.1	61.5	62.8	64.2	65.6	66.5	67.1	66.7	65.8	64.6	62.9
Lahaina, Maui No. 361											
80.7	80.6	80.7	82.6	84.0	85.8	87.1	87.4	87.1	86.5	84.6	82.3
61.8	61.9	62.0	63.2	64.8	66.4	67.6	68.1	67.4	66.8	65.3	63.4
Maunaloa, Molokai No. 511											
77.1	76.8	77.3	77.6	79.9	82.8	83.5	84.6	84.3	82.7	79.9	77.6
60.5	60.7	61.2	61.9	63.6	65.2	65.8	66.7	66.2	65.6	63.8	61.9

60 percent of the time during the entire year, and more than 75 percent of the time during the summer months.

In contrast, the Kona coast of Hawaii Island is so completely sheltered by the mountains to the east that the trades are never experienced near sea level, and local land and sea breezes constitute the prevailing winds.

Cloud Cover.—On sunny trade wind days, all but Hawaii's tallest mountains are typically capped by cumulus clouds that overhang and shadow the slopes and coastal plains. The bases rest upon the crest. These clouds form within the moist marine air ascending the topographic barriers and dissipate again as the air descends to the lee. Hence, clouds are more frequent and extensive over windward coasts and mountains than over leeward plains and shores. At Honolulu Airport, which receives 22 inches of rainfall annually and is well to the lee of the Koolaus, skies are clear (sky cover is three-tenths or less) about 26 percent of the time, and cloudy (sky cover is eight-tenths or more) about 28 percent of the time. In contrast, Lihue Airport, on Kauai's windward coast, is clear 14 percent of the time and cloudy 40 percent.

These are seasonal and diurnal variations in cloudiness. In all months of the year, probably because of solar heating, clouds tend to be more abundant during the day than at night. Widespread persistent cloudiness is principally a phenomena of large-scale winter storms. Presumably for this reason, skies are cloudy more often in winter than in summer. At Honolulu, for example, skies are cloudy on 29 percent of January days but on only 16 percent of July days. The heaviest overcast, however, seldom lasts for more than a day or two within a few intervals of blue sky and sunshine.

Relative Humidity.—Relative humidity varies considerably with time and place. In general, it is higher at night than in the afternoon and higher in rainier, cooler localities than in warmer, drier ones. As the trades reach Hawaii from cooler latitudes, the humidity is by no means as high as the tropical locale and surrounding ocean might imply. At Lihue, a windward station, the humidity ranges from about 79 percent in January to 75 percent in July, and from about 82 percent at 2 a.m. to 67 percent at 2 p.m. By comparison, the values at Honolulu Airport, on the leeward coast, average 70 percent in January, 68 percent in July, 74 percent at 2 a.m., and 58 percent at 2 p.m.

Hurricanes.—Hurricanes are relatively infrequent and mild in Hawaii. Before 1950, there were no authenticated reports of hurricanes in the Hawaiian area. Four storms have occurred there since then, and a number of others have approached the State, but not closely enough to affect the weather appreciably. The most damaging hurricane to strike Hawaii—DOT, in August 1959—did approximately $6 million in damage, largely on Kauai. About $1.5 million of this amount was damage to sugarcane.

TORNADOES.—A number of funnel clouds occur over or near the State during an average year, but most either fail to reach the ground or remain at sea as waterspouts. Only rarely does a small tornado, usually much weaker than its mainland counterpart, cause even slight damage. By far the most destructive tornado of recent years was the one that roared through the small plantation town of Kaumakani, Kauai, in the early morning of December 17, 1967. The damage to houses, sugarcane, and other crops amounted to $300,000.

HAIL.—On the average, hail falls several times a year somewhere in the State, but it is only a quarter inch or less in diameter and thus does little damage. At times, however, leafy crops have been severely battered. Hail occurs most frequently between October and April, but it has been reported in every month but July. Falls usually cover only a square mile or less; only on occasion are they more widespread.

Population

The population of the State of Hawaii in 1968 was 824,574. The island of Oahu, which makes up only 9.3 percent of the State, had a population of more than 683,796. Kauai had 24,757, Maui 41,490, Molokai 5,867, and Lanai 2,431. Hawaii and Niihau, neither of which is in the survey area, had populations of 65,941 and 292 respectively.

Transportation

Jet aircraft has reduced flight time across the Pacific from the continental United States, reduced fares, and increased visitor travel. Travel between the islands is by air. Two scheduled airlines provide jet service between major airports on each island.

Modern containerized cargo ships make regular calls to and from the mainland and the Orient. Intrastate cargo shipment is by scheduled barge service.

Modern highways link major destination areas on all the islands. Scheduled bus service is available in Honolulu.

Visitor Industry

Accommodating visitors continues to be one of Hawaii's most rapidly growing industries. Today, it exceeds sugar and pineapple as the top source of income for the State.

Farming and Ranching

The economy of Hawaii depends heavily on farming and ranching. Because of a wide range of soils and of climate, which is hot arid in some coastal areas to humid tropical and temperate in mountain regions, Hawaii produces a variety of crops. The sugar and pineapple industries have long been the dominant factors in the Hawaiian economy. Diversified crops, such as vegetables, melons, fruits, and taro, are grown mainly for local consumption. Cattle ranching is the principal livestock industry. More than half the food consumed in Hawaii is produced locally.

SUGARCANE

Sugarcane is grown on highly mechanized plantations. There are three plantations on Maui, four on Oahu, and eight on Kauai. The acreage totals about 131,000. All the sugarcane is irrigated except at higher elevations where rainfall is sufficient. The cane is processed into raw sugar at sugar mills on the plantation. The raw sugar is shipped to Crockett, Calif., where it is made into refined sugar.

The sugar workers are employed the year around. They are the highest paid of any in the sugar-producing areas.

Mechanization and technical developments have led to significant advances in land preparation, harvesting, fertilization, and weed control. The plantations average more than 11 tons of sugar per acre—the highest yield in the world.

PINEAPPLE

Pineapple is grown on all the islands in the survey area. Like sugarcane, it is grown mostly on highly mechanized plantations. There are two plantations on Molokai and Oahu, and one each on Maui, Lanai, and Kauai. There are also some independent growers on Maui and Kauai. The acreage totals about 69,000. The pineapple industry is the primary source of income on Molokai and Lanai.

Pineapple requires little water. It can be grown without irrigation in areas where rainfall is as low as 20 inches. If water is available, however, areas that receive less than 30 inches of rainfall are generally irrigated. Pineapple is an important crop on Molokai and Lanai, both of which have low rainfall and a limited supply of irrigation water. Sugarcane and other crops that require abundant water cannot be grown.

The peak harvesting season is in summer. Seasonal workers, mostly high school and university students, are hired to work in the fields and canneries.

DIVERSIFIED CROPS

Diversified crops, mainly tomatoes, cucumbers, head cabbage, lettuce, green peppers, snap beans, bananas, and papayas, are commercially produced on all islands except Lanai. Many other crops including specialty crops, such as gingerroot and taro, are grown also.

Diversified crops are grown mainly in the Kula and Kihei areas of Maui, the Waianae and Waimanalo areas of Oahu, the Hanalei, Wailua, and Hanapepe areas of Kauai, and the southern coast of Molokai. Most farms are family farms and are less than 10 acres in size. The growing season is year around, and the farms are intensively cultivated.

The largest market for the crops is on Oahu. Yet the farming areas on Oahu are decreasing because of urbanization. Farms on the neighbor islands have become increasingly important in meeting the islands' produce needs.

CATTLE

There are cattle ranches on all islands except Lanai. Most of these ranches occupy areas that are steep, stony, or otherwise unsuitable for cultivation. The ranches range in size from less than 100 acres to more than 50,000 acres. They are operated on a part-time basis. Herefords are the most commonly raised beef cattle; others are Santa Gertrudis, Black Angus, and Charolaise.

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Glossary

Aa lava. Highly basaltic lava flows typified by a rough jagged surface.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of a soil to hold water in a form available to plants. Amount of moisture held in soil between field capacity, or about one-third atmosphere of tension, and the wilting coefficient, or about 15 atmospheres of tension.

Base saturation. The degree to which material that has base-exchange properties is saturated with exchangeable cations other than hydrogen, expressed as a percentage of the cation-exchange capacity.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Slightly hard.—When dry, soil is slightly resistant to pressure but can be broken between thumb and forefinger.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart, rather than to pull free.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Weakly smeary.—Under strong pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears. After the soil smears, there is little or no evidence of free water on the fingers.

Moderately smeary.—Under moderate to strong pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears and is slippery. After the soil smears, there is evidence of free water on the fingers.

Strongly smeary.—Under moderate pressure, the soil material changes suddenly to fluid, the fingers skid, and the soil smears and is very slippery. After the soil smears, free water is easily seen on the fingers.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Gravel. A mass of rounded or angular fragments up to 3 inches in diameter.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R horizon.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Horizon, soil diagnostic. Combinations of specific soil characteristics that indicate certain classes of soils. Those that occur at the surface are called epipedons, those below the surface, diagnostic subsurface horizons.

Albic horizon.—A residual concentration of quartz and other primary minerals of gray to white colors.

Argillic horizon.—An accumulation of illuvial silicate clay. If the layer has an appreciable amount of exchangeable sodium and prismatic or columnar structure, it is called a natric horizon.

Calcic horizon.—An accumulation of appreciable amounts of calcium carbonate.

Cambic horizon.—A layer in which changes have been sufficient (1) to give rise to structure, (2) to liberate free iron oxide, (3) to form silicate clay minerals, (4) to obliterate most evidence of original rock structure, or (5) some combination of these. Illuviation of iron, humus, or clay is not sufficient to qualify horizon as argillic or spodic.

Histic epipedon.—A thin, less than 30 centimeters, organic layer (peat or muck) that is normally saturated with water.

Mollic epipedon.—A thick, dark-colored surface layer that is much like the surface layer of soils that formed under grass. This layer may have moderate to strong structure, a base saturation of 50 percent or more, and calcium as the dominant metallic cation.

Natric horizon.—A special kind of argillic horizon that has prismatic or columnar structure, generally columnar, and 15 percent saturation with sodium. If the C horizon also has more than 15 percent sodium, the natric horizon must have more magnesium plus sodium than calcium plus hydrogen.

Ochric epipedon.—A surface horizon that contains some organic matter but is too light colored or too thin to meet the requirements of other kinds of epipedons.

Oxic horizon.—A residual concentration of lattice clays and free sesquioxides that has very low cation exchange capacity.

Petrocalcic horizon.—A continuous indurated calcic horizon cemented with carbonates of calcium and in places with magnesium.

Spodic horizon.—An accumulation of illuvial humus and aluminum or iron in amorphous forms.

Duripan.—A horizon indurated with silicon dioxide, generally opal, to the extent that dry fragments will not slake in water.

Miscellaneous land type. A mapping unit for areas of land that have little or no natural soil; or that are too nearly inaccessible for orderly examination; or that occur where, for other reasons, it is not feasible to classify the soil.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Natural soil drainage. Refers to the conditions of frequency and duration of periods of saturation of partial saturation that existed during the development of the soil, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven different classes of natural soil drainage are recognized.

Excessively drained soils are commonly very porous and rapidly permeable and have a low available water capacity.

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Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Imperfectly or somewhat poorly drained soils are wet for significant periods but not all the time, and Podzolic soils commonly have mottlings below a depth of 6 to 16 inches, in the lower A horizon and in the B and C horizons.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Pahoehoe lava. Massive, impermeable basaltic lava flows typified by a smooth, billowy, or ropy surface.

Parent material (soil). The horizon of weathered rock or partly weathered soil material from which soil has formed; horizon C in the soil profile.

Permeability, soil. The capacity of a soil horizon to transmit air or water. Terms used to describe permeability are as follows: *very slow*, *slow*, *moderately slow*, *moderate*, *moderately rapid*, *rapid*, and *very rapid*.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other dilutents that commonly shows as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to hardpan or to irregular aggregates on repeated wetting and drying, or it is the hardened relicts of the soft, red mottles. It is a form of the material that has been called laterite.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 millimeter to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Saprolite. Thoroughly decomposed, earthy, untransported rock.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. An explanation of capability classification begins on page 153. Other information is given in tables as follows:

Acreage and extent, table 1, page 15.

Use of the soils in engineering, table 2, page 156, table 3, page 168, table 4, page 202.

HIGH- AND MEDIUM- INTENSITY SURVEY

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
AaB	Alae sandy loam, 3 to 7 percent slopes	26	IVs	VIs	1	136	--	---	1	143	--	---
AcA	Alae cobbly sandy loam, 0 to 3 percent slopes	14	IVs	VIs	1	136	--	---	1	143	--	---
AcB	Alae cobbly sandy loam, 3 to 7 percent slopes	26	IVs	VIs	1	136	--	---	1	143	--	---
AeB	Alaeloa silty clay, 3 to 7 percent slopes	26	IIe	IIe	--	---	5	140	6	145	5	150
AeC	Alaeloa silty clay, 7 to 15 percent slopes	26	IIIe	IIIe	--	---	6	140	6	145	5	150
AeE	Alaeloa silty clay, 15 to 35 percent slopes	26	---	VIe	--	---	6	140	6	145	5	150
EaA	Ewa silty clay loam, 0 to 3 percent slopes	30	I	IVc	1	136	1	137	2	144	--	---
EaB	Ewa silty clay loam, 3 to 6 percent slopes	29	IIe	IVc	1	136	2	138	2	144	--	---
EaC	Ewa silty clay loam, 6 to 12 percent slopes	30	IIIe	IVe	1	136	3	139	2	144	--	---
EcA	Ewa cobbly silty clay loam, 0 to 3 percent slopes	30	IIs	IVs	1	136	--	---	2	144	--	---
EcB	Ewa cobbly silty clay loam, 3 to 7 percent slopes	30	IIe	IVs	1	136	--	---	2	144	--	---
EmA	Ewa silty clay loam, moderately shallow, 0 to 2 percent slopes	30	IIs	IVs	1	136	1	137	2	144	--	---
EmB	Ewa silty clay loam, moderately shallow, 2 to 6 percent slopes	30	IIe	IVs	1	136	2	138	2	144	--	---
EsA	Ewa silty clay, 0 to 3 percent slopes	30	I	IVc	1	136	1	137	2	144	--	---
EsB	Ewa silty clay, 3 to 7 percent slopes	30	IIe	IVc	1	136	2	138	2	144	--	---
EtB	Ewa cobbly silty clay, 3 to 7 percent slopes	30	IIe	IVs	1	136	2	138	2	144	--	---
EwA	Ewa stony silty clay, 0 to 2 percent slopes	30	IIs	IVs	1	136	--	---	2	144	--	---
EwB	Ewa stony silty clay, 2 to 6 percent slopes	30	IIe	IVs	1	136	--	---	2	144	--	---
EwC	Ewa stony silty clay, 6 to 12 percent slopes	31	IIIe	IVe	1	136	--	---	2	144	--	---
Fd	Fill land	31	----	---	--	---	--	---	--	---	--	---
HaB	Haiku silty clay, 3 to 7 percent slopes	32	IIe	IIe	--	---	5	140	8	145	7	151
HaC	Haiku silty clay, 7 to 15 percent slopes	32	IIIe	IIIe	--	---	6	140	8	145	7	151
HbB	Haiku clay, 3 to 7 percent slopes	32	IIe	IIe	--	---	5	140	8	145	7	151
HbC	Haiku clay, 7 to 15 percent slopes	32	IIIe	IIIe	--	---	6	140	8	145	7	151

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
HcB	Haleiwa silty clay loam, 0 to 10 percent slopes--------------------	34	IIIe	IIIe	1	136	--	---	3	144	1	149
HdC	Haleiwa very stony silty clay loam, 0 to 15 percent slopes------------	34	VIs	VIs	--	---	--	---	3	144	1	149
HeA	Haleiwa silty clay, 0 to 2 percent slopes----------------------------	33	IIe	IIIc	1	136	--	---	3	144	1	149
HeB	Haleiwa silty clay, 2 to 6 percent slopes----------------------------	34	IIe	IIIc	1	136	--	---	3	144	1	149
HfB	Halii gravelly silty clay, 3 to 8 percent slopes--------------------	34	---	IVs	2	136	7	141	10	146	9	151
HfC	Halii gravelly silty clay, 8 to 15 percent slopes--------------------	35	---	IVe	2	136	8	141	10	146	9	151
HfD2	Halii gravelly silty clay, 15 to 25 percent slopes, eroded---------	35	---	IVe	2	136	--	---	10	146	9	151
HfE2	Halii gravelly silty clay, 25 to 40 percent slopes, eroded---------	35	---	VIe	--	---	--	---	10	146	9	151
HgB	Haliimaile silty clay loam, 3 to 7 percent slopes-------------------	36	IIe	IIe	1	136	5	140	3	144	1	149
HgC	Haliimaile silty clay loam, 7 to 15 percent slopes-------------------	36	IIIe	IIIe	1	136	6	140	3	144	1	149
HhB	Haliimaile silty clay, 3 to 7 percent slopes-----------------------	35	IIe	IIe	1	136	5	140	3	144	1	149
HhC	Haliimaile silty clay, 7 to 15 percent slopes--------------------	36	IIIe	IIIe	1	136	6	140	3	144	1	149
HkC2	Haliimaile gravelly silty clay, 7 to 15 percent slopes, eroded------	36	IVe	IVe	1	136	6	140	3	144	1	149
HlB	Hamakuapoko silty clay, 3 to 7 percent slopes-----------------------	36	IIe	IIe	--	---	5	140	6	145	5	150
HlC	Hamakuapoko silty clay, 7 to 15 percent slopes--------------------	37	IIIe	IIIe	--	---	6	140	6	145	5	150
HlC2	Hamakuapoko silty clay, 7 to 15 percent slopes--------------------	37	IVe	IVe	--	---	6	140	6	145	5	150
HmA	Hanalei silty clay loam, 0 to 2 percent slopes--------------------	38	IIw	IIw	3	137	--	---	7	145	4	149
HnA	Hanalei silty clay, 0 to 2 percent slopes---------------------------	38	IIw	IIw	3	137	--	---	7	145	4	149
HnB	Hanalei silty clay, 2 to 6 percent slopes---------------------------	38	IIw	IIw	3	137	--	---	7	145	4	149
HoB	Hanalei stony silty clay, 2 to 6 percent slopes--------------------	38	IIw	IIw	3	137	--	---	7	145	4	149
HpA	Hanalei peaty silty clay loam, 0 to 2 percent slopes---------------	38	IVw	IVw	3	137	--	---	7	145	4	149
HrB	Hanalei silty clay, deep water table, 0 to 6 percent slopes------	38	IIw	IIw	3	137	--	---	7	145	4	149
HsB	Hanamaulu silty clay, 3 to 8 percent slopes--------------------------	39	IIe	IIe	2	136	--	---	8	145	7	151
HsC	Hanamaulu silty clay, 8 to 15 percent slopes--------------------	39	IIIe	IIIe	2	136	--	---	8	145	7	151
HsD	Hanamaulu silty clay, 15 to 25 percent slopes-------------------	39	IVe	IVe	2	136	--	---	8	145	7	151
HsE	Hanamaulu silty clay, 25 to 40 percent slopes-------------------	39	---	VIe	--	---	--	---	8	145	7	151
HtE	Hanamaulu stony silty clay, 10 to 35 percent slopes-----------------	39	---	VIe	--	---	--	---	8	145	7	151
HuE	Hanamaulu bouldery silty clay, 10 to 35 percent slopes-----------	39	---	VIe	--	---	--	---	8	145	7	151

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
KaeB	Kaena stony clay, 2 to 6 percent slopes	50	IIIw	IVw	4	137	--	---	7	145	4	149
KaeC	Kaena stony clay, 6 to 12 percent slopes	49	IIIw	IVw	4	137	--	---	7	145	4	149
KaeD	Kaena stony clay, 12 to 20 percent slopes	50	IVw	VIw	4	137	--	---	7	145	4	149
KanE	Kaena very stony clay, 10 to 35 percent slopes	50	---	VIs	--	---	--	---	7	145	4	149
KavB	Kaena clay, brown variant, 1 to 6 percent slopes	50	IIIw	IVw	3	137	--	---	7	145	4	149
KavC	Kaena clay, brown variant, 6 to 12 percent slopes	50	IIIw	IVw	3	137	--	---	7	145	4	149
KbB	Kahana silty clay, 3 to 7 percent slopes	51	IIe	IIe	--	---	5	140	3	144	1	149
KbC	Kahana silty clay, 7 to 15 percent slopes	50	IIIe	IIIe	--	---	6	140	3	144	1	149
KbD	Kahana silty clay, 15 to 25 percent slopes	51	IVe	IVe	--	---	6	140	3	144	1	149
KcB	Kalae silty clay, 2 to 7 percent slopes	54	IIe	IIIc	--	---	5	140	6	145	5	150
KcC	Kalae silty clay, 7 to 15 percent slopes	55	IIIe	IIIe	--	---	6	140	6	145	5	150
KcC3	Kalae silty clay, 5 to 15 percent slopes, severely eroded	55	IVe	IVe	--	---	6	140	6	145	5	150
KcD3	Kalae silty clay, 15 to 25 percent slopes, severely eroded	55	VIe	VIe	--	---	--	---	6	145	5	150
KcE3	Kalae silty clay, 25 to 40 percent slopes, severely eroded	55	---	VIe	--	---	--	---	6	145	5	150
KdD	Kalapa silty clay, 8 to 20 percent slopes	56	IVe	IVe	2	136	--	---	8	145	7	151
KdE	Kalapa silty clay, 20 to 40 percent slopes	56	---	VIe	--	---	--	---	8	145	7	151
KdF	Kalapa silty clay, 40 to 70 percent slopes	55	---	VIIe	--	---	--	---	8	145	14	152
Ke	Kalihi clay	57	IIIw	IVw	3	137	--	---	7	145	4	149
Kf	Kaloko clay loam	58	IIIw	Vw	3	137	--	---	7	145	--	---
Kfa	Kaloko clay	58	IIIw	Vw	3	137	--	---	7	145	--	---
Kfb	Kaloko clay, noncalcareous variant	58	IIIw	Vw	3	137	--	---	7	145	--	---
KgB	Kaneohe silty clay, 3 to 8 percent slopes	59	---	IIe	--	---	--	---	8	145	7	151
KgC	Kaneohe silty clay, 8 to 15 percent slopes	60	---	IIIe	--	---	--	---	8	145	7	151
KhB	Kanepuu silty clay, 3 to 7 percent slopes	60	IIe	IIIc	--	---	--	---	3	144	--	---
KhB2	Kanepuu silty clay, 3 to 7 percent slopes, eroded	61	IIe	IIIc	--	---	--	---	3	144	--	---
KhC	Kanepuu silty clay, 7 to 15 percent slopes	61	IIIe	IIIe	--	---	--	---	3	144	--	---
KhC2	Kanepuu silty clay, 7 to 15 percent slopes, eroded	61	IIIe	IVe	--	---	--	---	3	144	--	---
KkB	Kapaa silty clay, 3 to 8 percent slopes	61	---	IIIs	2	136	7	141	10	146	9	151
KkC	Kapaa silty clay, 8 to 15 percent slopes	62	---	IIIe	2	136	8	141	10	146	9	151

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
KkD	Kapaa silty clay, 15 to 25 percent slopes	62	---	IVe	2	136	8	141	10	146	9	151
KkE	Kapaa silty clay, 25 to 40 percent slopes	62	---	VIe	--	---	--	---	10	146	9	151
KlA	Kawaihapai clay loam, 0 to 2 percent slopes	64	I	IIc	1	136	--	---	3	144	1	149
KlB	Kawaihapai clay loam, 2 to 6 percent slopes	64	IIe	IIe	1	136	--	---	3	144	1	149
KlC	Kawaihapai clay loam, 6 to 15 percent slopes	64	IIIe	IIIe	1	136	--	---	3	144	1	149
KlaA	Kawaihapai stony clay loam, 0 to 2 percent slopes	64	IIs	IIs	1	136	--	---	3	144	1	149
KlaB	Kawaihapai stony clay loam, 2 to 6 percent slopes	64	IIe	IIe	1	136	--	---	3	144	1	149
KlbC	Kawaihapai very stony clay loam, 0 to 15 percent slopes	64	---	VIs	--	---	--	---	3	144	1	149
KlcB	Kawaihapai silty clay loam, 2 to 7 percent slopes	64	IIe	IIe	1	136	--	---	3	144	1	149
KmA	Keaau clay, 0 to 2 percent slopes	65	IIIw	Vw	3	137	--	---	7	145	4	149
KmaB	Keaau stony clay, 2 to 6 percent slopes	65	IIIw	Vw	3	137	--	---	7	145	4	149
KmbA	Keaau clay, saline, 0 to 2 percent slopes	65	---	VIw	--	---	--	---	7	145	4	149
KnB	Keahua silty clay loam, 3 to 7 percent slopes	65	IIe	IVc	1	136	2	138	2	144	--	---
KnC	Keahua silty clay loam, 7 to 15 percent slopes	66	IIIe	IVe	1	136	3	139	2	144	--	---
KnaB	Keahua cobbly silty clay loam, 3 to 7 percent slopes	66	IIe	IVs	1	136	--	---	2	144	--	---
KnaC	Keahua cobbly silty clay loam, 7 to 15 percent slopes	66	IIIe	IVe	1	136	--	---	2	144	--	---
KnaD	Keahua cobbly silty clay loam, 15 to 25 percent slopes	66	IVe	IVe	1	136	--	---	2	144	--	---
KnbD	Keahua very stony silty clay loam, 7 to 25 percent slopes	66	---	VIs	--	---	--	---	2	144	--	---
KncC	Keahua silty clay, 7 to 15 percent slopes	66	IIIe	IVe	1	136	3	139	2	144	--	---
KnhC	Keahua cobbly silty clay, 7 to 15 percent slopes	66	IIIe	IVe	1	136	--	---	2	144	--	---
KnsC	Keahua stony silty clay, 7 to 15 percent slopes	67	IIIe	IVe	1	136	--	---	2	144	--	---
KoA	Kekaha silty clay, 0 to 2 percent slopes	68	I	IVc	1	136	--	---	2	144	4	149
KoB	Kekaha silty clay, 2 to 6 percent slopes	69	IIe	IVc	1	136	--	---	2	144	4	149
KobA	Kekaha clay, 0 to 2 percent slopes	69	I	IVc	1	136	--	---	2	144	4	149
KpB	Kemoo silty clay, 2 to 6 percent slopes	70	---	IIe	1	136	5	140	5	145	5	150
KpC	Kemoo silty clay, 6 to 12 percent slopes	70	---	IIIe	1	136	6	140	5	145	5	150
KpD	Kemoo silty clay, 12 to 20 percent slopes	69	---	IVe	1	136	6	140	5	145	5	150
KpE	Kemoo silty clay, 20 to 35 percent slopes	70	---	VIe	--	---	--	---	5	145	5	150

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
KpF	Kemoo silty clay, 35 to 70 percent slopes	70	---	VIIe	--	---	--	---	5	145	15	152
KrB	Koele silty clay loam, 3 to 7 percent slopes	70	IIe	IIIc	--	---	2	138	3	144	--	---
KrC	Koele silty clay loam, 7 to 15 percent slopes	71	IIIe	IIIe	--	---	3	139	3	144	--	---
KrD	Koele silty clay loam, 15 to 25 percent slopes	71	IVe	IVe	--	---	3	139	3	144	--	---
KsB	Koko silt loam, 2 to 6 percent slopes	72	IIe	VIc	--	---	--	---	2	144	--	---
KsC	Koko silt loam, 6 to 12 percent slopes	73	IIIe	VIe	--	---	--	---	2	144	--	---
KsD	Koko silt loam, 12 to 25 percent slopes	73	IVe	VIe	--	---	--	---	2	144	--	---
KtC	Kokokahi clay, 6 to 12 percent slopes	73	---	VIe	--	---	--	---	3	144	--	---
KuB	Kolekole silty clay loam, 1 to 6 percent slopes	73	IIe	IIIe	1	136	5	140	6	145	6	150
KuC	Kolekole silty clay loam, 6 to 12 percent slopes	74	IIIe	IIIe	1	136	6	140	6	145	6	150
KuD	Kolekole silty clay loam, 12 to 25 percent slopes	74	IVe	IVe	1	136	6	140	6	145	6	150
KvB	Koloa stony silty clay, 3 to 8 percent slopes	74	IIe	IVe	1	136	--	---	5	145	5	150
KvC	Koloa stony silty clay, 8 to 15 percent slopes	75	IIIe	IVe	1	136	--	---	5	145	5	150
KvD	Koloa stony silty clay, 15 to 25 percent slopes	75	IVe	IVe	1	136	--	---	5	145	5	150
Kw	Kolokolo clay loam	75	IIw	IIw	--	---	--	---	8	145	7	151
KxC	Kula loam, 4 to 12 percent slopes	77	IIIe	IIIe	--	---	--	---	4	144	2	149
KxD	Kula loam, 12 to 20 percent slopes	77	IVe	IVe	--	---	--	---	4	144	2	149
KxaD	Kula cobbly loam, 12 to 20 percent slopes	76	IVe	IVe	--	---	--	---	4	144	2	149
KxbE	Kula very rocky loam, 12 to 40 percent slopes	77	---	VIs	--	---	--	---	4	144	2	149
KyA	Kunia silty clay, 0 to 3 percent slopes	77	I	IIIc	1	136	1	137	3	144	1	149
KyB	Kunia silty clay, 3 to 8 percent slopes	78	IIe	IIIc	1	136	2	138	3	144	1	149
KyC	Kunia silty clay, 8 to 15 percent slopes	78	IIIe	IIIe	1	136	3	139	3	144	1	149
LaA	Lahaina silty clay, 0 to 3 percent slopes	79	I	IIIc	1	136	1	137	3	144	1	149
LaB	Lahaina silty clay, 3 to 7 percent slopes	78	IIe	IIIc	1	136	2	138	3	144	1	149
LaB3	Lahaina silty clay, 3 to 7 percent slopes, severely eroded	79	IIIe	IVe	1	136	2	138	3	144	1	149
LaC	Lahaina silty clay, 7 to 15 percent slopes	79	IIIe	IIIe	1	136	3	139	3	144	1	149
LaC3	Lahaina silty clay, 7 to 15 percent slopes, severely eroded	79	IVe	IVe	1	136	3	139	3	144	1	149
LaD	Lahaina silty clay, 15 to 25 percent slopes	79	IVe	IVe	1	136	3	139	3	144	1	149
LaD3	Lahaina silty clay, 15 to 25 percent slopes, severely eroded	79	VIe	VIe	--	---	--	---	3	144	1	149

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification Irrigated Symbol	Capability classification Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
LaE3	Lahaina silty clay, 25 to 40 percent slopes, severely eroded----	79	VIe	VIe	--	---	--	---	3	144	1	149
LcB	Lawai silty clay, 0 to 8 percent slopes-------------------------	81	---	IIIw	2	136	--	---	8	145	7	151
LcC	Lawai silty clay, 8 to 15 percent slopes-------------------------	81	---	IIIe	2	136	--	---	8	145	7	151
LcD	Lawai silty clay, 15 to 25 percent slopes-------------------------	81	---	IVe	2	136	--	---	8	145	7	151
LeB	Leilehua silty clay, 2 to 6 percent slopes---------------------	81	IIe	IIe	2	136	5	140	8	145	7	151
LeC	Leilehua silty clay, 6 to 12 percent slopes---------------------	82	IIIe	IIIe	2	136	6	140	8	145	7	151
LhB	Lihue silty clay, 0 to 8 percent slopes-------------------------	82	IIe	IIe	1	136	5	140	5	145	5	150
LhC	Lihue silty clay, 8 to 15 percent slopes---------------------	83	IIIe	IIIe	1	136	6	140	5	145	5	150
LhD	Lihue silty clay, 15 to 25 percent slopes---------------------	83	IVe	IVe	1	136	6	140	5	145	5	150
LhE2	Lihue silty clay, 25 to 40 percent slopes, eroded-------------	83	---	VIe	--	---	--	---	5	145	5	150
LlB	Lihue gravelly silty clay, 0 to 8 percent slopes----------------	83	IIe	IIe	1	136	5	140	5	145	5	150
LlC	Lihue gravelly silty clay, 8 to 15 percent slopes--------------	83	IIIe	IIIe	1	136	6	140	5	145	5	150
LoB	Lolekaa silty clay, 3 to 8 percent slopes---------------------	83	---	IIe	--	---	--	---	8	145	7	151
LoC	Lolekaa silty clay, 8 to 15 percent slopes---------------------	84	---	IIIe	--	---	--	---	8	145	7	151
LoD	Lolekaa silty clay, 15 to 25 percent slopes---------------------	84	---	IVe	--	---	--	---	8	145	7	151
LoE	Lolekaa silty clay, 25 to 40 percent slopes---------------------	84	---	VIe	--	---	--	---	8	145	7	151
LoF	Lolekaa silty clay, 40 to 70 percent slopes---------------------	84	---	VIIe	--	---	--	---	8	145	14	152
LuA	Lualualei clay, 0 to 2 percent slopes-------------------------	84	IIIs	VIs	4	137	--	---	2	144	4	149
LuB	Lualualei clay, 2 to 6 percent slopes-------------------------	85	IIIe	VIs	4	137	--	---	2	144	4	149
LvA	Lualualei stony clay, 0 to 2 percent slopes------------------	85	IIIs	VIs	4	137	--	---	2	144	4	149
LvB	Lualualei stony clay, 2 to 6 percent slopes------------------	85	IIIe	VIs	4	137	--	---	2	144	4	149
MaC	Mahana silt loam, 6 to 12 percent slopes-------------------------	85	IIIe	IVe	1	136	6	140	6	145	5	150
MaD	Mahana silt loam, 12 to 20 percent slopes---------------------	86	IVe	IVe	1	136	6	140	6	145	5	150
MaD3	Mahana silt loam, 12 to 20 percent slopes, severely eroded----	86	IVe	VIe	1	136	6	140	6	145	5	150
MaE	Mahana silt loam, 20 to 35 percent slopes---------------------	86	---	VIe	--	---	--	---	6	145	5	150
MaE3	Mahana silt loam, 20 to 35 percent slopes, severely eroded----	86	---	VIe	--	---	--	---	6	145	5	150
McC2	Mahana silty clay loam, 6 to 12 percent slopes, eroded----------	86	IIIe	IVe	1	136	6	140	6	145	5	150
McD2	Mahana silty clay loam, 12 to 20 percent slopes, eroded----------	86	IVe	IVe	1	136	6	140	6	145	5	150

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
McE2	Mahana silty clay loam, 20 to 35 percent slopes, eroded-----------	86	---	VIe	--	---	--	---	6	145	5	150
MdB	Makalapa clay, 2 to 6 percent slopes--------------------------	87	---	IIIs	4	137	--	---	3	144	--	---
MdC	Makalapa clay, 6 to 12 percent slopes--------------------------	88	---	IVe	4	137	--	---	3	144	--	---
MdD	Makalapa clay, 12 to 20 percent slopes--------------------------	88	---	IVe	4	137	--	---	3	144	--	---
MeB	Makapili silty clay, 0 to 8 percent slopes----------------------	88	IIe	IIe	--	---	--	---	10	146	9	151
MeC	Makapili silty clay, 8 to 15 percent slopes----------------------	89	IIIe	IIIe	--	---	--	---	10	146	9	151
MeD	Makapili silty clay, 15 to 25 percent slopes----------------------	89	IVe	IVe	--	---	--	---	10	146	9	151
MeE	Makapili silty clay, 25 to 40 percent slopes----------------------	89	---	VIe	--	---	--	---	10	146	9	151
MfB	Makawao silty clay, 3 to 7 percent slopes----------------------	89	---	IIe	--	---	5	140	8	145	7	151
MfC	Makawao silty clay, 7 to 15 percent slopes----------------------	90	---	IIIe	--	---	6	140	8	145	7	151
MgB	Makaweli silty clay loam, 0 to 6 percent slopes-------------------	90	IIe	IVc	1	136	--	---	2	144	--	---
MgC	Makaweli silty clay loam, 6 to 12 percent slopes-------------------	90	IIIe	IVe	1	136	--	---	2	144	--	---
MgD	Makaweli silty clay loam, 12 to 20 percent slopes-------------------	90	IVe	IVe	1	136	--	---	2	144	--	---
MgE2	Makaweli silty clay loam, 20 to 35 percent slopes, eroded-----------	90	---	VIe	--	---	--	---	2	144	--	---
MhB	Makaweli stony silty clay loam, 0 to 6 percent slopes-------------	90	IIe	IVs	1	136	--	---	2	144	--	---
MhC	Makaweli stony silty clay loam, 6 to 12 percent slopes-------------	91	IIIe	IVe	1	136	--	---	2	144	--	---
MhD	Makaweli stony silty clay loam, 12 to 20 percent slopes-------------	91	IVe	IVe	1	136	--	---	2	144	--	---
MhE	Makaweli stony silty clay loam, 20 to 35 percent slopes-------------	91	---	VIe	--	---	--	---	2	144	--	---
MkA	Makiki clay loam, 0 to 2 percent slopes--------------------------	91	---	IIIc	--	---	--	---	--	---	--	---
MlA	Makiki stony clay loam, 0 to 3 percent slopes-------------------	92	---	IIIs	--	---	--	---	--	---	--	---
MmA	Mala silty clay, 0 to 3 percent slopes--------------------------	92	I.	VIc	--	---	--	---	1	143	--	---
MmB	Mala silty clay, 3 to 7 percent slopes--------------------------	93	IIe	VIc	--	---	--	---	1	143	--	---
MnC	Mamala stony silty clay loam, 0 to 12 percent slopes-------------	93	IIIs	VIs	1	136	--	---	2	144	--	---
MoB	Manana silty clay loam, 2 to 6 percent slopes-------------------	94	IIe	IIIe	1	136	5	140	6	145	6	150
MoC	Manana silty clay loam, 6 to 12 percent slopes-------------------	94	IIIe	IVe	1	136	6	140	6	145	6	150
MoD2	Manana silty clay loam, 12 to 25 percent slopes, eroded-----------	94	VIe	VIe	1	136	--	---	6	145	6	150
MpB	Manana silty clay, 3 to 8 percent slopes--------------------------	94	IIe	IIe	1	136	5	140	6	145	6	150
MpC	Manana silty clay, 8 to 15 percent slopes--------------------------	95	IIIe	IIIe	1	136	6	140	6	145	6	150

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
MpD	Manana silty clay, 15 to 25 percent slopes	95	IVe	IVe	1	136	6	140	6	145	6	150
MpD2	Manana silty clay, 12 to 25 percent slopes, eroded	95	VIe	VIe	1	136	--	---	6	145	6	150
MpE	Manana silty clay, 25 to 40 percent slopes	95	---	VIe	--	---	--	---	6	145	6	150
Mr	Mokuleia fine sandy loam	95	IIIs	IVs	1	136	--	---	3	144	--	---
Ms	Mokuleia loam	96	IIs	VIs	1	136	--	---	3	144	--	---
Mt	Mokuleia clay loam	95	IIs	VIs	1	136	--	---	3	144	--	---
Mta	Mokuleia clay loam, poorly drained variant	96	IIIw	IIIw	3	137	--	---	3	144	--	---
Mtb	Mokuleia clay	95	IIIs	VIs	1	136	--	---	3	144	--	---
MuA	Molokai silty clay loam, 0 to 3 percent slopes	96	I	IVc	1	136	1	137	2	144	--	---
MuB	Molokai silty clay loam, 3 to 7 percent slopes	96	IIe	IVc	1	136	2	138	2	144	--	---
MuB3	Molokai silty clay loam, 3 to 7 percent slopes, severely eroded	97	IIIe	IVe	1	136	2	138	2	144	--	---
MuC	Molokai silty clay loam, 7 to 15 percent slopes	97	IIIe	IVe	1	136	3	139	2	144	--	---
MuC3	Molokai silty clay loam, 7 to 15 percent slopes, severely eroded	97	IVe	VIe	--	---	3	139	2	144	--	---
MuD	Molokai silty clay loam, 15 to 25 percent slopes	97	IVe	IVe	1	136	3	139	2	144	--	---
MvD3	Molokai silty clay loam, shallow variant, 15 to 25 percent slopes, severely eroded	97	VIe	VIe	--	---	--	---	2	144	--	---
NcC	Niu silty clay loam, 6 to 12 percent slopes	98	IIIe	IIIe	1	136	--	---	3	144	1	149
NcD	Niu silty clay loam, 12 to 20 percent slopes	98	IVe	IVe	1	136	--	---	3	144	1	149
NcD2	Niu silty clay loam, 6 to 20 percent slopes, eroded	98	---	IVe	1	136	--	---	3	144	1	149
NcE2	Niu silty clay loam, 20 to 35 percent slopes, eroded	98	---	VIe	--	---	--	---	3	144	1	149
Nh	Nohili clay	99	IIIw	Vw	3	137	--	---	7	145	--	---
NnC	Nonopahu clay, 2 to 10 percent slopes	100	IIIe	VIe	4	137	--	---	2	144	--	---
NoC	Nonopahu stony clay, 2 to 12 percent slopes	101	IIIe	VIe	4	137	--	---	2	144	--	---
OlD	Oli loam, 12 to 20 percent slopes	103	IVe	IVe	--	---	--	---	6	145	5	150
PaC	Paaloa silty clay, 3 to 12 percent slopes	106	---	IIIe	2	136	--	---	8	145	7	151
PbC	Paaloa clay, 2 to 12 percent slopes	106	---	IIIe	2	136	--	---	8	145	7	151
PcB	Paia silty clay, 3 to 7 percent slopes	107	IIe	IIIc	1	136	--	---	3	144	--	---
PcC	Paia silty clay, 7 to 15 percent slopes	107	IIIe	IIIe	1	136	--	---	3	144	--	---
PcC2	Paia silty clay, 7 to 15 percent slopes, eroded	107	IVe	IVe	1	136	--	---	3	144	--	---
PdA	Pakala clay loam, 0 to 2 percent slopes	107	I	IVc	1	136	--	---	2	144	4	149

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
PdC	Pakala clay loam, 2 to 10 percent slopes	108	IIe	IVe	1	136	--	---	2	144	4	149
PeB	Paumalu silty clay, 3 to 8 percent slopes	111	IIe	IIe	--	---	--	---	8	145	7	151
PeC	Paumalu silty clay, 8 to 15 percent slopes	111	IIIe	IIIe	--	---	--	---	8	145	7	151
PeD	Paumalu silty clay, 15 to 25 percent slopes	110	IVe	IVe	--	---	--	---	8	145	7	151
PeE	Paumalu silty clay, 25 to 40 percent slopes	111	VIe	VIe	--	---	--	---	8	145	7	151
PeF	Paumalu silty clay, 40 to 70 percent slopes	111	---	VIIe	--	---	--	---	8	145	14	152
PfB	Pauwela clay, 3 to 7 percent slopes	111	---	IIe	--	---	7	141	8	145	7	151
PfC	Pauwela clay, 7 to 15 percent slopes	112	---	IIIe	--	---	8	141	8	145	7	151
PfD	Pauwela clay, 15 to 25 percent slopes	112	---	IVe	--	---	8	141	8	145	7	151
Ph	Pearl Harbor clay	112	IVw	IVw	--	---	--	---	7	145	4	149
PkB	Pohakupu silty clay loam, 0 to 8 percent slopes	113	IIe	IIIe	1	136	--	---	6	145	5	150
PkC	Pohakupu silty clay loam, 8 to 15 percent slopes	113	---	IIIe	1	136	--	---	6	145	5	150
PlB	Pooku silty clay loam, 3 to 8 percent slopes	114	---	IIIs	2	136	--	---	10	146	9	151
PlD	Pooku silty clay loam, 8 to 25 percent slopes	114	---	IVe	2	136	--	---	10	146	9	151
PmB	Pooku silty clay, 0 to 8 percent slopes	114	---	IIIs	2	136	--	---	10	146	9	151
PmC	Pooku silty clay, 8 to 15 percent slopes	114	---	IIIe	2	136	--	---	10	146	9	151
PmD	Pooku silty clay, 15 to 25 percent slopes	114	---	IVe	2	136	--	---	10	146	9	151
PmE	Pooku silty clay, 25 to 40 percent slopes	114	---	VIe	--	---	--	---	10	146	9	151
PnA	Puhi silty clay loam, 0 to 3 percent slopes	115	IIs	IIs	1	136	4	139	8	145	7	151
PnB	Puhi silty clay loam, 3 to 8 percent slopes	115	IIe	IIe	1	136	5	140	8	145	7	151
PnC	Puhi silty clay loam, 8 to 15 percent slopes	115	IIIe	IIIe	1	136	6	140	8	145	7	151
PnD	Puhi silty clay loam, 15 to 25 percent slopes	115	IVe	IVe	1	136	6	140	8	145	7	151
PnE	Puhi silty clay loam, 25 to 40 percent slopes	115	---	VIe	--	---	--	---	8	145	7	151
PoB	Pulehu sandy loam, 2 to 6 percent slopes	116	IIIe	VIs	1	136	--	---	2	144	--	---
PoaB	Pulehu stony sandy loam, 0 to 7 percent slopes	117	IIIe	VIs	1	136	--	---	2	144	--	---
PpA	Pulehu silt loam, 0 to 3 percent slopes	116	I	IVc	1	136	--	---	2	144	--	---
PpB	Pulehu silt loam, 3 to 7 percent slopes	116	IIe	IVc	1	136	--	---	2	144	--	---
PrA	Pulehu cobbly silt loam, 0 to 3 percent slopes	116	IIs	IVs	1	136	--	---	2	144	--	---

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
PrB	Pulehu cobbly silt loam, 3 to 7 percent slopes	116	IIe	IVs	1	136	--	---	2	144	--	---
PsA	Pulehu clay loam, 0 to 3 percent slopes	115	I	IVc	1	136	--	---	2	144	--	---
PtA	Pulehu cobbly clay loam, 0 to 3 percent slopes	116	IIs	IVs	1	136	--	---	2	144	--	---
PtB	Pulehu cobbly clay loam, 3 to 7 percent slopes	116	IIe	IVs	1	136	--	---	2	144	--	---
PuB	Pulehu stony clay loam, 2 to 6 percent slopes	116	IIe	IVs	1	136	--	---	2	144	--	---
PvC	Pulehu very stony clay loam, 0 to 12 percent slopes	116	---	IVs	1	136	--	---	2	144	--	---
PwC	Puu Opae silty clay loam, 8 to 15 percent slopes	117	IIIe	IIIe	--	---	--	---	6	145	5	150
PwD	Puu Opae silty clay loam, 15 to 25 percent slopes	118	IVe	IVe	--	---	--	---	6	145	5	150
PwE	Puu Opae silty clay loam, 25 to 40 percent slopes	118	---	VIe	--	---	--	---	6	145	5	150
UwB	Uwala silty clay loam, 2 to 7 percent slopes	123	IIe	IVc	--	---	2	138	2	144	--	---
UwC	Uwala silty clay loam, 7 to 15 percent slopes	124	IIIe	IVe	--	---	3	139	2	144	--	---
UwC3	Uwala silty clay loam, 7 to 15 percent slopes, severely eroded	124	IVe	IVe	--	---	3	139	2	144	--	---
WaA	Wahiawa silty clay, 0 to 3 percent slopes	124	I	IIc	1	136	4	139	5	145	5	150
WaB	Wahiawa silty clay, 3 to 8 percent slopes	125	IIe	IIe	1	136	5	140	5	145	5	150
WaC	Wahiawa silty clay, 8 to 15 percent slopes	125	IIIe	IIIe	1	136	6	140	5	145	5	150
WaD2	Wahiawa silty clay, 15 to 25 percent slopes, eroded	125	---	IVe	1	136	6	140	5	145	5	150
WbB	Wahikuli silty clay, 3 to 7 percent slopes	125	IIe	IVs	1	136	--	---	3	144	--	---
WcB	Wahikuli stony silty clay, 3 to 7 percent slopes	126	IIe	IVs	1	136	--	---	3	144	--	---
WcC	Wahikuli stony silty clay, 7 to 15 percent slopes	126	IIIe	IVe	1	136	--	---	3	144	--	---
WdB	Wahikuli very stony silty clay, 3 to 7 percent slopes	126	IVs	VIs	1	136	--	---	3	144	--	---
WeB	Waiakoa silty clay loam, 3 to 7 percent slopes	127	IIe	VIs	1	136	--	---	1	143	--	---
WeC	Waiakoa silty clay loam, 7 to 15 percent slopes	127	IIIe	VIe	1	136	--	---	1	143	--	---
WfB	Waiakoa cobbly silty clay loam, 3 to 7 percent slopes	127	IIe	VIs	1	136	--	---	1	143	--	---
WgB	Waiakoa very stony silty clay loam, 3 to 7 percent slopes	126	IVs	VIs	1	136	--	---	1	143	--	---
WgC	Waiakoa very stony silty clay loam, 7 to 15 percent slopes	127	IVs	VIs	1	136	--	---	1	143	--	---
WhB	Waiakoa extremely stony silty clay loam, 3 to 7 percent slopes	127	---	VIIs	--	---	--	---	1	143	--	---

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
WhC	Waiakoa extremely stony silty clay loam, 7 to 15 percent slopes----	127	---	VIIs	--	---	--	---	1	143	--	---
WkA	Waialua silty clay, 0 to 3 percent slopes---------------------	128	I	IIIc	4	137	--	---	3	144	1	149
WkB	Waialua silty clay, 3 to 8 percent slopes---------------------	128	IIe	IIIc	4	137	--	---	3	144	1	149
WlB	Waialua stony silty clay, 3 to 8 percent slopes-------------------	128	IIIe	IIIs	4	137	--	---	3	144	1	149
WlE	Waialua stony silty clay, 12 to 30 percent slopes---------------	129	---	IVe	--	---	--	---	3	144	1	149
WmD	Waialua very stony silty clay, 12 to 20 percent slopes---------	129	---	VIs	--	---	--	---	3	144	1	149
WnB	Waialua clay, 2 to 6 percent slopes--------------------------	129	IIe	IIIc	4	137	--	---	3	144	1	149
WoA	Waihuna clay, 0 to 3 percent slopes--------------------------	129	IIs	IIIs	--	---	1	137	3	144	--	---
WoB	Waihuna clay, 3 to 7 percent slopes--------------------------	130	IIe	IIIs	--	---	2	138	3	144	--	---
WoC	Waihuna clay, 7 to 15 percent slopes--------------------------	130	IIIe	IIIe	--	---	3	139	3	144	--	---
WoD	Waihuna clay, 15 to 25 percent slopes--------------------------	130	IVe	IVe	--	---	3	139	3	144	--	---
WohB	Waihuna gravelly clay, 3 to 7 percent slopes-------------------	130	IIe	IIIs	--	---	2	138	3	144	--	---
WpB	Waikane silty clay, 3 to 8 percent slopes---------------------	131	IIe	IIe	--	---	--	---	8	145	7	151
WpC	Waikane silty clay, 8 to 15 percent slopes--------------------	131	IIIe	IIIe	--	---	--	---	8	145	7	151
WpE	Waikane silty clay, 25 to 40 percent slopes---------------------	130	---	VIe	--	---	--	---	8	145	7	151
WpF	Waikane silty clay, 40 to 70 percent slopes--------------------	131	---	VIIe	--	---	--	---	8	145	14	152
WpF2	Waikane silty clay, 40 to 70 percent slopes, eroded-------------	131	---	VIIe	--	---	--	---	8	145	14	152
WpaE	Waikane stony silty clay, 15 to 30 percent slopes---------------	131	---	VIe	--	---	--	---	8	145	7	151
WrA	Waikapu silty clay loam, 0 to 3 percent slopes------------------	131	I	IVc	--	---	1	137	2	144	--	---
WrB	Waikapu silty clay loam, 3 to 7 percent slopes------------------	132	IIe	IVc	--	---	2	138	2	144	--	---
WrB3	Waikapu silty clay loam, 3 to 7 percent slopes, severely eroded-------------------------	132	IIIe	IVe	--	---	2	138	2	144	--	---
WrC3	Waikapu silty clay loam, 7 to 15 percent slopes, severely eroded-------------------------	132	IVe	IVe	--	---	3	139	2	144	--	---
Ws	Waikomo stony silty clay----------	132	IVs	VIs	1	136	--	---	5	145	13	152
Wt	Waikomo very rocky silty clay-----	133	VIs	VIs	--	---	--	---	5	145	13	152
Wu	Waikomo extremely rocky silty clay----------------------------	133	---	VIIs	--	---	--	---	5	145	13	152
WvB	Wailuku silty clay, 3 to 7 percent slopes---------------------	133	IIe	IIIc	1	136	--	---	3	144	1	149
WvC	Wailuku silty clay, 7 to 15 percent slopes---------------------	133	IIIe	IIIe	1	136	--	---	3	144	1	149
WwC	Wailuku cobbly silty clay, 7 to 15 percent slopes---------------	133	IIIe	IIIe	1	136	--	---	3	144	1	149

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
WxB	Wainee very stony silty clay, 3 to 7 percent slopes----------------	134	IVs	VIs	1	136	--	---	1	143	--	---
WxC	Wainee very stony silty clay, 7 to 15 percent slopes---------------	134	IVs	VIs	1	136	--	---	1	143	--	---
WyB	Wainee extremely stony silty clay, 3 to 7 percent slopes-----------	134	VIs	VIs	--	---	--	---	1	143	--	---
WyC	Wainee extremely stony silty clay, 7 to 15 percent slopes----------	134	VIs	VIs	--	---	--	---	1	143	--	---
WzA	Waipahu silty clay, 0 to 2 percent slopes---------------------	134	I	IVc	1	136	--	---	3	144	--	---
WzB	Waipahu silty clay, 2 to 6 percent slopes---------------------	135	IIe	IVc	1	136	--	---	3	144	--	---
WzC	Waipahu silty clay, 6 to 12 percent slopes---------------------	135	IIIe	IVe	1	136	--	---	3	144	--	---

LOW-INTENSITY SURVEY

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
ALE3	Alaeloa silty clay, 15 to 35 percent slopes, severely eroded----	27	---	VIIe	--	---	--	---	6	145	5	150
ALF	Alaeloa silty clay, 40 to 70 percent slopes----------------------	26	---	VIIe	--	---	--	---	6	145	15	152
AME3	Alaeloa stony silty clay, 15 to 35 percent slopes, severely eroded------------------------	27	---	VIIe	--	---	--	---	6	145	5	150
ANE	Alaeloa stony silty clay, overwash, 15 to 35 percent slopes---------	27	---	VIe	--	---	--	---	6	145	5	150
BL	Badland----------------------------	28	---	VIIIe	--	---	--	---	--	---	--	---
BM	Badland-Mahana complex------------	28										
	Badland-----------------------	--	---	VIIIe	--	---	--	---	--	---	--	---
	Mahana------------------------	--	---	VIe	--	---	--	---	6	145	5	150
BS	Beaches----------------------------	28	---	VIIIw	--	---	--	---	--	---	--	---
BW	Blown-out land--------------------	28	---	VIIe	--	---	--	---	--	---	--	---
CO	Colluvial land--------------------	29	---	VIIe	--	---	--	---	--	---	15	152
CR	Coral outcrop---------------------	29	---	VIIIs	--	---	--	---	--	---	--	---
DL	Dune land-------------------------	29	---	VIIIe	--	---	--	---	--	---	--	---
FL	Fill land, mixed------------------	31	---	---	--	---	--	---	--	---	--	---
GL	Gullied land----------------------	31	---	VIIe	--	---	--	---	--	---	--	---
HID	Halawa silty clay, 3 to 25 percent slopes---------------------	32	IVe	IVe	--	---	--	---	6	145	5	150
HID3	Halawa silty clay, 3 to 25 percent slopes, severely eroded----	33	VIe	VIe	--	---	--	---	6	145	5	150
HJE	Halawa silt loam, 20 to 35 percent slopes---------------------	33	---	VIe	--	---	--	---	6	145	5	150
HJF2	Halawa silt loam, 35 to 70 percent slopes, eroded-------------	33	---	VIIe	--	---	--	---	6	145	15	152
HKLD	Hana very stony silty clay loam, 3 to 25 percent slopes----------	37	---	VIs	--	---	--	---	11	147	8	151
HKMD	Hana extremely stony silty clay loam, 3 to 25 percent slopes----	37	---	VIs	--	---	--	---	11	147	8	151
HKNC	Hana silty clay loam, moderately deep variant, 3 to 15 percent slopes--------------------------	37	---	IIIe	--	---	--	---	11	147	8	151

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated	Capability classification: Nonirrigated	Sugarcane group		Pineapple group		Pasture group		Woodland group	
			Symbol	Symbol	No.	Page	No.	Page	No.	Page	No.	Page
HKOC	Hana extremely stony silty clay loam, moderately deep variant, 3 to 15 percent slopes----------	37	---	VIs	--	---	--	---	9	146	8	151
HLMG	Helemano silty clay, 30 to 90 percent slopes------------------	40	---	VIIe	--	---	--	---	3	144	15	152
HMMF	Hihimanu silty clay loam, 40 to 70 percent slopes---------------	40	---	VIIe	--	---	--	---	8	145	14	152
HNUD	Hulua gravelly silty clay loam, 3 to 25 percent slopes----------	46	---	VIe	--	---	--	---	--	---	16	152
HNUF	Hulua gravelly silty clay loam, 25 to 70 percent slopes---------	45	---	VIIe	--	---	--	---	--	---	16	152
ISD	Io silt loam, 7 to 25 percent slopes--------------------------	47	---	IVe	--	---	--	---	4	144	2	149
JL	Jaucas-Blown-out land complex-----	49	---	VIe	--	---	--	---	1	143	--	---
KASD	Kahanui silty clay, 3 to 20 percent slopes---------------------	52	---	VIe	--	---	--	---	8	145	12	152
KATD	Kahanui gravelly silty clay, 3 to 20 percent slopes---------------	51	---	VIe	--	---	--	---	8	145	12	152
KBID	Kailua silty clay, 3 to 25 percent slopes---------------------	53	---	IVe	--	---	--	---	11	147	8	151
KCXD	Kaimu extremely stony peat, 7 to 25 percent slopes---------------	53	---	VIs	--	---	--	---	5	145	3	149
KDIE	Kaipoioi loam, 7 to 40 percent slopes-------------------------	54	---	VIe	--	---	--	---	13	148	11	151
KDVE	Kaipoioi very rocky loam, 7 to 40 percent slopes------------------	54	---	VIs	--	---	--	---	13	148	11	151
KEHF	Kalapa very rocky silty clay, 40 to 70 percent slopes------------	56	---	VIIs	--	---	--	---	8	145	14	152
KFID	Kalaupapa very rocky silty clay loam, 3 to 25 percent slopes----	56	---	VIIs	--	---	--	---	5	145	13	152
KGKC	Kamaole very stony silt loam, 3 to 15 percent slopes------------	59	---	VIs	--	---	--	---	3	144	--	---
KGLC	Kamaole extremely stony silt loam, 3 to 15 percent slopes----	59	---	VIs	--	---	--	---	3	144	--	---
KHMC	Kaneohe silty clay loam, 5 to 15 percent slopes------------------	60	---	IIIe	--	---	--	---	8	145	7	151
KHME	Kaneohe silty clay loam, 15 to 30 percent slopes------------------	60	---	VIe	--	---	--	---	8	145	7	151
KHMF	Kaneohe silty clay loam, 30 to 65 percent slopes------------------	60	---	VIIe	--	---	--	---	8	145	14	152
KHOF	Kaneohe silty clay, 30 to 65 percent slopes---------------------	60	---	VIIe	--	---	--	---	8	145	14	152
KIG	Kapaa silty clay, 40 to 100 percent slopes---------------------	62	---	VIIe	--	---	--	---	10	146	14	152
KKTC	Kapuhikani extremely stony clay, 3 to 15 percent slopes----------	62	---	VIIs	--	---	--	---	1	143	--	---
KLUD	Kaupo very stony silty clay loam, 3 to 25 percent slopes----------	63	---	VIs	--	---	--	---	3	144	1	149
KLVD	Kaupo extremely stony silty clay, 3 to 25 percent slopes----------	63	---	VIs	--	---	--	---	3	144	1	149
KMW	Kealia silt loam------------------	67	---	VIIw	--	---	--	---	1	143	--	---
KNXD	Keawakapu extremely stony silty clay loam, 3 to 25 percent slopes-------------------------	68	---	VIs	--	---	--	---	1	143	--	---
KOYE	Kekaha extremely stony silty clay loam, 0 to 35 percent slopes----	69	---	VIs	--	---	--	---	2	144	4	149

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
KPZ	Kemoo-Badland complex-------------	70										
	Kemoo-------------------------	--	---	VIIe	--	---	--	---	5	145	5	150
	Badland-----------------------	--	---	VIIIe	--	---	--	---	--	---	--	---
KRL	Koele-Badland complex------------	71										
	Koele-------------------------	--	---	VIe	--	---	--	---	3	144	--	---
	Badland-----------------------	--	---	VIIIe	--	---	--	---	--	---	--	---
KRX	Koele rocky complex---------------	71	---	VIs	--	---	--	---	3	144	--	---
KSKE	Kokee silty clay loam, 0 to 35 percent slopes------------------	71	---	VIe	--	---	--	---	12	147	10	151
KSKF	Kokee silty clay loam, 35 to 70 percent slopes------------------	72	---	VIIe	--	---	--	---	12	147	10	151
KTKE	Kokokahi very stony clay, 0 to 35 percent slopes------------------	73	---	VIs	--	---	--	---	3	144	--	---
KUL	Kolokolo extremely stony clay loam----------------------------	75	---	VIIs	--	---	--	---	8	145	7	151
KVSB	Koolau silty clay, 0 to 8 percent slopes--------------------	76	---	VIw	--	---	--	---	11	147	16	152
KVSE	Koolau silty clay, 8 to 30 percent slopes--------------------	76	---	VIw	--	---	--	---	11	147	16	152
KZC	Kunuweia very gravelly clay loam, 0 to 15 percent slopes----------	78	---	VIs	--	---	--	---	12	147	12	152
LME	Laumaia loam, 7 to 40 percent slopes-------------------------	80	---	VIe	--	---	--	---	13	148	11	151
LMF	Laumaia loam, 40 to 70 percent slopes-------------------------	80	---	VIIe	--	---	--	---	13	148	11	151
LNE	Laumaia extremely stony loam, 7 to 40 percent slopes-----------	80	---	VIIs	--	---	--	---	13	148	11	151
LPE	Lualualei extremely stony clay, 3 to 35 percent slopes----------	85	---	VIIs	--	---	--	---	2	144	4	149
MBL	Mahana-Badland complex-----------	86										
	Mahana------------------------	--	---	IVe	--	---	--	---	6	145	5	150
	Badland-----------------------	--	---	VIIIe	--	---	--	---	--	---	--	---
MID	Makaalae silty clay, 7 to 25 percent slopes--------------------	87	---	IVe	--	---	--	---	8	145	7	151
MJD	Makaalae extremely stony silty clay, 7 to 25 percent slopes----	87	---	VIIs	--	---	--	---	8	145	7	151
MWE	Makaalae clay, 7 to 40 percent slopes-------------------------	87	---	VIe	--	---	--	---	8	145	7	151
MXC	Makena loam, stony complex, 3 to 15 percent slopes---------------	91										
	Makena------------------------	--	---	VIs	--	---	--	---	1	143	--	---
	Stony land--------------------	--	---	VIIs	--	---	--	---	--	---	--	---
MYD	Malama extremely stony muck, 3 to 25 percent slopes---------------	93	---	VIs	--	---	--	---	9	146	8	151
MZ	Marsh----------------------------	95	---	VIIIw	--	---	--	---	--	---	--	---
NAC	Naiwa silty clay loam, 3 to 20 percent slopes-----------------	97	---	IVe	--	---	--	---	6	145	5	150
NAC3	Naiwa silty clay loam, 7 to 15 percent slopes, severely eroded--------------------------	98	---	VIe	--	---	--	---	6	145	5	150
NLE	Niulii silty clay loam, 7 to 30 percent slopes------------------	99	---	VIe	--	---	--	---	9	146	8	151
NME	Niulii silty clay loam, medium textured variant, 7 to 30 percent slopes--------------------	99	---	VIe	--	---	--	---	9	146	8	151

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
OAD	Oanapuka very stony silt loam, 7 to 25 percent slopes----------	101	---	VIs	--	---	--	---	2	144	--	---
OED	Oanapuka extremely stony silt loam, 7 to 25 percent slopes----	101	---	VIIs	--	---	--	---	2	144	--	---
OFC	Olelo silty clay, 3 to 15 percent slopes---------------------	101	---	IIIe	--	---	--	---	8	145	7	151
OMB	Oli silt loam, 3 to 10 percent slopes------------------------	103	---	IVe	--	---	--	---	6	145	5	150
OME	Oli silt loam, 10 to 30 percent slopes------------------------	102	---	VIe	--	---	--	---	6	145	5	150
OMF	Oli silt loam, 30 to 70 percent slopes------------------------	103	---	VIIe	--	---	--	---	6	145	15	152
ONC	Olinda loam, 4 to 12 percent slopes-------------------------	103	---	IIIe	--	---	--	---	12	147	10	151
OND	Olinda loam, 12 to 20 percent slopes-------------------------	103	---	IVe	--	---	--	---	12	147	10	151
ONE	Olinda loam, 20 to 40 percent slopes-------------------------	104	---	VIe	--	---	--	---	12	147	10	151
OOE	Olokui silty clay loam, 3 to 30 percent slopes-----------------	104	---	VIIw	--	---	--	---	--	---	16	152
OPD	Opihikao extremely rocky muck, 3 to 25 percent slopes-----------	105	---	VIs	--	---	--	---	9	146	--	---
PGE	Paaiki loam, 6 to 35 percent slopes--------------------------	105	---	VIe	--	---	--	---	12	147	10	151
PGF	Paaiki loam, 35 to 70 percent slopes--------------------------	106	---	VIIe	--	---	--	---	12	147	10	151
PHXC	Pakala extremely stony sandy clay loam, 0 to 12 percent slopes----	108	---	VIIs	--	---	--	---	2	144	4	149
PID	Pamoa silty clay, 5 to 20 percent slopes-------------------------	108	---	IVe	--	---	--	---	3	144	--	---
PID2	Pamoa silty clay, 5 to 20 percent slopes, eroded-----------------	109	---	VIe	--	---	--	---	3	144	--	---
PJD2	Pamoa stony silty clay, 5 to 20 percent slopes, eroded----------	109	---	VIe	--	---	--	---	3	144	--	---
PXD	Pane silt loam, 7 to 25 percent slopes-------------------------	109	---	IVe	--	---	--	---	5	145	3	149
PYD	Papaa clay, 6 to 20 percent slopes--------------------------	110	---	IVe	--	---	--	---	3	144	1	149
PYE	Papaa clay, 20 to 35 percent slopes-------------------------	110	---	VIe	--	---	--	---	3	144	1	149
PYF	Papaa clay, 35 to 70 percent slopes-------------------------	110	---	VIIe	--	---	--	---	3	144	1	149
PZ	Paumalu-Badland complex-----------	111										
	Paumalu-----------------------	--	---	VIIe	--	---	--	---	8	145	7	151
	Badland----------------------	--	---	VIIIe	--	---	--	---	--	---	--	---
PZUE	Puuone sand, 7 to 30 percent slopes------------------------	117	---	VIIe	--	---	--	---	1	143	--	---
PZVE	Puu Pa very stony silt loam, 7 to 40 percent slopes--------------	118	---	VIs	--	---	--	---	2	144	--	---
TAE	Tantalus silt loam, 15 to 40 percent slopes------------------	121	---	VIe	--	---	--	---	9	146	8	151
TAF	Tantalus silt loam, 40 to 70 percent slopes------------------	121	---	VIIe	--	---	--	---	9	146	8	151
TCC	Tantalus silty clay loam, 8 to 15 percent slopes------------------	121	---	IIIe	--	---	--	---	9	146	8	151

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
TCE	Tantalus silty clay loam, 15 to 40 percent slopes------------------	121	---	VIe	--	---	--	---	9	146	8	151
TR	Tropaquepts-----------------------	121	IVw	IVw	--	---	--	---	--	---	--	---
ULD	Ulupalakua silt loam, 7 to 25 percent slopes---------------------	122	---	IVe	--	---	--	---	5	145	3	149
UME	Uma loamy coarse sand, 15 to 40 percent slopes------------------	123	---	VIs	--	---	--	---	4	144	11	151
UMF	Uma loamy coarse sand, 40 to 70 percent slopes------------------	123	---	VIIs	--	---	--	---	4	144	11	151
URD	Uma rocky loamy coarse sand, 7 to 25 percent slopes---------------	123	--	VIs	--	---	--	---	4	144	11	151
WID2	Waiakoa extremely stony silty clay loam, 3 to 25 percent slopes, eroded--------------------------	127	---	VIIs	--	---	--	---	1	143	--	---
WJF	Waiawa extremely rocky clay, 30 to 80 percent slopes------------	129	---	VIIs	--	---	--	---	2	144	--	---

RECONNAISSANCE SURVEY

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated Symbol	Capability classification: Nonirrigated Symbol	Sugarcane group No.	Sugarcane group Page	Pineapple group No.	Pineapple group Page	Pasture group No.	Pasture group Page	Woodland group No.	Woodland group Page
rAAE	Alakai mucky peat, 0 to 30 percent slopes---------------------	27	---	VIIw	--	---	--	---	--	---	16	152
rAMD	Amalu peaty silty clay, 3 to 20 percent slopes------------------	28	---	VIIw	--	---	--	---	--	---	16	152
rAOD	Amalu-Olokui association, 3 to 20 percent slopes------------------	28										
	Amalu------------------------	--	---	VIIw	--	---	--	---	--	---	16	152
	Olokui-----------------------	--	---	VIIIw	--	---	--	---	--	---	16	152
rCI	Cinder land-----------------------	29	---	VIIIs	--	---	--	---	--	---	--	---
rHOD	Honomanu silty clay, 5 to 25 percent slopes---------------------	43	---	IVe	--	---	--	---	11	147	8	151
rHR	Honomanu-Amalu association--------	43										
	Honomanu---------------------	--	---	IVe	--	---	--	---	--	---	8	151
	Amalu------------------------	--	---	VIIw	--	---	--	---	--	---	--	---
rHT	Hydrandepts-Tropaquods association---------------------	46										
	Hydrandepts-------------------	--	---	VIIe	--	---	--	---	--	---	--	---
	Tropaquods--------------------	--	---	VIIw	--	---	--	---	--	---	--	---
rLW	Lava flows, Aa--------------------	80	---	VIIIs	--	---	--	---	--	---	--	---
rRH	Riverwash-------------------------	118	---	VIIIw	--	---	--	---	--	---	--	---
rRK	Rock land-------------------------	119	---	VIIs	--	---	--	---	--	---	--	---
rRO	Rock outcrop----------------------	119	---	VIIIs	--	---	--	---	--	---	--	---
rRR	Rough broken land-----------------	119	---	VIIe	--	---	--	---	--	---	--	---
rRS	Rough broken and stony land-------	119	---	VIIs	--	---	--	---	--	---	--	---
rRT	Rough mountainous land------------	119	---	VIIIe	--	---	--	---	--	---	--	---
rRU	Rubble land-----------------------	119	---	VIIIs	--	---	--	---	--	---	--	---
rSL	Sandy alluvial land---------------	119	---	VIIw	--	---	--	---	--	---	--	---
rSM	Stony alluvial land---------------	120	---	VIIs	--	---	--	---	--	---	--	---
rSN	Stony blown-out land--------------	120	---	VIIs	--	---	--	---	--	---	--	---
rSO	Stony colluvial land--------------	120	---	VIIs	--	---	--	---	--	---	--	---
rST	Stony land------------------------	120	---	VIIs	--	---	--	---	--	---	--	---
rSY	Stony steep land------------------	121	---	VIIs	--	---	--	---	--	---	--	---
rTO	Tropaquods------------------------	121	---	VIIw	--	---	--	---	--	---	--	---
rTP	Tropohumults-Dystrandepts association---------------------	122	---	VIIe	--	---	--	---	--	---	--	---

Map symbol	Mapping unit	Described on page	Capability classification: Irrigated	Capability classification: Nonirrigated	Sugarcane group		Pineapple group		Pasture group		Woodland group	
			Symbol	Symbol	No.	Page	No.	Page	No.	Page	No.	Page
rVS	Very stony land--------------------	124	---	VIIs	--	---	--	---	--	---	--	---
rVT2	Very stony land, eroded------------	124	---	VIIs	--	---	--	---	--	---	--	---
rWAF	Waialeale mucky silty clay loam, 30 to 70 percent slopes----------	127	---	VIIe	--	---	--	---	--	---	16	152

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Natural Resources Conservation Service

Pacific Islands Area

MLRA Soil Survey Office
Kealakekua Service Center
Central Kona Center
81-948 Waena 'Oihana Loop, Suite 101
Kealakekua, HI 96750

12/18/13

Subject: Trip Report – Soil investigation for HC&S Field 921
1. Verify existing soils information
2. Classification of soil pedons

To: Mae Nakahata
HC&S
Maui, Hawaii

CC: Tony Rolfes, USDA-NRCS, Asst. Director for Soil Science and Natural Resource Assessments
Ranae Ganske, USDA-NRCS, Maui District Conservationist

Purpose for Soil Investigation

On November 18, 2013, Michael Kolman and Carl Hashimoto, NRCS Soil Conservation Technician, met with Mae Nakahata and Kyle Onaga of HC&S. The purpose of the meeting was to discuss soil mapping deficiencies that have been observed in field 921 compared to the published 1972 Soil Survey of Island of Maui, Hawaii. Through Mae Nakahata, HC&S requested that the NRCS soils staff verify existing soils information and to classify the soil pedons located within the field. From November 19-20, I photographed, described, and classified seven soil pits and made three additional auger hole observations in the field. All documentation will be made available.

Observations for Field 921

I. Geomorphology and Soils

According to *Geology of Hawaii* (Stearns and MacDonald,1942), field 921 is in a dune field that trends north to south on the Isthmus of Maui Island. The dune deposit consists of calcareous sand that can be cemented. Color infrared (CIR) photographs, from 1990, show that in the field the sand dune had been breached by two dry stream channels from West Maui. Pulehu Stream channel also breaches the sand dune along the west side of field 921.

Field 921 is about 143 acres in total area. The published 1972 *Soil Survey of Island of Maui, Hawaii* shows the field to be composed of about 107 acres of JaC- Jaucas sand, 0 to 15 percent slopes; 30 acres of PZUE- Puuone sand, 7 to 30 percent slopes; and 6 acres of PrB- Pulehu cobbly silt loam, 3 to 7 percent slopes. The composition of the field is not accurate and I present the deficiencies below in the Soil Data section.

II. Soils Data

On November 19-20, I photographed, described, and classified seven soil pits (see attached map of field 921 and Pedon Description Report) and made three additional auger hole observations in the field. I measured slopes that ranged from 0 to 4 percent. I was not able to discern how the published soil survey lines represent the landform or soil types as the measured slope was quite different. Slope phases for soil map units should represent the range of slopes found on the landform to aid soil survey users in making informed land use decisions.

I also observed alluvial deposits in and on the dune field. I noted this as recent alluvium from West Maui Mountain. The recent alluvium is characterized by fine and coarse loamy soil textures with and without rounded cobbles and gravels. I also observed a paleosol (relict soil) about 1 to 1.5 meters below the surface in four of the seven soil pits. The paleosol, made from old alluvium from West Maui Mountain, is under the dune field and is a relict landform with clayey or fine-silty soils. The soils in this field show a high degree of variability as compared to the published soil maps and data. It is my opinion that the composition of soil map units should be described as a complex of soil components rather than a single soil component. Accurately defined soil map unit composition would also help users to make informed land use decisions.

The current standard for soil classification is *Keys to Soil Taxonomy, 11th Edition, 2010.* Upon review of the official soil series description (OSD) of Puuone, it occurred to me that the soil order is incorrectly classified as Entisols. The presence of calcite in the soil has produced calcic and petrocalcic horizons which are diagnostic features not found in Entisols. The Puuone OSD and soil series classification needs to be updated to current standards and to reflect the true genesis of the soil.

It may also be necessary to propose a new soil series to replace the Jaucas soil as mollic epipedons and calcic horizons were observed in the JaC map unit. These diagnostic features are not found in Entisols which Jaucas is classified as. More observations in this map unit may reveal this to be a new soil series.

I must point out that I was impressed that HC&S uses conservation management practices in field 921. The soil conservation practices I observed were mulching, no till, and drip irrigation. In my experience, I have found that these particular practices improve soil health, reduce wind and water erosion, and help to manage irrigation more efficiently.

Conclusions

As a result of the data collected during this site investigation and a review of the existing soil data, I propose that the Puuone soil series needs to be reclassified to the current taxonomic standard; that a new soil series may need to replace the Jaucas component on Maui; and map units PZUE and JaC, which have single components, need to be updated so that the composition and slope phases of the map units are more accurately defined for the intended land use. The soil map units in this field showed more variability than the published soil survey and should be described as a complex of soils.

The reclassification of Puuone and updating of the components in map units JaC and PZUE are proposed soil survey update projects for the MLRA Soil Survey Office. Once the projects are approved by the MLRA management team, in 2014, we can begin updating this data and correct the observed and noted deficiencies.

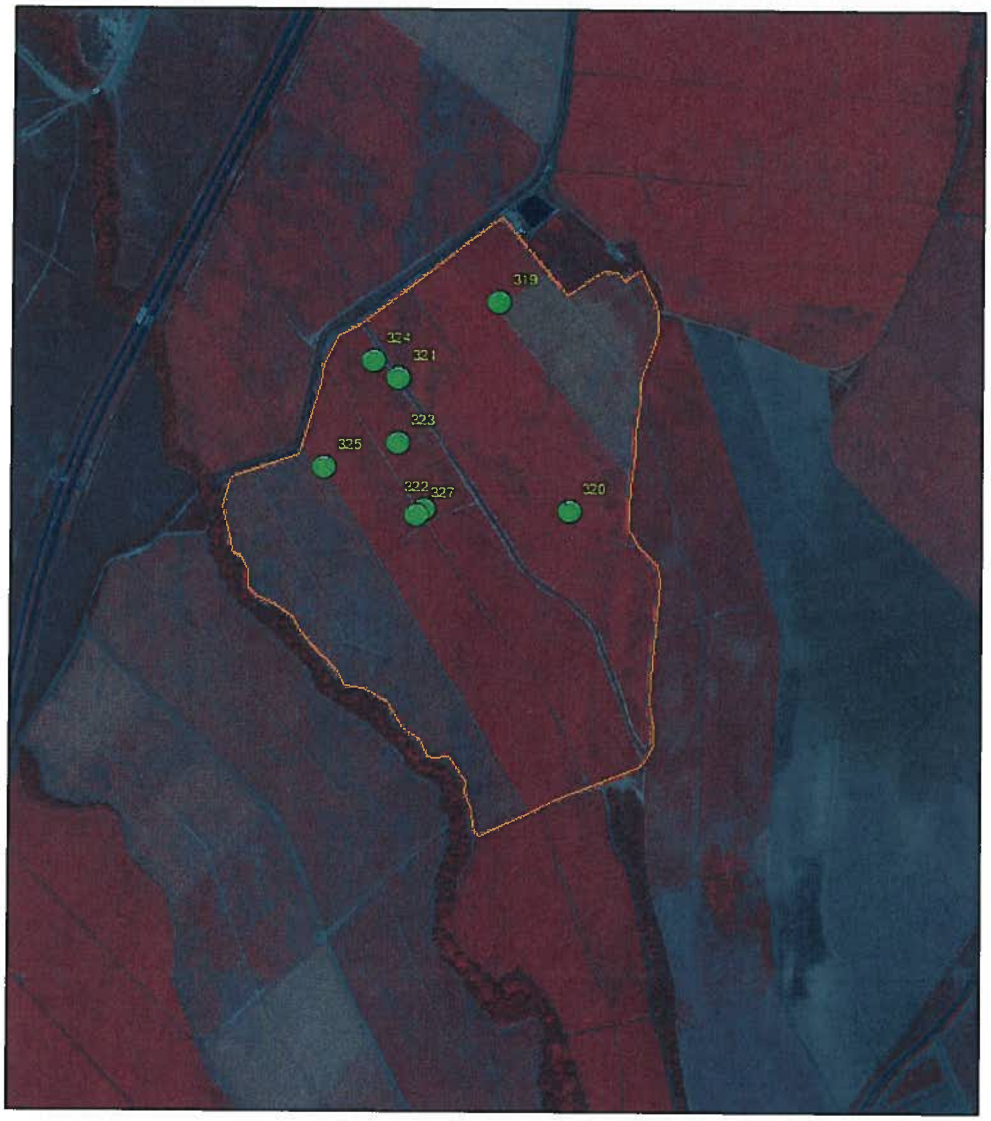
Submitted by:

Michael Kolman
Soil Scientist
MLRA Soil Survey Leader

Attachments:

1. Map of Field 921 with GPS points
2. Pedon Description Report, HC&S field 921, 12/18/13

HC&S Field 921



Legend

HC&S soil pits

hcs_921_b

1:10,000

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USDA-Natural Resources Conservation Service

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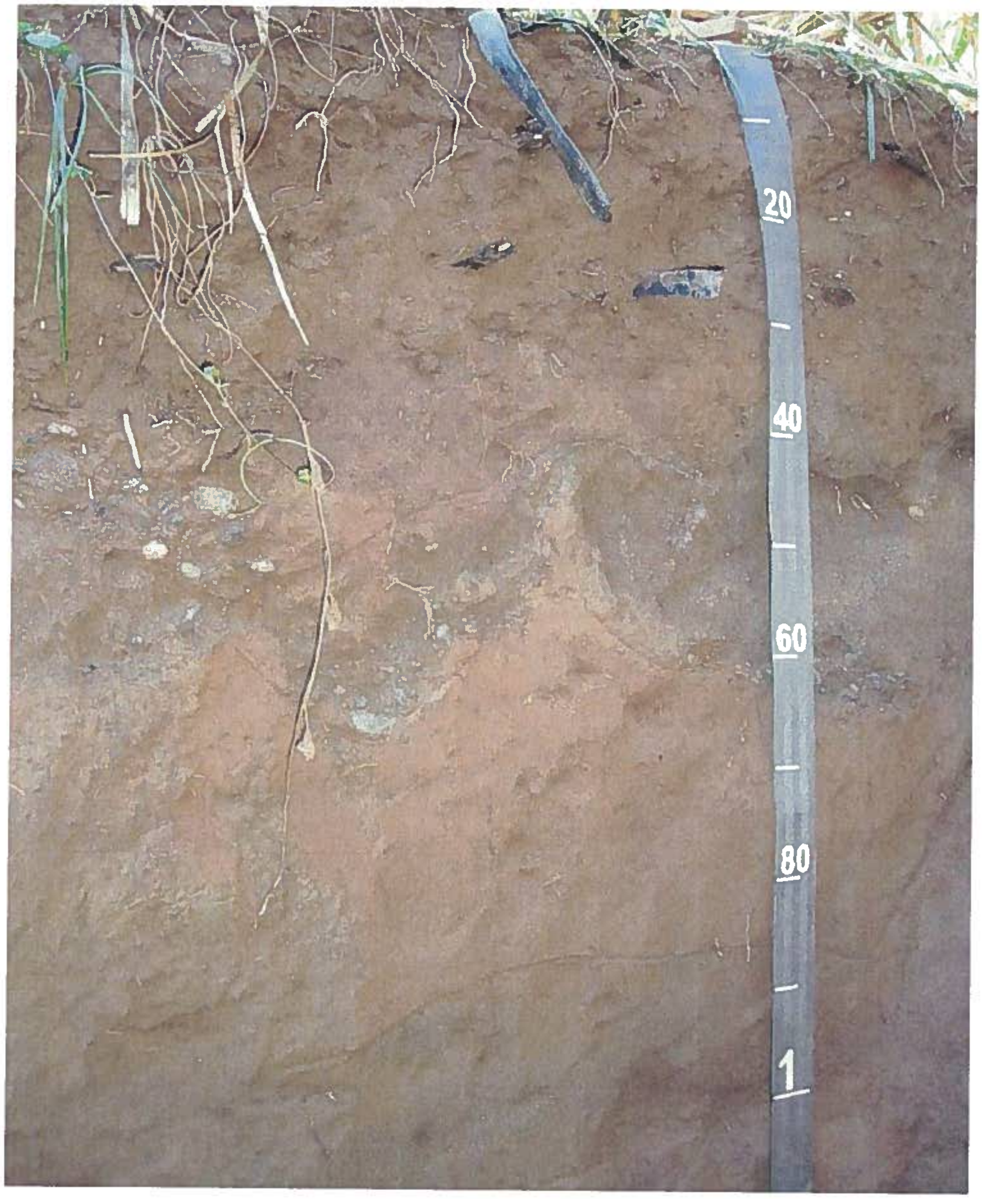
Pedon Description Report

HC&S Field 921

Michael Kolman

12/18/2013

USDA - NATURAL RESOURCES CONSERVATION SERVICE



Soil Pit 1
PEDON DESCRIPTION

Description Date: 11/19/2013
Describer: Mike Kolman

User Site ID: 2013HI980001
User Pedon ID: 2013HI980001

Soil Name as Correlated: Jaucas
Taxon Kind as Correlated: family
Correlated Classification: Sandy, mixed, semiactive, isohyperthermic Aridic Argiustolls

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii

Location Description: HC&S field 921; Pit 1; WP 319, Pic 70
Latitude: 20 degrees 50 minutes 25.00 seconds north
Longitude: 156 degrees 29 minutes 0.60 seconds west
Datum: WGS84

Geomorphic Setting: on summit of dune
Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Parent Material: eolian sands over alluvium
Ksat Class Upper: high
Ksat Class Lower: moderately low
Particle Size Control Section: 25 to 100 cm.

Diagnostic Features:		
	mollic epipedon	0 to 35 cm.
	cambic horizon	61 to 87 cm.
	abrupt textural change	102 to 152 cm.
	argillic horizon	102 to 152 cm.

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
0.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 5 centimeters; sandy loam, very dark grayish brown (10YR 3/2), moist; weak very fine granular structure, and weak fine subangular blocky structure; friable, slightly hard, nonsticky, nonplastic; common fine roots and common medium roots; many very fine interstitial pores; 5 percent 2- to 75-millimeter unspecified fragments; ; clear smooth boundary.

Ap2--5 to 15 centimeters; sandy loam, very dark grayish brown (10YR 3/2), moist; moderate medium subangular blocky structure; friable, slightly hard, nonsticky, nonplastic; common fine roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; ; clear smooth boundary.

Bw1--15 to 35 centimeters; loamy sand, very dark grayish brown (10YR 3/2), moist; moderate coarse subangular blocky structure; friable, slightly hard, nonsticky, nonplastic; common fine roots; many very fine interstitial pores; 2- to 75-millimeter unspecified fragments; ; abrupt wavy boundary.

C1--35 to 61 centimeters; cobbly sand, dark yellowish brown (10YR 3/4), moist; weak medium subangular blocky structure; loose, loose, nonsticky, nonplastic; common fine roots; common very fine interstitial pores; 75- to 250-millimeter unspecified fragments and 2- to 75-millimeter unspecified fragments; ; abrupt wavy boundary.

Bw2--61 to 87 centimeters; sandy loam, dark brown (7.5YR 3/3), moist; moderate fine subangular blocky structure; friable, slightly hard, slightly sticky, slightly plastic; common fine roots; common very fine tubular pores; ; abrupt smooth boundary.

C2--87 to 102 centimeters; loamy sand, dark brown (10YR 3/3), moist; weak very fine subangular blocky structure; loose, loose, nonsticky, nonplastic; common very fine tubular pores; ; abrupt smooth boundary.

2Bt--102 to 152 centimeters; silty clay loam, dark brown (7.5YR 3/2), moist; moderate medium subangular blocky structure; friable, slightly hard, moderately sticky, moderately plastic; common very fine tubular pores; .

Soil Pit 2
PEDON DESCRIPTION

Description Date: 11/19/2013
Describer: Mike Kolman

User Site ID: 2013HI980002
User Pedon ID: 2013HI980002

Soil Name as Correlated: Jaucas
Taxon Kind as Correlated: family
Correlated Classification: Sandy over loamy, carbonatic over mixed, semiactive, isohyperthermic Calcidic Paleustolls

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Pit 2; WP 320
Latitude: 20 degrees 50 minutes 12.50 seconds north
Longitude: 156 degrees 28 minutes 56.30 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Parent Material: eolian sands over alluvium
Surface Fragments: 2.0 percent 2- to 75-millimeter
Ksat Class Upper: high
Ksat Class Lower: moderately low
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features: mollic epipedon 0 to 31 cm.
calcic horizon 31 to 89 cm.
argillic horizon 89 to 150 cm.

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
1.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 6 centimeters; sandy loam, dark brown (7.5YR 3/2), moist; weak very fine granular structure, and weak medium subangular blocky structure; friable, slightly hard, nonsticky, slightly plastic; common fine roots and common medium roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; clear smooth boundary.

Ap2--6 to 31 centimeters; sandy loam, very dark brown (7.5YR 2.5/2), moist; moderate fine subangular blocky structure; friable, slightly hard, slightly sticky, slightly plastic; common fine roots; many very fine tubular pores; 5 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 7.9, pH meter; ; clear wavy boundary.

Bk--31 to 87 centimeters; sand, strong brown (7.5YR 4/6), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; common medium roots; many very fine interstitial pores; 2 percent fine yellow (10YR 7/6) carbonate, finely disseminated lining pores; 75- to 250-millimeter unspecified fragments and 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; abrupt smooth boundary.

Bkk--87 to 89 centimeters; cemented material, light gray (10YR 7/2), moist; structureless massive structure; extremely firm, extremely hard, nonsticky, nonplastic; 100 percent coarse prominent platy very strongly cemented yellow (10YR 7/6) carbonate beds with sharp boundaries at top of horizon; very strongly alkaline, pH 9.1, pH meter; ; abrupt smooth boundary.

2Bt--89 to 152 centimeters; silty clay loam, dark brown (7.5YR 3/3), moist; strong medium subangular blocky structure; firm, hard, moderately sticky, moderately plastic; common very fine tubular pores; moderately alkaline, pH 8.0, pH meter; .

Soil Pit 3
PEDON DESCRIPTION

Description Date: 11/19/2013
Describer: Mike Kolman

User Site ID: 2013HI980003
User Pedon ID: 2013HI980003

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy, carbonatic, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory
Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Pit 3; WP 324; Pic 72
Latitude: 20 degrees 50 minutes 21.70 seconds north
Longitude: 156 degrees 29 minutes 8.60 seconds west
Datum: WGS84

Geomorphic Setting: on shoulder of dune

Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Shrub cover
Parent Material: eolian sands
Ksat Class Upper: high
Ksat Class Lower: moderately high
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features: ochric epipedon 0 to 21 cm.
calcic horizon 21 to 75 cm.
petrocalcic horizon 75 to 115 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
75	115	petrocalcic	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
4.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 8 centimeters; loamy sand, and brown (10YR 4/3), moist; weak medium subangular blocky structure parts to weak very fine granular structure; very friable, soft, nonsticky, nonplastic; many fine roots; many fine interstitial pores; 2 percent 75- to 250-millimeter unspecified fragments and 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; ; clear smooth boundary.

Ap2--8 to 21 centimeters; loamy sand, dark yellowish brown (10YR 4/4), moist; weak fine subangular blocky structure; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.3, pH meter; ; clear wavy boundary.

Bk1--21 to 45 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless single grain structure; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; ; abrupt smooth boundary.

Bk2--45 to 75 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless massive structure; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 10 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; ; diffuse smooth boundary.

Bkm--75 to 115 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless massive structure; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; very strongly alkaline, pH 9.1, pH meter; ; diffuse smooth boundary.

Bk3--115 to 152 centimeters; sand, dark yellowish brown (10YR 4/4), moist; structureless massive structure; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 10 percent very fine faint irregular weakly cemented yellowish brown (10YR 5/6) carbonate masses with diffuse boundaries lining pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; .

Soil pit 4
PEDON DESCRIPTION

Description Date: 11/19/2013
Describer: Mike Kolman

User Site ID: 2013HI980004
User Pedon ID: 2013HI980004

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy, carbonatic, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory
Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Pit 4; WP 321; Pic 73&74
Latitude: 20 degrees 50 minutes 20.60 seconds north
Longitude: 156 degrees 29 minutes 7.00 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex Cross Slope Shape: linear

Primary Earth Cover: Shrub cover
Parent Material: eolian sands
Ksat Class Upper: high
Ksat Class Lower: moderately high
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features: ochric epipedon 0 to 20 cm.
calcic horizon 20 to 30 cm.

petrocalcic horizon 30 to 45 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
30	45	petrocalcic	moderately cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 5 centimeters; loamy sand, and brown (10YR 4/3), moist; weak medium granular structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; many fine roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; .

Ap2--5 to 20 centimeters; loamy sand, dark yellowish brown (10YR 4/4), moist; weak medium subangular blocky structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.3, pH meter; .

Bk--20 to 30 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; common very fine roots; common very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; .

Bkm--30 to 45 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless massive structure; extremely firm, very rigid, nonsticky, nonplastic; common very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; very strongly alkaline, pH 9.1, pH meter; .

2C1--45 to 57 centimeters; loamy sand, dark yellowish brown (10YR 4/4), moist; weak medium subangular blocky structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 10 percent very fine faint irregular weakly cemented yellowish brown (10YR 5/6) carbonate masses with diffuse boundaries lining pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; .

2C2--57 to 90 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; moderately alkaline, pH 8.4, pH meter; .

2C3--90 to 102 centimeters; loamy sand, dark yellowish brown (10YR 4/4), moist; weak medium subangular blocky structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; .

2C4--102 to 152 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; moderately alkaline, pH 8.4, pH meter; .

Soil Pit 5
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980005
User Pedon ID: 2013HI980005

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy over loamy, carbonatic over mixed, semiactive, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Pit 5; WP 323; Pic 79&80
Latitude: 20 degrees 50 minutes 16.70 seconds north
Longitude: 156 degrees 29 minutes 7.20 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Shrub cover
Parent Material: eolian sands over alluvium
Ksat Class Upper: high
Ksat Class Lower: moderately low
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features: ochric epipedon 0 to 27 cm.
calcic horizon 27 to 34 cm.
petrocalcic horizon 34 to 44 cm.
argillic horizon 100 to 162 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
34	44	petrocalcic	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 7 centimeters; loamy sand, and brown (10YR 4/3), moist; weak fine granular structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; common fine roots; many very fine interstitial pores; 5 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; ; clear smooth boundary.
Ap2--7 to 27 centimeters; sand, brown (10YR 4/3), moist; weak fine granular structure parts to structureless single grain structure; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; 5 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.3, pH meter; ; clear wavy boundary.

Bk--27 to 34 centimeters; sand, yellowish brown (10YR 5/6), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; common very fine roots; common very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; 2 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; ; clear wavy boundary.

Bkm--34 to 44 centimeters; cemented material, brownish yellow (10YR 6/6), moist; structureless massive structure; rigid, rigid, nonsticky, nonplastic; common very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; 2 percent 2- to 75-millimeter unspecified fragments; very strongly alkaline, pH 9.1, pH meter; ; abrupt smooth boundary.

2C1--44 to 65 centimeters; sand, brown (10YR 4/3), moist; structureless massive structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; 10 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.4, pH meter; ; diffuse wavy boundary.

2C2--65 to 84 centimeters; sand, brown (10YR 4/3), moist; structureless single grain structure; firm, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; ; abrupt smooth boundary.

3Ab--84 to 100 centimeters; loam, black (7.5YR 2.5/1), moist; moderate medium platy structure; firm, slightly hard, slightly sticky, slightly plastic; common very fine tubular and common very fine interstitial pores; ; clear smooth boundary.

3Bt1--100 to 110 centimeters; silty clay loam, very dark brown (7.5YR 2.5/3), moist; moderate medium platy structure; firm, slightly hard, slightly sticky, slightly plastic; common very fine tubular and common very fine interstitial pores; ; clear smooth boundary.

3Bt2--110 to 117 centimeters; loam, black (7.5YR 2.5/1), moist; moderate medium platy structure; firm, slightly hard, slightly sticky, slightly plastic; common very fine tubular and common very fine interstitial pores; ; clear smooth boundary.

3Bt3--117 to 162 centimeters; silty clay loam, very dark brown (7.5YR 2.5/3), moist; moderate medium platy structure; firm, slightly hard, slightly sticky, slightly plastic; common very fine tubular and common very fine interstitial pores; .

Soil pit 6
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980006
User Pedon ID: 2013HI980006

Soil Name as Correlated: Jaucas
Taxon Kind as Correlated: family
Correlated Classification: Carbonatic, isohyperthermic Ustic Torripsamments

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; pit 6; WP 327; pic 76-77-78
Latitude: 20 degrees 50 minutes 12.40 seconds north
Longitude: 156 degrees 29 minutes 5.90 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Grass/herbaceous cover
Ksat Class Upper: high
Ksat Class Lower: moderately high
Parent Material: eolian sands over alluvium
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features: ochric epipedon 0 to 10 cm.

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 10 centimeters; loamy sand, brown (10YR 4/3), moist; weak fine granular structure parts to single grain structure; very friable, soft, nonsticky, nonplastic; many fine roots and common medium roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments; ; clear smooth boundary.

Ap2--10 to 28 centimeters; sand, brown (10YR 4/3), moist; single grain structure, and weak fine subangular blocky structure; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; 2- to 75-millimeter unspecified fragments; ; clear smooth boundary.

C1--28 to 60 centimeters; sand, yellowish brown (10YR 5/4), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; ; clear wavy boundary.

C2--60 to 80 centimeters; sand, dark yellowish brown (10YR 3/4), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; ; abrupt wavy boundary.

2Ab--80 to 87 centimeters; loam, dark brown (7.5YR 3/2), moist; strong medium platy structure; firm, slightly hard, slightly sticky, moderately plastic; common fine roots; common very fine interstitial and common very fine tubular pores; ; abrupt wavy boundary.

3C--87 to 152 centimeters; sand, 50 percent yellowish brown (10YR 5/4) and 40 percent brown (10YR 4/3) and 10 percent very dark grayish brown (10YR 3/2), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; many very fine interstitial pores; .

Soil Pit 7
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980007
User Pedon ID: 2013HI980007

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy-skeletal, carbonatic, isohyperthermic Typic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; pit 9; wp 325; pic 81-82
Latitude: 20 degrees 50 minutes 15.40 seconds north
Longitude: 156 degrees 29 minutes 11.80 seconds west
Datum: WGS84

Geomorphic Setting: on footslope of dune
Upslope Shape: convex   Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Ksat Class Upper: high
Ksat Class Lower: moderately low
Parent Material: eolian sands over alluvium
Surface Fragments: 2.0 percent 2- to 75-millimeter
Particle Size Control Section: 25 to 100 cm.
Diagnostic Features:

ochric epipedon	0 to 20 cm.
cambic horizon	34 to 75 cm.
petrocalcic horizon	75 to 100 cm.
calcic horizon	100 to 140 cm.
argillic horizon	140 to 162 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
75	100	petrocalcic horizon	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap--0 to 20 centimeters; sand, brown (10YR 4/3), moist; single grain structure, and weak medium subangular blocky structure; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; 2 percent 2- to 75-millimeter unspecified fragments and 10 percent 75- to 250-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; clear smooth boundary.

2Ab--20 to 34 centimeters; cobbly sandy loam, very dark brown (10YR 2/2), moist; moderate medium platy structure; friable, slightly hard, slightly sticky, slightly plastic; many fine roots; many very fine interstitial and common very fine tubular pores; 15 percent 75- to 250-millimeter unspecified fragments and 15 percent 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 7.9, pH meter; ; clear wavy boundary.

2Bw1--34 to 45 centimeters; extremely cobbly loamy sand, very dark grayish brown (10YR 3/2), moist; moderate medium subangular blocky structure; friable, slightly hard, nonsticky, nonplastic; many fine roots; many very fine interstitial pores; 75- to 250-millimeter unspecified fragments and 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; abrupt smooth boundary.

2Bw2--45 to 75 centimeters; extremely cobbly loamy sand, very dark grayish brown (10YR 3/2), moist; structureless single grain structure; loose, loose, nonsticky, nonplastic; common fine roots; many very fine interstitial pores; 75- to 250-millimeter unspecified fragments and 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; abrupt smooth boundary.

2Bkm--75 to 100 centimeters; cemented material, yellowish brown (10YR 5/6), moist; structureless massive structure; extremely firm, extremely hard, nonsticky, nonplastic; common very fine interstitial pores; 100 percent coarse prominent platy very strongly cemented yellow (10YR 7/6) carbonate beds with sharp boundaries at top of horizon; 30 percent 2- to 75-millimeter unspecified fragments and 40 percent 75- to 250-millimeter unspecified fragments; very strongly alkaline, pH 9.1, pH meter; ; abrupt smooth boundary.

2Bk--100 to 140 centimeters; sand, yellowish brown (10YR 5/6), moist; structureless massive structure; loose, loose, nonsticky, nonplastic; common very fine interstitial pores; 75- to 250-millimeter unspecified fragments and 2- to 75-millimeter unspecified fragments; moderately alkaline, pH 8.1, pH meter; ; abrupt smooth boundary.

3Bt--140 to 152 centimeters; silty clay, dark reddish brown (5YR 3/3), moist; strong medium subangular blocky structure; firm, hard, moderately sticky, moderately plastic; common very fine tubular pores; moderately alkaline, pH 8.0, pH meter; .

The following 3 pedon descriptions were done on auger holes. No photographs are included.

USDA - NATURAL RESOURCES CONSERVATION SERVICE
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980008
User Pedon ID: 2013HI980008

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy, carbonatic, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Bermudagrass and very young sugar cane.
Latitude: 20 degrees 50 minutes 0.10 seconds north
Longitude: 156 degrees 29 minutes 10.70 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex
Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Parent Material: eolian sands
Ksat Class Upper: high
Ksat Class Lower: moderately high
Particle Size Control Section: 25 to 100 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
90	100	petrocalcic	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap1--0 to 20 centimeters; sand, brown (10YR 4/3), moist; ; very friable, soft, nonsticky, nonplastic; moderately alkaline, pH 8.4, pH meter; ; clear smooth boundary.

Ap2--20 to 40 centimeters; sand, dark yellowish brown (10YR 4/4), moist; ; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; moderately alkaline, pH 8.3, pH meter; ; clear wavy boundary.

Bk--40 to 90 centimeters; sand, yellowish brown (10YR 5/4), moist; ; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; ; abrupt smooth boundary.

Bkm--90 to 100 centimeters; cemented material, yellowish brown (10YR 5/4), moist; ; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; very strongly alkaline, pH 9.1, pH meter; ; diffuse smooth boundary.

USDA - NATURAL RESOURCES CONSERVATION SERVICE
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980009
User Pedon ID: 2013HI980009

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy, carbonatic, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; Bermudagrass and very young sugar cane.
Latitude: 20 degrees 50 minutes 10.00 seconds north
Longitude: 156 degrees 29 minutes 12.90 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Parent Material: eolian sands
Ksat Class Upper: high
Ksat Class Lower: moderately high
Particle Size Control Section: 25 to 100 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
56	100	petrocalcic	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap--0 to 28 centimeters; loamy sand, and brown (10YR 4/3), moist; ; very friable, soft, nonsticky, nonplastic; moderately alkaline, pH 8.4, pH meter; ; clear smooth boundary.

Bk--28 to 56 centimeters; sand, yellowish brown (10YR 5/4), moist; ; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; ; abrupt smooth boundary.

Bkm--56 to 100 centimeters; cemented material, yellowish brown (10YR 5/4), moist; ; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; very strongly alkaline, pH 9.1, pH meter; ; diffuse smooth boundary.

USDA - NATURAL RESOURCES CONSERVATION SERVICE
PEDON DESCRIPTION

Description Date: 11/20/2013
Describer: Mike Kolman

User Site ID: 2013HI980010
User Pedon ID: 2013HI980010

Soil Name as Correlated: Puuone
Taxon Kind as Correlated: family
Correlated Classification: Sandy, carbonatic, isohyperthermic Calcic Petrocalcids

Pedon Type: correlates to named soil
Pedon Purpose: soil survey inventory

Location Information:
State: Hawaii
County: Maui
Soil Survey Area: HI980 -- Island of Maui, Hawaii
Location Description: HC&S field 921; very young sugar cane.
Latitude: 20 degrees 50 minutes 13.10 seconds north
Longitude: 156 degrees 29 minutes 14.70 seconds west
Datum: WGS84

Geomorphic Setting: on backslope of dune
Upslope Shape: convex
Cross Slope Shape: linear

Primary Earth Cover: Crop cover
Parent Material: eolian sands
Ksat Class Upper: high
Ksat Class Lower: moderately high
Particle Size Control Section: 25 to 100 cm.

Top Depth (cm)	Bottom Depth (cm)	Restriction Kind	Restriction Hardness
71	100	petrocalcic	strongly cemented

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
3.0	55.0	140	24.0			737	365	somewhat excessively		

Ap--0 to 35 centimeters; loamy sand, and brown (10YR 4/3), moist; ; very friable, soft, nonsticky, nonplastic; moderately alkaline, pH 8.4, pH meter; ; clear smooth boundary.

Bk1--35 to 56 centimeters; sand, dark yellowish brown (10YR 4/4), moist; ; very friable, soft, nonsticky, nonplastic; common very fine roots; many very fine interstitial pores; moderately alkaline, pH 8.3, pH meter; ; clear wavy boundary.

Bk2--56 to 71 centimeters; sand, yellowish brown (10YR 5/4), moist; ; very friable, soft, nonsticky, nonplastic; many very fine interstitial pores; 5 percent very fine distinct irregular weakly cemented yellow (10YR 7/6) carbonate concretions with clear boundaries lining pores; moderately alkaline, pH 8.4, pH meter; ; abrupt smooth boundary.

Bkm--71 to 100 centimeters; cemented material, yellowish brown (10YR 5/4), moist; ; friable, slightly hard, nonsticky, nonplastic; many very fine interstitial pores; 20 percent coarse distinct platy strongly cemented yellow (10YR 7/6) carbonate masses with sharp boundaries throughout; very strongly alkaline, pH 9.1, pH meter; ; diffuse smooth boundary.

Exhibit E-R23

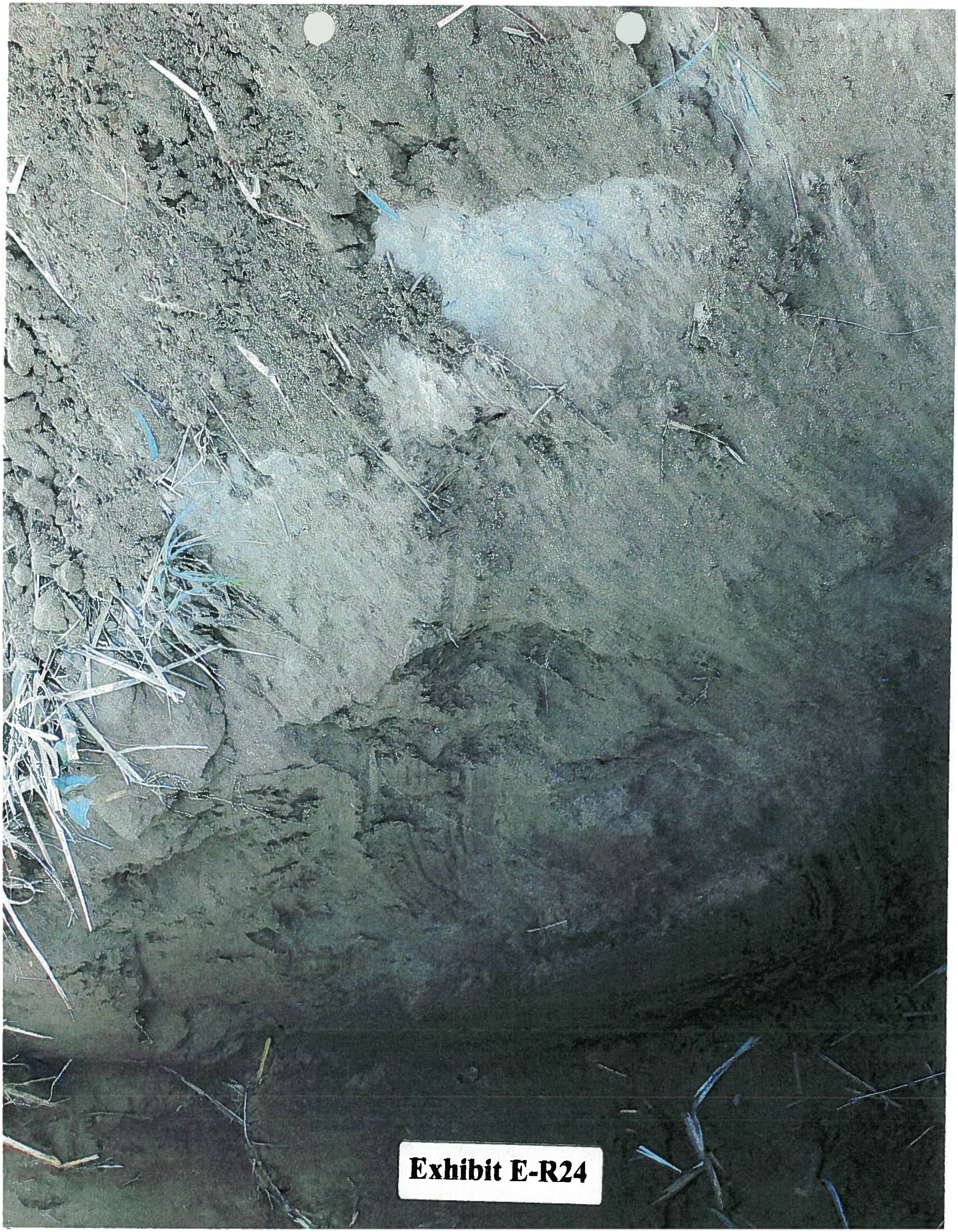


Exhibit E-R24

Exhibit E-R25

Exhibit E-R26

Exhibit E-R27

Exhibit E-R28

	2009	2010	2011	2012
Hoopoi Seed Fields				
Total gal/year	3,418,788,336.64	2,867,502,458.94	2,351,507,531.57	2,400,289,917.00
acres	1,445.00	1,445.00	1,445.00	1,445.00
average gal/ac/yr	2,365,943.49	1,984,430.77	1,627,340.85	1,661,100.29
gal/ac/day	6,482.04	5,436.80	4,458.47	4,550.96
Fields 921 & 922				
Total gal/year	657,641,443.00	512,387,630.00	467,786,684.00	406,179,246.00
acres	301.60	301.60	301.60	301.60
average gal/ac/yr	2,180,508.76	1,698,897.98	1,551,016.86	1,346,748.16
gal/ac/day	5,974.00	4,654.52	4,249.36	3,689.72
Hoopoi Seed Fields Minus Fields 921 & 922				
Total gal/year	2,761,146,893.64	2,355,114,828.94	1,883,720,847.57	1,994,110,671.00
acres	1,143.40	1,143.40	1,143.40	1,143.40
average gal/ac/yr	2,414,856.48	2,059,747.10	1,647,473.19	1,744,018.43
gal/ac/day	6,616.05	5,643.14	4,513.63	4,778.13

Exhibit E-R29