CRYSTAL CITY AIRPORT SITE

CRYSTAL CITY, TEXAS

FEASIBILITY STUDY

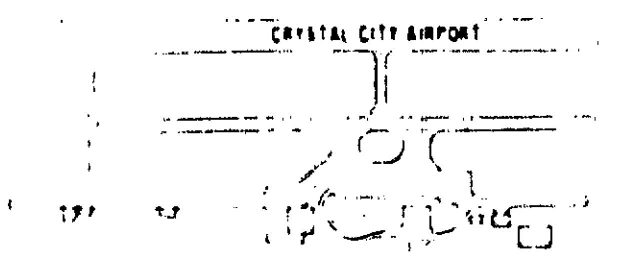
FINAL REPORT

JULY, 1989

1001244

PREPARED FOR

TEXAS WATER COMMISSION



EBASCO SERVICES INCORPORATED

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CRYSTAL CITY AIRPORT SITE

CRYSTAL CITY, TEXAS

FINAL REPORT

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PREPARED IN COOPERATION WITH THE
TEXAS WATER COMMISSION
AND
U S ENVIRONMENTAL PROTECTION AGENCY

THE PREPARATION OF THIS REPORT WAS FINANCED THROUGH GRANTS
FROM THE U S ENVIRONMENTAL PROTECTION AGENCY THROUGH THE
TEXAS WATER COMMISSION

EBASCO SERVICES INCORPORATED

EBASCO SERVICES INCORPORATED

EBASCO

July 14, 1987
ENVTWC-87-059

Ms. Martyn M. Turner
Texas Water Commission
EAS Building
1611 Brazos
Austin, Texas 78711-3087

Dear Ms. Turner:

Subject: CRYSTAL CITY AIRPORT RI/FS
CONTRACT NO. 14-60042
FINAL FEASIBILITY STUDY REPORT

In accordance with Section 2.5.2 of Exhibit A of the subject contract, please find enclosed thirteen copies of the Final Crystal City Airport Feasibility Study Report. Twelve copies are also hereby transmitted to Mr. Jim McGuire of USEPA Region VI. As requested by TWC and EPA Region VI, this report includes an evaluation of an eighth alternative, Consolidation/Capping, which has been incorporated throughout the report.

Please contact me (404/662-2385) or Mr. Sam Mason (404/662-239) with any questions or comments at your earliest convenience.

Very truly yours,

Edward C. Bates
Project Manager

ECB:sw
Enclosure

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TAL CITY AIRPORT FEASIBILITY STUDY
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EXECUTIVE SUMMARY

The Remedial Investigation and Feasibility Study (RI/FS) for the Crystal City Airport (CCA) Superfund Site is presented in two companion documents, the RI report and the FS report. These documents are intended to be used concurrently. The RI report details the site background, a description of environmental contamination, and the current situation, supported by the results of extensive sampling of various media. The FS report (this document) evaluates site conditions for the purpose of determining feasible solutions to the contamination at the site.

Pesticide contamination left by aerial applicators at the CCA site was reported to the State of Texas in 1983. Several sampling studies by the Texas Water Commission (TWC) and the U.S. Environmental Protection Agency (EPA) led to the implementation of two Immediate Removal (IR) actions by EPA in 1983 and 1984. This RI/FS was conducted for the TWC and funded through the EPA Superfund Program to determine the nature and extent of remaining contamination and feasible solutions to the problem.

The site was sampled extensively during the RI, including the collection and analysis of surface soil, below ground soil, surface water, sediments, public drinking water, air, and building surface wipe samples. Contamination at the site was found to be limited to the surface soil. Contaminants found at the site in the highest concentrations during the RI include the following compounds (typical agricultural chemicals):

- Arsenic
- DDT
- Toxaphene
- Dieldrin

Many other chemical compounds were found in samples analyzed (Table E-1) and also determined to be present from information listed on container labels or markings. A more comprehensive presentation of this data is in the RI report.

TABLE F-1

SUMMARY OF REMEDIAL INVESTIGATION SAMPLING

Constituent	Media	Number of Locations Sampled	Number of Locations Identified	Maximum Concentration mg/kg	Maximum Concentration mg/l
Chlorinated Hydrocarbons (Chloroform)	Ground water	12	2		.007
	Surface water	17	4		
	Soil	27	21	0.095	
	Sediment	14	4	0.87	
	Air	4	1	0.026	
Aromatic Hydrocarbons (Benzene)	Ground water	12	0		
	Surface water	17	0		
	Soil	27	12	.022	
	Sediment	14	2	.008	
	Air	4	4	0.053	
Solvents (4-methy-2-pentanone)	Ground water	12	1	.010	.010
	Surface water	17	4		
	Soil	27	6	.030	
	Sediment	14	1	.133	
Organophosphorus (Parathion)	Ground water	12	0		
	Surface water	17	0		
	Soil	203	24	2.63	
	Sediment	14	4		
Herbicides (2,4, 5-T)	Ground water	12	0		
	Surface water	17	9		
	Soil	47	2	0.251	
	Sediment	14	1	.047	
Phthalates (di-n-octylphthalate)	Ground water	12	5		.007
	Surface water	17	4		
	Soil	25	11	0.73	
	Sediment	14	4		
	Air	4	2	0.024	

TABLE E-1 (Cont.)

SUMMARY OF REMEDIAL INVESTIGATION SAMPLING

Constituent	Media	Number of Locations Sampled	Number of Locations Identified	Maximum Concentration mg/kg	Maximum Concentration mg/l
PAH (Benzo(a)pyrene)	Ground water	12	0		
	Surface water	17	0		
	Soil	25	6	1.1	
	Sediment	14	0		
Dieldrin (Class IV)	Ground water	12	0		
	Surface water	17	4		
	Soil	203	8	2.3	
	Sediment				
Toxaphene (Class II)	Ground water		0		
	Surface water	17	1		1.90
	Soil	203	130	1113	
	Sediment	14	1	.400	
DDT (Class I)	Ground water	12	0		
	Surface water	17	0		
	Soil	203	175	2502	
	Sediment	14	2	1125	
Endrin (Class 0)	Ground water	12	0		
	Surface water	17	0		
	Soil	203	11	15	
	Sediment				
Arsenic	Ground water	12	0		
	Surface water	7	2	.097	
	Soil	66	52	2.0-1450	
	Sediment	7	7	2.7-12.0	
Nitrophenols (4-nitrophenol)	Ground water	12	0		
	Surface water	17	4		
	Soil	2[illegible]	1	0.11	
	Sediment	14	4		

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The areas where contamination was found are indicated on Figure E-1. Contour lines are shown for areas where total contamination was found in excess of 10 milligrams per kilogram (mg/kg) or parts per million (ppm). The 100 ppm contour lines indicate areas which are contaminated in excess of the cleanup limit determined by EPA to be appropriate for this site.

Drilling activities at the site included 35 borings 5 feet in depth, one boring 10 feet in depth, two borings 20 feet in depth, 8 borings 50 feet in depth, and one boring 180 feet in depth. No shallow groundwater was observed in any of the borings.

Soils contaminated above the EPA cleanup limit are confined to surface soils within the site boundaries. Surface waters and shallow groundwater are not present at the CCA site. Potential contaminant migration pathways are surface runoff and airborn particulates.

The contaminants have been evaluated to determine their public health impact according to their chemical, physical, and toxicological properties, the pathways of exposure; and the receptors who might be impacted. This evaluation identified that the unremediated site presents an unacceptable public health risk to the potentially exposed receptors. At the level of cleanup (100 ppm total contamination) determined by EPA, the public health risk of exposure is acceptable when site access is limited to 15 days per year.

Given the cleanup limits, a review of potentially applicable remedial technologies was conducted. Based on this review a list of 22 feasible remedial alternatives and combinations of technologies was developed. Preliminary cost data and technical evaluation of these 22 alternatives resulted in selection of 8 alternatives for detailed analysis. The following remedial alternatives were selected for detailed analysis.

Alternative 1 - No Action
Alternative 2 - Capping
Alternative 3 - Landfill On Site

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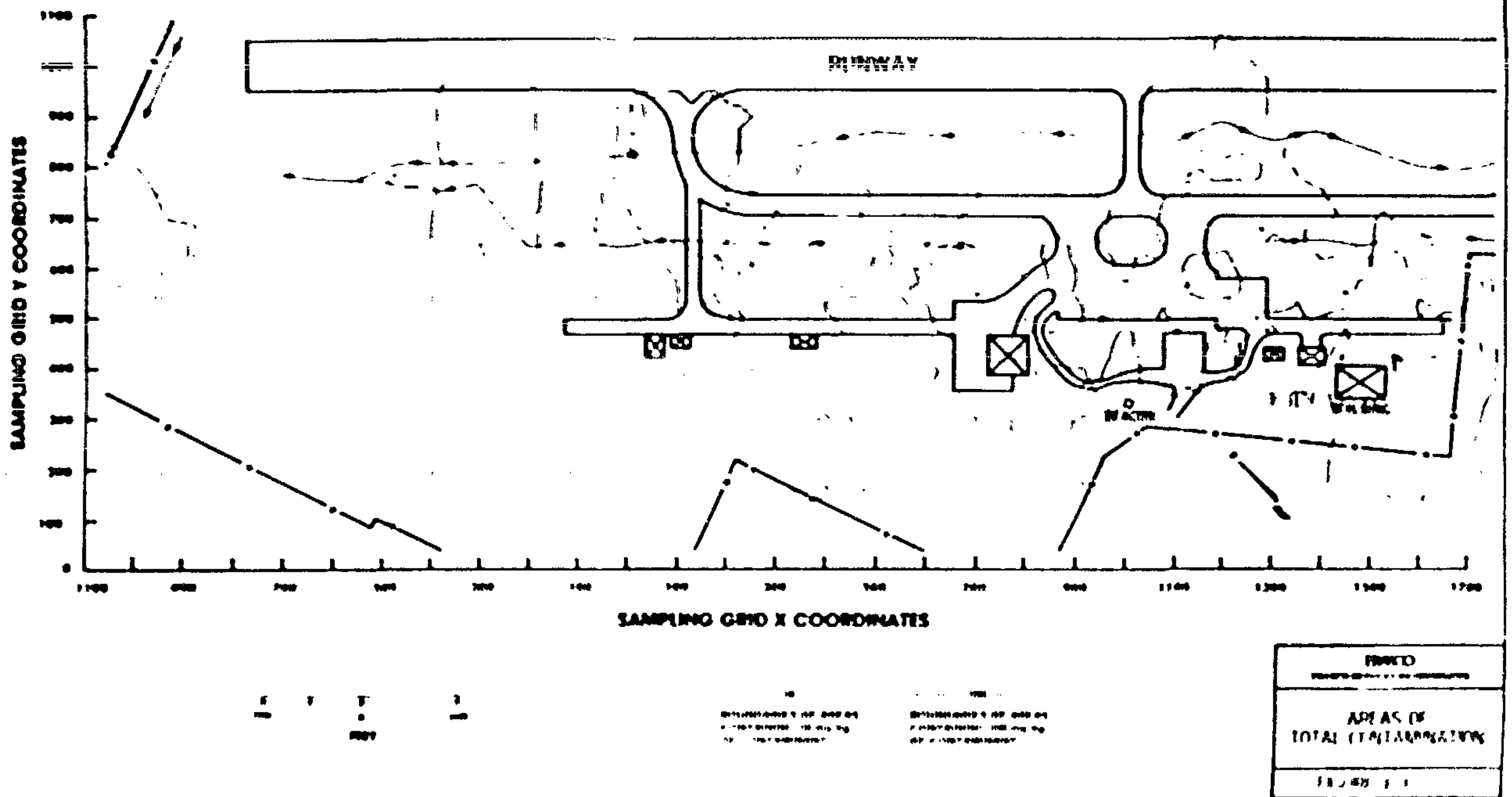
RUNWAY
SAMPLING GRID X COORDINATES
SAMPLING GRID Y COORDINATES
AREAS OF
TOTAL CONTAMINATION

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Alternative 4 - Immobilization and Landfill On Site
Alternative 11 - Incineration
Alternative 17 - Total Offsite
Alternative 21 - Soil Flushing
Alternative 22 - Consolidation/Capping

All of the alternatives include construction of a security fence with posted signs in order to limit site access to 15 days per year or less.

Alternative 1 - No Action means that no cleanup activities will be undertaken. Security fencing will be constructed and warning signs will be posted. Site use will be prohibited except for periodic monitoring activities.

Alternative 2 - Capping is the construction of an asphalt cap on contaminated surface areas. The cap is intended to isolate the contaminants from potential receptors. The soils below the contamination are highly impermeable, therefore downward migration is minimized. The contaminants have a strong affinity to soil particles and become tightly bound in the soil matrix. After capping is completed the contamination is sealed between the asphalt cap above and the impermeable soils below.

Alternative 3 - Landfill on site is a cleanup alternative involving the constructo [illegible] an on site landfill, designed according to the requirements of the Resource Conservation and Recovery Act (RCRA). This landfill will have double liner, leachate collection, and leak detection systems, and a composite cap. The contaminated soils (above cleanup limits) and other contaminated solid wastes be excavated or removed and placed in the landfill without treatment.

Alternative 4 - Immobilization and landfill on site is similar to Alternative 3, except that all wastes will be combined with solidification materials to immobilize the wastes prior to placement in the landfill.

Alternative 11 - Incineration is an alternative making use of Best Demonstrated Available Technology (BDAT). It involves excavation and removal of contaminated soils (above cleanup limits) and other contaminated wastes. These wastes will be treated by incineration using an on site incinerator. Arsenic residue will be separated from treated soil by an aqueous extraction process. The final treated soil would then be land applied to areas where removal originally occurred.

Alternative 17 - Total offsite is a removal and transportation remedy. All contaminated soils (above cleanup limits) and other contaminated wastes will be excavated and transported to a commercial off site disposal facility.

Alternative 21 - Soil flushing is an innovative treatment technology involving a two step soil extraction. Contaminated soils (above cleanup limits) and other wastes will undergo a solvent flush treatment for extraction of chlorinated organic pesticides followed by an aqueous treatment for extraction of arsenic. Concentrated pesticide extracts will be disposed by incineration and secure disposal at off site commercial facilities.

Alternative 22 - Consolidation/capping involves the excavation of contaminated soils (above cleanup limits) and consolidation of these materials in an unlined cell. The on site cell would be closed with a secure cap, designed in accordance with RCRA.

Table E-2 presents the results of the detailed evaluation of alternatives.

TABLE E-2

SUMMARY OF DETAILED EVALUATION

Remedial Alternative	Technical Feasibility Rating	Institutional Requirements Rating	Public Health Requirements Rating	Environmental Impacts Rating	Cost Analysis ($ 1000)
1. No Action	Low	Low to Moderate	Low	Low	$ 503
2. Containment - Capping	Moderate to High	Moderate to High	Moderate to High	Moderate to High	2,020
3. Containment - Landfill	Moderate	Moderate to High	Moderate to High	Moderate	1,982
4. Total Immobilization	Moderate to High	Moderate to High	Moderate to High	Moderate to High	3,741
11. Total Incineration	Moderate	Moderate to High	High	Moderate	11,381
17. Total Off Site	Moderate	Moderate	Moderate to High	Moderate	6,994
21. Soil Flushing	Moderate to High	Moderate to High	Moderate to High	Moderate	16,081
22. Consolidation/Capping	High	Low to Moderate	Moderate to High	Moderate to High	1,603

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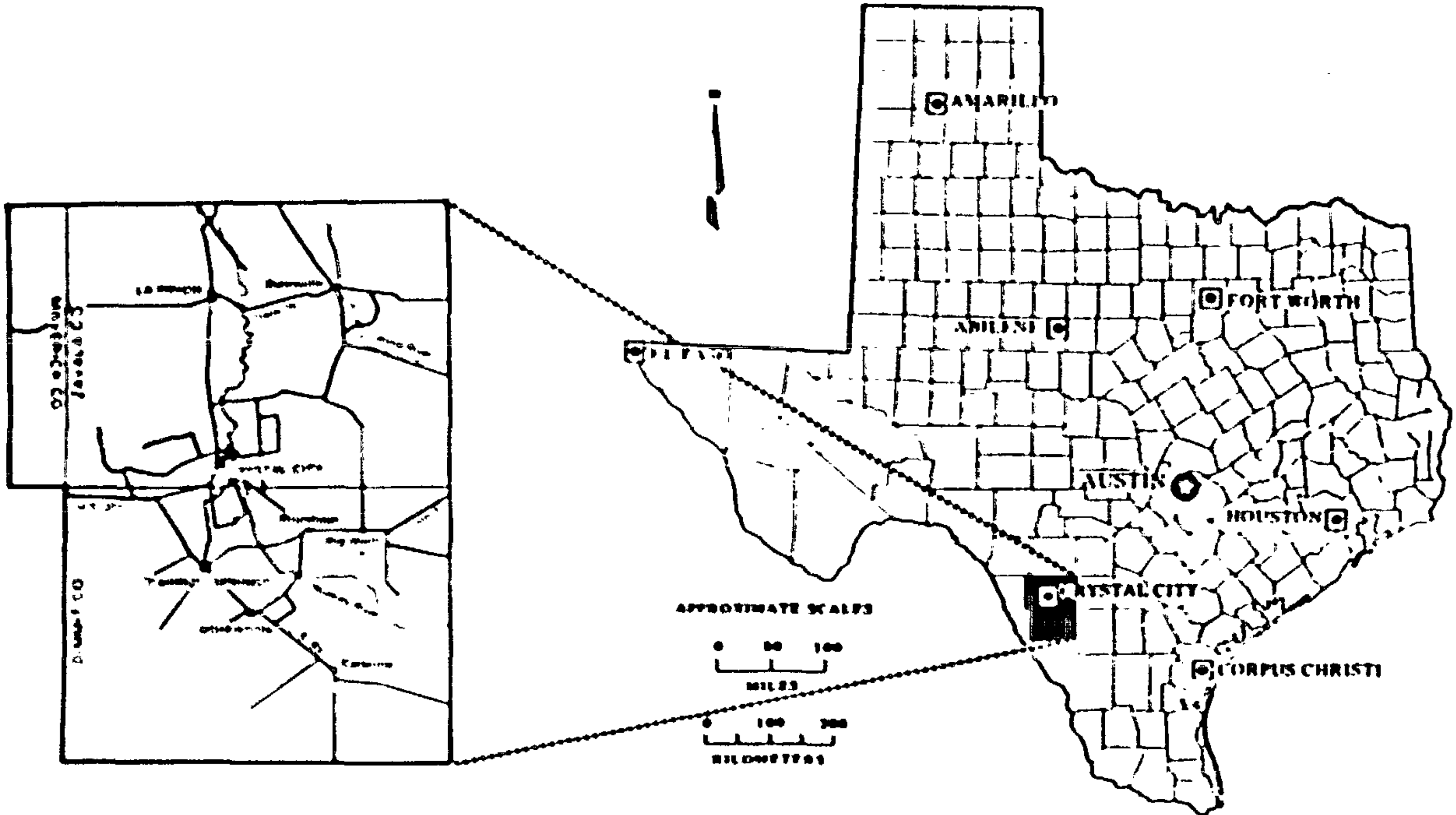
1.0 INTRODUCTION

This report is the Feasibility Study (FS), prepared in conjunction with a Remedial Investigation (RI) conducted at the Crystal City Airport (CCA) Superfund site. The CCA site is located in the City of Crystal City, Zavala County, Texas, in the South-Central part of Texas commonly referred to as the Winter Garden District (see Figure 1-1).

The site is contaminated with hazardous chemicals. The contamination resulted from spills and careless handling of agricultural chemicals (pesticides and herbicides) by aerial applicator (crop dusting) companies who operated out of the airport. The primary contaminants of concern at the site are organochlorine pesticides and arsenic.

A preliminary evaluation of the site was conducted during 1984 by the Texas Department of Water Resources (the predecessor agency to the Texas Water Commission) and the U. S. Environmental Protection Agency (EPA), using the EPA's Hazard Ranking System (HRS). Under this system, a site must receive a HRS Score of at least 28.5 out of a possible score of 100 to qualify for remedial action (cleanup) under the federal Superfund Program. The CCA site received a HRS score of 32.26, and was nominated for inclusion on the National Priorities List (NPL) of Superfund sites on October 5, 1984. The site was formally added to the NPL by the EPA on May 20, 1986.

Before initiating a remedial action at the site, the Texas Water Commission (TWC) and the EPA determined to conduct a Remedial Investigation (RI) and Feasibility Study (FS) of the site. The purpose of a RI is to obtain and present information on the degree and extent of contamination at a site adequate to: (1) evaluate the risk to public health posed by the contaminants at the site and (2) conduct the FS. The purpose of a FS is to evaluate the technical, environmental, economic, and institutional feasibility of various cleanup options that might be employed at a site. These evaluations are then used by the EPA and TWC in reaching decisions regarding the extent and methods of cleanup that will actually be employed.



★ LOCATION OF CRYSTAL CITY AIRPORT SUPERFUND SITE

FIGURE 1-1

MAP OF WINTER GARDEN DISTRICT
AND LOCATION OF CRYSTAL CITY AIRPORT SUPERFUND SITE

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Ebasco Services Incorporated, Houston, Texas, conducted this FS (and the companion RI) for the TWC under Contract Number 14-60042. Funding for the studies was provided by the EPA under a Cooperative Agreement (Number V-006-61-1) between the TWC and the EPA. The RI/FS process is being conducted according to the terms and conditions of the contract and the cooperative agreement, and in conformance with the applicable requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendment and Reauthorization Act (SARA).

The RI report includes background information on the site, descriptions of the activities conducted during the RI, and discussions of the results of the investigations. This FS report uses the information gathered during the RI to evaluate site-specific feasible solutions for the contamination problems identified at the CCA site. An evaluation of the potential public health threat posed by the site is also presented in this report.

The results are intended to facilitate critical decision-making by state and federal agencies regarding the extent and feasibility of cleanup. The FS is an evaluation of alternative remedial solutions to the contamination problem at the CCA site. Possible solutions are evaluated within a range including an alternative in which no further cleanup action is undertaken, to one in which a complete cleanup is accomplished and no further actions are required. This report combines the information obtained in the Remedial Investigation with a technological review of feasible cleanup alternatives to facilitate the selection of a final remedy.

1.1 SITE BACKGROUND INFORMATION

The Crystal City Airport (CCA) is owned by the City of Crystal City. The site covers an area of approximately 120 acres. Airport related facilities include a 3550-foot asphalt runway, a rotating beacon on an elevated tower, a windsock, paved and unpaved taxiways, and several buildings and foundations. These features, as well as the uses of lands adjacent to the site, are shown on Figure 1-2.

Some of the operational areas near site structures have concrete pads and roadways. The building structures are in various states of disrepair, ranging from the completely demolished old terminal building, of which only the concrete building slab remains, to dilapidated metal siding buildings which have suffered wind damage, to the undamaged and functionally complete hanger which was utilized by the most recent aerial applicator occupant (Franks Hangar). The airport is fenced and warning signs, indicating that the area has been contaminated, have been posted.

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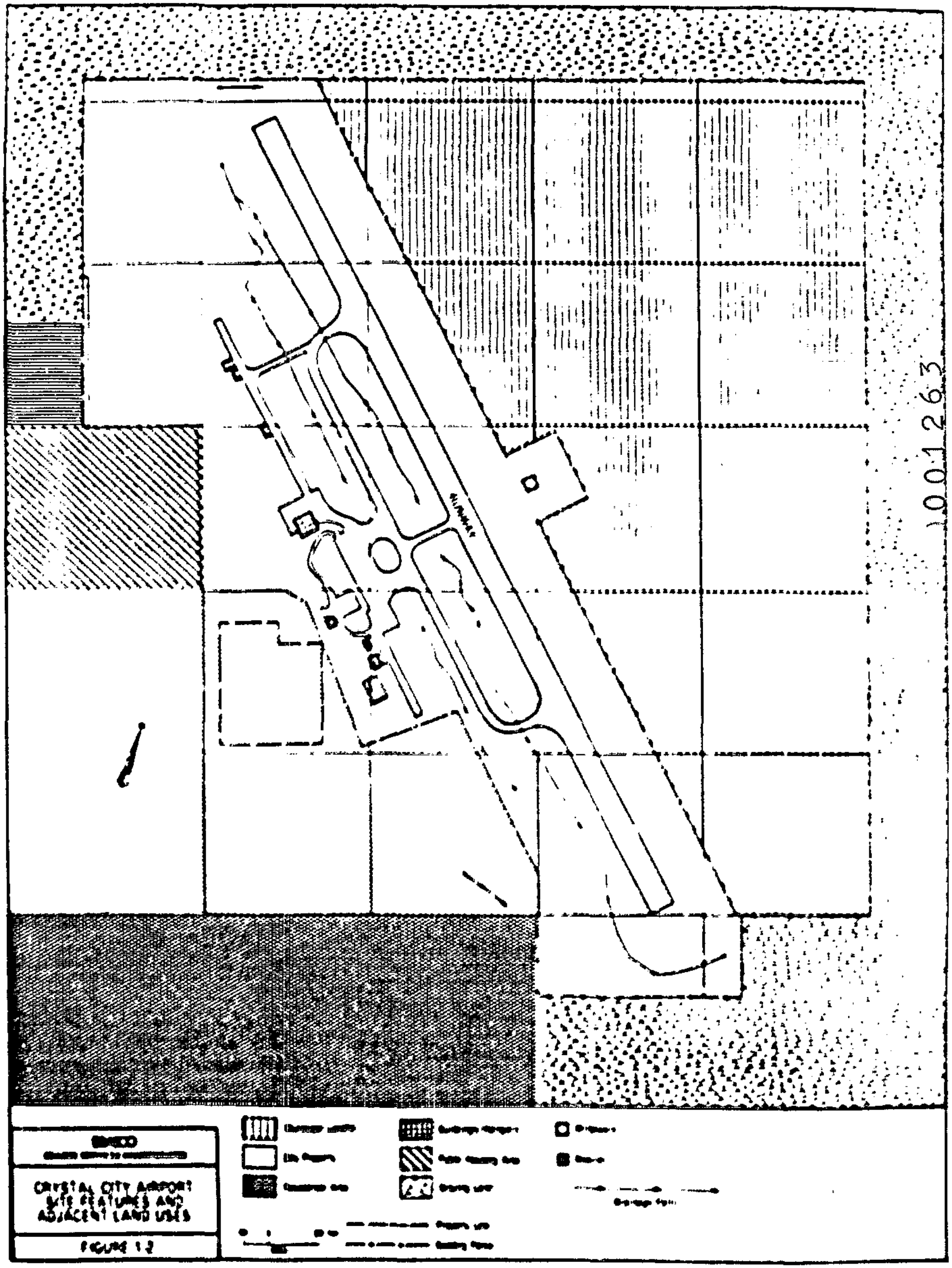
As depicted in Figure 1-2, the land surrounding the airport property has a variety of uses. A municipal landfill, also owned by the City of Crystal City, is located directly adjacent to the airport to the northeast. To the north, the land is used as pasture land. Directly west of the site is a private residential area and a public housing project. Southwest of the site is an elementary school and high school, including athletic fields. South of the site is a second residential area. Southeast of the site is more agricultural grazing land.

During World War II, the airport was owned and operated by the U.S. Government as a military installation. It was used primarily for transporting and housing persons detained during the war. In 1949, the U.S. Government deeded the airport property to the city. The City of Crystal City has operated the facility as a municipal airport since that time.


CRYSTAL CITY AIRPORT
SITE FEATURES AND
ADJACENT LAND USES
FIGURE 1.2

1-3

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Several private companies operated aerial applicating businesses at the municipal airport, including Franks Crop Dusting Service, Crystal City Spraying Service, Southwestern Flyers and Silver Dollar Pest Control. By 1980, all aerial applicators had gone bankrupt except for Franks Crop Dusting Service. In 1982, Franks Crop Dusting Service also went bankrupt and aerial spraying operations were abandoned at the airport.

Currently, the CCA is fenced with a locked gate. Therefore, access to and from the site is limited. There are infrequent users of the airport for aircraft operations including local residents and recreational visitors, mostly during hunting season.

1.2 Nature and Extent of the Problem

On April 21, 1983, the Texas Department of Water Resources (TDWR), the predecessor agency to the TWC, was notified by Crystal City officials that they were concerned that agricultural chemicals, left by defunct aerial operators at the Crystal City Municipal Airport, presented a threat to local residents. Table 1-1 chronicles the events which have occurred at the CCA site after the initial notification of the contamination problem.

On April 25, 1983, TDWR District 8 personnel initiated a preliminary on site investigation of the Crystal City Municipal Airport. Two abandoned aerial applicator operation areas were identified. Drums and tanks of chemicals were observed in various locations throughout the west-central part of the airport. Samples were collected to assess the extent of contamination. The sampling investigation identified severe soil contamination. At least 50 drums of various agricultural pesticides and herbicides were observed, as well as indications of past on site disposal. There was evidence of direct pouring or dumping of chemical wastes on the ground in addition to leakage from decomposed containers. Investigators reported particularly strong odors due to the volatilization of the pesticides during the hot, dry weather conditions prevalent at the site.

Additional sampli programs, which included the collection of samples of ambient air and drinking water, were conducted by the TWC and EPA as indicated previously in Table 1-1. The results of the soil sampling confirmed that very high concentrations of agricultural pesticides were present in areas of the site where visual evidence (stained or discolored areas) of contamination was present. Soil samples taken in areas along the entrance road outside the fence of the airport indicated that contamination also was present, but to a much lesser degree than on site. Soil samples taken from areas distant from the chemical handling areas did not exhibit contamination at detection levels. The samples of drinking water and air also did not contain any detectable contamination.

TABLE 1-1

SUMMARY OF EVENTS

CRYSTAL CITY AIRPORT SUPERFUND SITE

DATE	AGENCY	EVENT
04/21/83	TDWR	Received notification from Crystal City officials that they were concerned about the conditions at the Crystal City Airport
04/25/83	TDWR, District 8	Initial investigation - composite soil samples obtained from contaminated areas on the site
05/05/83	TDWR, District 8	Site visit, determination of approximate area of contamination
06/13/83	TDWR/EPA	Sampling - 4 soil samples taken at points where apparent drainage pattern from areas of contamination intersect airport boundaries, 2 soil samples from dirt road, 1 soil sample from the nearby schoolyard, 1 water well, 1 open drum
06/21/83	TDWR/EPA	Site visit, on-site observations
07/23/83	EPA	Soil sampling - 38 soil samples taken from contaminated areas of the site

TABLE 1-1 (cont.)

SUMMARY OF EVENTS

CRYSTAL CITY AIRPORT SUPERFUND SITE

DATE	AGENCY	EVENT
10/30/83-11/02/83	EPA	Initial Removal action - soil and drums were placed in on site trenches; two contaminated areas capped with clean soil
12/15/83	TDWR, District 8	Sampling - 4 composite soil samples from contaminated areas of the site
02/14/84	TDWR/TACB	Sampling - 17 soil samples, air samples at the site and nearby school
03/29/84	TDWR	Sampling - 1 composite soil sample from area in front of Franks Hangar, plus six soil samples from other on site areas
04/22/84-04/23/84	EPA/City of Crystal City	Removal - repaired erosion gullies, built fence, removed contaminated soil and drums offsite
10/05/84	TDWR/EPA	Site proposed for inclusion on National Priorities List (NPL)
08/19/85	TDWR/EPA	Site visit to determine level of effort for anticipated RI/FS

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TABLE 1-1 (cont.)

SUMMARY OF EVENTS

CRYSTAL CITY AIRPORT SUPERFUND SITE

DATE	AGENCY	EVENT
09/25/85	EPA	Awarded funds to TWC for RI/FS studies
02/25/86	TWC	Issued Request for Proposals to perform the RI/FS at the CCA site
05/20/86	EPA	Formally promulgated site as a NPL Superfund site
06/30/86	TWC	Awarded RI/FS contract to Ebasco Services Incorporated
09/25/86	TWC/EPA Ebasco	Began RI field studies at the site
02/13/87	TWC/EPA Ebasco	Completed RI field studies
04/07/87	Ebasco	Submitted Draft RI Report

On June 13 and July 23, 1983, personnel from the TDWR Central Office, EPA Region VI, and TDWR District 8 made follow-up investigations. During these investigations, soil samples, air samples, and one drum sample were collected. Photographs of the site were taken and an inventory of the drums remaining on site was conducted. The results of these sampling events confirmed the initial findings and indicated the presence of very high concentrations of agricultural chemicals in the vicinity of the abandoned crop dusting operations. Results from the various sampling events conducted by both the TWC and the EPA are summarized in Table 1-2, which lists both the chemicals found in on site soil samples and those listed as ingredients on container labels observed during the various site visits and investigations. Some soils in an unpaved area in front of Franks Hangar contained toxaphene measured in concentrations high enough to be reported in percentages (parts per hundred) of toxaphene rather than parts per million.

After reviewing the results of the investigations, the TDWR requested the EPA to conduct an Immediate Removal (IR) action at CCA. This request was agreed to by the EPA, Region VI Emergency Response Unit. Between October 30 and November 2, 1983, the EPA conducted the IR action to eliminate the immediate threat to public health and the environment posed by the contamination at the site. Cleanup goals for this IR action were established as follows:

1) Disposal of liquids collected from drums and other containers scattered throughout the site
2) Removal of containers causing or threatening to cause additional contamination
3) Removal of soil from areas of gross, visually observable contamination, and
4) Placement of a clay cap over two areas where heavily contaminated soils were removed

TABLE 1-2

CONTAMINANTS PREVIOUSLY DETECTED IN SOIL SAMPLES OR IDENTIFIED FROM DRUM OR CONTAINER LABELS

DDT	Ethyl Parathion (Parathion)
DDD	Methyl Parathion
DDE	Malathion
BHC (Tech)	2,4-D
g-BHC (Lindane)	2,4-DB
Endrin	2,4,5-T
Endrin Aldehyde	Silvex (2,4,5-TP)
Dieldrin	Ethion
Toxaphene	Carbopenthion
Chlordane (Tech)	Disulfoton
Sevin	Daconil
DEF	Dacthal
EPN	Endosulfan I
DCPA	Terbutryn
Atrazine	Weedone
Azodrin 5	Paraquat
Bravo 500	Lannate
Chlordimeform	Methomyl-Lannate
Dimethoate	Hepta[illegible]
Methamidophos	Diazi[illegible]
Stull's Bivert	De-Fend E-267
Carbaryl	4-Nitrophenol
Cycloate	Tetrachlorophenol
Nitrofen	Pentachlorophenol (PCP)
Pyrene	Hexachlorobenzene
Anthracene	Pentachloronitro Benzene (PCNB)
Crysene	Octachlorodibenzo-dioxin
Benz (a) Anthracene	Bis-(2-Ethylhexyl)phthalate
Fluoranthene	Di-n-Butyl Phthalate
Phenanthrene	Arsenic

Source: TWC File Data

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The IR action taken by EPA at the site was intended to remove only the most highly contaminated materials. In the removal action, contaminated soils and decomposing drums containing chemical residues were removed to an on site landfill. Two disposal cells were constructed in the central part of the property, east of the runway and near the windsock. The larger of these cells measured 50 ft. by 10 ft. The smaller cell measured 30 ft. by 6 ft. Both cells were 8 ft. deep. An estimated 50-70 drums (not all of which were full) were placed into the disposal cells. The drum contents and approximately 40 cubic yards of contaminated soil from highly contaminated areas of the site were placed in the cells and mixed with lime. The excavation was then backfilled with approximately three feet of clean clay fill.

On December 15, 1983, February 14 and March 29, 1984, TDWR, EPA, and Texas Air Control Board (TACB) personnel traveled to Crystal City to determine the status of the site. Soil and air sampling was conducted to determine if contamination remained on the site after the EPA's removal activities and in areas adjacent to these locations. The results of this sampling indicated that, while the immediate threat to public health and the environment posed by the site had been eliminated, additional action was warranted because high concentrations of contaminants remained on site which posed a potential threat to public health and the environment.

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The continuing threat to public health and the environment at CCA prompted the TWC to request EPA to conduct a second cleanup to remove materials which remained after the IR conducted in the fall of 1983. EPA concurred and initiated a second removal action which was completed in May, 1984. The second IR resulted in the removal of an additional 21 drums of contaminated materials. These drums were transported off site to a secure hazardous waste landfill (Chemical Waste Management, Inc., in Port Arthur, Texas) for disposal. Eroded areas of the clay caps were repaired during this effort. In addition, a fence with a locked gate was constructed around the airport site and warning signs were posted.

In 198-, because the IR actions were not intended to be a permanent, final remedy, the TWC ranked the site in accordance with the EPA Hazard Ranking System (HRS). The site scored high enough (32.26) to be proposed as a candidate for the NPL. In accordance with the HRS, the ranking reflected conditions at the site prior to the IR actions by the EPA. The site was proposed for listing on the NPL as a Superfund site on October 5, 1985.

Following this, the TWC, in cooperation with the EPA, Region VI, began planning a RI/FS study. The study was to determine if the site posed a long term threat to human health or the environment. In September, 1985, the EPA awarded funds to the TWC to begin the RI/FS study. The site was formally added to the NPL on May 20, 1986. Table 1-3 presents the dates and events which comprise the RI/FS schedule.

The results of the RI are presented in the RI report. The principal findings of the RI are as follows:

- There was no ground water found in any of the soil borings drilled at the site, including eight 50-foot borings and one 180-foot boring. The potential for migration of contaminants into ground water is very low, due to the depth to the ground water and the low permeability of the soil.

- Ground water samples collected from three City of Crystal City water wells (which are completed in the Carrizo Aquifer at depths of approximately 800 to 1000 feet) did not indicate the presence of contaminants.

- Samples of stream water and sediment were collected from seven sampling stations located on nearby streams. Contaminant concentrations measured in these samples ranged from "None Detected" to a maximum of 0.090 mg/l of organochlorine pesticide in water samples and 12 mg/kg of arsenic in sediment. Samples of surface water from the

TABLE 1-3

RI/FS SCHEDULE

Date	Event
02/25/86	TWC publishes Request for Proposals
03/28/86	Contractors submit proposals
06/03/86	TWC submits draft contract to EPA
06/30/86	TWC and Ebasco sign contract
07/30/86	TWC submits Ebasco work plan, QA/QC, H&SP to EPA
08/22/86	EPA & TWC submit work plan comments to Ebasco
09/19/86	EPA & TWC approve Ebasco's work plans
09/25/86	RI field work starts, FS authorized
04/07/87	Ebasco submits Draft RI Report
04/24 - 05/06 1987	TWC & EPA submit comments on Draft RI Report to Ebasco
05/15/87	Ebasco submits Draft FS Report
06/01/87	Ebasco submits Final RI Report
06/12/87	TWC & EPA submit comments on Draft FS Report to Ebasco
07/13/87	Ebasco submits Final FS Report

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receiving stream, Espantosa Slough, did not contain significant quantities of contaminants. There were isolated indications of low levels of contaminants in three samples of storm water runoff collected from on site drainage ditches immediately after a storm event. Contaminant concentrations in these samples ranged from "None Detected" to a maximum of 0.097 mg/l of arsenic. The potential exists for low levels of contamination to migrate off site in storm water runoff during rainfall events.

- Three hundred fourteen surface and subsurface soil samples were collected and analyzed. The soil in many areas of the site was found to be free of significant levels of contaminants. Significant contamination was measured in soils in the vicinity of hangar buildings which had been occupied by aerial spraying operators, and in surface soils topographically downgradient from these areas. The maximum concentrations of significant con- taminants measured in soil samples from highly contaminated areas were 1,110 mg/kg of toxaphene, 2,300 mg/kg of DDT, and 1,450 mg/kg of arsenic. Soil samples collected at various depths below the surface indicated that contaminants did not penetrate in significant concentrations below approximately 1 foot. The volume of significantly contaminated soil (soil containing 100 mg/kg or more of "total contaminant") was estimated to be approximately 12,000 cubic yards.

- Air sampling did not indicate the presence of contaminant vapors or contaminants in airborn particles, either during RI activities or from the site when no activities were being performed.

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- There are four buildings located within the areas where cleanup action may be required. Two of these hangar buildings were sampled by wipe tests which did not indicate significant contamination of the building structures.

- The Immediate Removal actions at the site resulted in the burial of approximately 50 crushed drums and approximately [illegible] cubic yards of highly contaminated soils in two on site locations. The RI also resulted in the burial of 90 drums of site wastes. The buried drums and wastes are to be addressed as part of this Feasibility Study.

- Access to the Crystal City Airport site has been restricted by means of a fence with a locked entrance gate. The City of Crystal City intends to use the airport as a municipal airport in the future. The evaluation of possible cleanup strategies conducted during this Feasibility Study considers this possible post-cleanup land use.

The sampling results of the Remedial Investigation resulted in identification of the contaminants listed in Table 1-4.

TABLE 1-4

LIST OF CONTAMINANTS

IDENTIFIED DURING RI

Organ chlorine Pesticides

Dieldrin
Toxaphene
Chlordane
Heptachlor epoxide
alpha-BHC
beta-BHC
gamma-BHC
DDT
DDD
DDE
Endrin
Endosulfan sulfate
Methoxychlor
Endrin keytone

Semi-Volatile Compounds[a]

bis(2-Ethylhexyl)phthalate
4-Nitrophenol
Hexachlorophenol
Fluoranthene
Pyrene
Butyl benzyl phthalate
Benzo(a)anthracene
Chrysene
Di-n-octyl phthalate
Benzo(b)fluoranthene
Benzo(a)pyrene
Ideno(1,2,3-cd)pyrene
Di-n-butylphthalate

Herbicides

2,4,5-TP
Dicamba

Organophosphorus Pesticides

Bolstar
Chlorpyrifos
Diazinon
Dimethoate
EPN
Fenthion
Parathion
Methyl parathion
Naled

Volatile Organic Compounds

Methylene chloride
Carbon disulfide
Chloroform
2-Butanone
1,1,1-Trichloroethane
Carbon tetrachloride
Vinyl acetate
Benzene
4-Methyl 2-pentanone
Bromodichloromethane
Trichloroethene
Tetrachloroethane
Toluene
Chlorobenzene
Ethylbenzene
Styrene
Total Xylenes
Chloromethane
Dibromochloromethane
Bromoform

Inorganics

Arsenic

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(a) Acid/Base Neutral (A/BN) extractable organic compounds

1.3 OBJECTIVES OF REMEDIAL ACTION

The nature and extent of contamination at the CCA site are relatively well defined. Surface soils have been contaminated with agricultural chemicals, including chlorinated pesticides and arsenic, in the areas where these chemicals were used. At a depth of less than 180 feet, groundwater is not present at the site and therefore need not be cleaned up. There are no pits, ponds, lagoons, or contaminated surface waters at the site. Given these conditions, the objectives of the remedial action to be conducted on this site are associated with the principal contamination problem, which is contaminated surface soil at the site.

Remedial action alternatives are judged to be appropriate for the cleanup of the site, depending on how they control or eliminate the harmful effects of the contamination. Both short term and long term objectives were developed for the pathways of concern. Short term objectives will apply to activities involved in the construction of the remedy. Long term objectives will apply to the use of the site after the cleanup is completed.

There are three ways that the contaminated soil could be harmful:

1. Direct contact, including direct skin absorption and oral ingestion.

2. Dispersion and inhalation of soil particles carried by the wind.

3. Erosion of contaminated soil particles into surface water.

Table 1-5 presents the short and long term objectives for the CCA site which address the three pathways of health and environmental endangerment posed by the contaminated soils at CCA.

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TABLE 1-5
CRYSTAL CITY AIRPORT RI/FS
RESPONSE OBJECTIVES

PATHWAY	OBJECTIVE	CRITERIA	REMEDIATION REQUIREMENTS	BENEFITS	DISADVANTAGES
SOILS - SHORT TERM	MINIMIZE DIRECT EXPOSURE TO WORKERS ONSITE	PERFORM REMEDY IN AREAS OF CONTAMINATION ABOVE SITE SPECIFIC CLEANUP CRITERIA	PERSONAL PROTECTION MONITORING	EFFECTIVE PROTECTION OF WORKERS	DIFFICULT TO CONTROL OFFSITE IMPACTS
SOILS - LONG TERM	REDUCE LEVELS TO PREVENT CHRONIC OR ACUTE EXPOSURE	ATTAIN SITE SPECIFIC CLEANUP CRITERIA	PARTIAL REMOVAL, ISOLATION OR TREATMENT	EFFECTIVE PROTECTION OF PUBLIC HEALTH FROM EXPOSURE RISK	UNCERTAINTY OF COMPLETENESS
AIR - SHORT TERM	PREVENT SIGNIFICANT DETERIORATION, ONSITE AND OFFSITE	MAINTAIN BACKGROUND AIR QUALITY LEVELS, OR OSHA, NIOSH STDS	MINIMIZE TEMPORARY RELEASES DURING SITE ACTIVITIES DUST CONTROL PERSONAL PROTECTION MONITORING	MINIMIZE DEGRADATION	POSSIBLE TEMPORARY IMPACT DURING ACTIVITIES
AIR - LONG TERM	PREVENT SIGNIFICANT DETERIORATION, ONSITE AND OFFSITE	MAINTAIN BACKGROUND AIR QUALITY LEVELS	NO SPECIFIC ACTION REQUIRED, NO CURRENT IMPACT	NO DEGRADATION NO CURRENT IMPACT	NOT APPLICABLE
SURFACE WATERS - SHORT TERM	MINIMIZE SURFACE WATER DEGRADATION	MAINTAIN BACKGROUND SURFACE WATER QUALITY OR AMBIENT WATER QUALITY CRITERIA AT SITE BOUNDARY	RUNOFF CONTROL ONSITE MANAGEMENT OF RAINFALL RUNOFF	MAINTAIN CURRENT STREAM QUALITY AND USES	POSSIBILITY OF RELEASE DURING IMPLEMENTATION
SURFACE WATERS - LONG TERM	PREVENT SURFACE WATER DEGRADATION	MAINTAIN BACKGROUND SURFACE WATER QUALITY OR AMBIENT WATER QUALITY CRITERIA AT DISCHARGE TO SURFACE WATERS	SOURCE CONTROL CAPPING REMOVAL/TREATMENT	MAINTAIN CURRENT STREAM QUALITY AND USES	POSSIBILITY OF CONTAMINANTS REMAINING ONSITE
GROUNDWATER	NO GROUNDWATER ENCOUNTERED	NO GROUNDWATER ENCOUNTERED	NO GROUNDWATER ENCOUNTERED	NO GROUNDWATER ENCOUNTERED	NO GROUNDWATER ENCOUNTERED

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1.4 PUBLIC HEALTH EVALUATION

1.4.1 Methodology

The quantitative health effects evaluation performed for this FS required several steps. The first step was the determination of potential exposure pathways of the human population. The second step was the selection of indicator chemicals to model the exposure pathways. The third step was the formulation of arithmetic pathway models used to estimate the carcinogenic risk of exposure to site soils containing potential carcinogens and toxic non-carcinogenic compounds. A hazard index for non-carcinogens was computed, based on acceptable chronic intake (ACI). The exposure pathways were then re-examined to determine the most likely pathways of human health risk from this site according to the projected use.

The purpose of conducting a Public Health Evaluation for a hazardous waste site is to determine, within a reasonable probability range, whether or not a hazard to humans exists. A determination can also be made of the potential human health effects from the remediated site at the projected cleanup levels.

Risk can be defined as the probability of one individual developing a disease such as cancer from exposure to a chemical. For example, if a person smokes cigarettes, there is a risk of 3.6 E-3 of developing lung cancer (Wilson, 1987). This risk estimate was developed from epidemiological studies that found 36 out of every 10,000 people who smoked cigarettes developed lung cancer.

However, for many of the compounds found at hazardous waste sites, there is no direct evidence of human carcinogensis. Instead, extrapolations are made from animal experiments to project the effects on humans. The Cancer Assessment Group (CAG) of the EPA has derived a model to extrapolate the dose response of these animal experiments to a dose response for a compound in humans. A factor known as the potency slope factor was derived by the

CAG for a number of carcinogenic compounds. The model used to calculate this potency slope factor assumes a linear dose response for carcinogenisis, and subsequent review suggests that this is a worst case assumption. That is, the use of these factors will result in risk estimates that are conservative when compared to the average risk. Use of this assumption will provide for adequate protection of human subjects.

Toxaphene, for example, has a potency slope factor of 1.1/mg/kg.day. Translation of this value means that if a person was dosed with and absorbed toxaphene at 1 mg/kg for each day of a 70 year life time, he would have a probability (risk) of 1 (certainty) that he would develop a cancer. For a 70 kg (154 lb) person this would be an absorbed dose of 70 mg/day or 32,600 mg per year. At a dose of 0.001 mg/kg per day he would have 1 chance out of a 1000 (risk = 1E-3) of developing a cancer over a 70 year exposure. At a dose of 0.000001 mg/kg per day he would have 1 chance out of 1,000,000 (risk = 1E-6) developing a cancer. This risk estimate is related to the duration of exposure and if a person is exposed to 0.001 mg/kg for 1/10th a year for 7 years, the risk of cancer is 1E-5 (1E-3 x 0.1 x 0.1). For regulatory purposes a risk of 1E-6 is considered to be an acceptable risk.

There is not a direct relationship between animal cancer studies and human cancer. To express the degree of uncertainty of such extrapolations, the CAG has formulated a weight of evidence classification for potentially carcinogenic chemicals. The group classifications are presented as follows:

Category	Description	Description of Evidence
A	Human carcinogen	Evidence from epidemiologic studies of human cancer association with exposure
B1	Probable human carcinogen	Limited evidence from epidemiologic studies
B2	Probable human carcinogen	Evidence of carcinogenicity from animal study
C	Possible human carcinogen	Limited evidence of carcinogenicity from animal studies

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D	Not classified	Inadequate evidence
E	No evidence	No evidences for carcinogenicity in at least two animals

In this evaluation the risk of developing a cancer from an exposure model will be presented along with the weight of evidence as to the possibility of a compound bei g a human carcinogen.

1.4.2 EXPOSURE PATHWAYS AND HUMAN RECEPTOR CONSIDERATIONS

1.4.2.1 Human Receptors

The Crystal City Airport Site is relatively flat and is used intermittently by community residents who own and operate their own private planes and occasional visitors, primarily during the hunting season. The site is not used for any agricultural purposes nor are any hunting activities conducted on site. Despite complete site fencing and warning signs, the site appears to occasionally be used by individuals with all terrain vehicles. Due to the close proximity of a public housing development and schools, there exists the possibility of exposure of neighborhood children and other residents to site soil, site runoff, and sediments. The intended use of the property in the future is as a municipal airport.

After the cessation of use by the pesticide operators, the use of the airport has been minimal. According to Region VI EPA projections (USEPA a, 1987) the continued use is expected to be minimal. The referenced letter directs that this evaluation be performed assuming access to the site will be limited and that adults will be the only users of the airport site. A maximum annual exposure of 15 days by grounds maintenance personnel mowing the grass is assumed.

Future exposed populations at potential risk, if access is not controlled, would be airport workers, airplane crew and passengers, occasional recreational users, local residents, and neighborhood children.

1.4.2.2 Exposure Pathways

Soil samples collected in the RI have revealed that chemical contamination is confined to the surface of the soil (two feet or less). Since there has been minimal migration in the past and given the soil characteristics (clays with a very low water permeability) the probability of future downward migration of the contaminants is very low. For a more thorough discussion of the degree of permeability, see the RI report.

There was no groundwater detected in the eight (8) soil borings drilled to a depth of 50 feet or in the one (1) soil boring drilled to a depth of 160 feet. With the great depth to ground water and a low migration rate, contamination of ground water is not expected. Therefore, drinking of contaminated ground water is not a potential exposure pathway.

There were periods of heavy rainfall while site investigations were being performed and appreciable stormwater runoff was observed. Samples were taken of this runoff water. Low levels of arsenic and chlorinated pesticides were found in these samples of runoff water during one storm event. However, there are no ponds, lakes, or streams on the site. Therefore, contaminated surface waters appears not to be a potential exposure pathway.

The initial population receptors are:

- o Occasional (casual) users of the site such as aircraft personnel and passengers, recreational users, and airport maintenance personnel, and
- o Residents of housing area

The casual receptors could be exposed by the following pathways:

- o Inhalation of airborne particulates from contaminated site soil/sediments;
- o Dermal absorption of contaminants through direct contact of soil/sediment particles;

- Ingestion of soil/sediment containing contaminants,
- Ingestion of runoff water; and
- Dermal absorption of contaminants through direct contact with runoff water.

1.4.3 SELECTION OF INDICATOR CHEMICALS

A large number of chemicals were detected at this site. Table 1-6 lists these chemicals with their pertinent toxicological and chemical characteristics. It should be noted that 1E-3 is equivalent to 1×10^{-3} and this notation (E) is used throughout to express powers of ten. The compounds were grouped according to similar chemical and toxicological characteristics to facilitate evaluation. Table 1-7 presents this grouping with representative compounds and indicator chemicals. The indicator compound for each group was selected through consideration of toxicity, number of positive samples and available toxicological information. Using these groupings, the Remedial Investigation sample data was reviewed to determine the number of locations sampled, the number of positive samples, and the maximum concentrations found. Table 1-8 presents a summary of this data.

Indicator chemicals are chosen to represent groupings of contaminants at the site in lieu of calculating individual risk assessments for each chemical compound. Typically, the number of indicator chemicals is ten or less. These compounds are chosen to represent a broad range of toxicological effects and potential pathways, which are typical for the particular group of compounds.

TABLE 1-6

SUMMARY OF PARAMETERS FOR IDENTIFIED COMPOUNDS

CONSTITUENTS	Log Koc (c,d) log(ml/g)	Henry's Law (c,d) Constant (atm-m³/mol)	LD50 (i) Oral mg/kg	LD50 (i) Dermal mg/kg	TLV (e) mg/m³	Potency (d) Slope (mg/kg/day)⁻¹	Acceptable Chronic Intake mg/kg/day
Inorganic							
Arsenic, oral	-	-	-	-	-	15	3.6 E-4 (a)
Arsenic, inhalation	-	-	-		0.2	50	3.6 E-4 (a)
Organochlorine Pesticides							
BHC (Lindane)	3.58	7.85 E-06	76 (j)	500 (j)	0.5 (f)	1.33	3 E-4 (d)
DDD	5.89	7.96 E-06					
DDE	6.64	6.80 E-06					
DDT	5.39	5.13 E-04	400 (j)	2,500 (j)	1.0	0.34	5 E-4 (d)
Chlordane	5.15	9.46 E-05	365 (j)	780 (j)	0.5 (f)	1.61	1 E-3 (g)
Dieldrin	3.23	4.58 E-07	46 (j)	100 (j)	0.25 (f)	30	2.9 E-4 (g)
Endrin	5.6	-	4.3 (j)	990 (j)	0.1 (f)	NC	1 E-3 (g)
Methoxychlor						ND	
Endosulfan		-	11 (j)	106 (j)	0.1	NC	1.0 E-2 (d)
Heptachlor Epoxide	4.09	8.15 E-04			0.5	2.6	5 E-4 (g)
Toxaphene	2.90	4.30 E-01	300 (c)	1000 (c)	0.5	1.1	1 E-3 (h)

(a) Primary drinking water standard 40 CFR 141 (0.5 mg/l x 2.0 l/70 kg)
(c) Clement Associates, 1985
(d) USEPA, 1986
(e) ACGIH, 1986
(f) NRC 1982
(g) Calculated from NRC recommended exposure limits in humans
(h) Chlordane NRC Limit
(i) Estimated from structural similarity of 2,4,5-T
(j) USEPA, 1975
(l) Sax, 1984
(m) Calculated from TLV

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TABLE 1-6 (Continued)

SUMMARY OF PARAMETERS FOR INDICATOR CONSTITUENTS

CONSTITUENTS	Log Koc[d] log(ml/g)	Henry's Law[d] Constant (atm-m³/mol)	LD50[f] Oral mg/kg	LD50[f] Dermal mg/kg	TLV[e] mg/m³	Potency[d] Slope (mg/kg/day)⁻¹	Acceptable[m] Chronic Intake mg/kg/day
Herbicides							
2,4-D	1.3		450	1500	10	NC	3.0 E-2 (1)
2,4,5-T	-		550		10	NC	3.0 E-2 (d)
2,4,5-TP	4.0		850			NC	
Dicamba			1100	1000		NC	
Dalapon			6700			NC	
Phosphate Esters							
Dimethoate			250	900		NC	
EPN			12	75	0.5	NC	1.4 E-3
Fenthion			200	130		NC	
Methyl Parathion	2.64	5.59 E-08	14	67	.2	NC	5.8 E-4
Parathion			4	102	.1	NC	2.9 E-4
Semivolatile							
Benzo(a)Pyrene	6.74	1.55 E-06	-	-	-	11.5	-
Hexachlorobenzene	3.59	6.81 E-04	177	-	-	1.69	-
Fluoranthene	4.58	6.46 E-06	2000	3180	-	PC	-
Pyrene	4.58	5.04 E-06		10,000 mg/kg	-	PC	-
Benzo(a)Anthracene	6.14	1.16 E-06	2	18	-	PC	-

(a) Primary drinking water standard 40 CFR 141 (0.5 mg/l x 2.0 l/70 kg)
(c) Clement Associates, 1985
(d) USEPAa, 1986
(e) ACGIH, 1986
(f) NRC 1982
(g) Calculated from NRC recommended exposure limits in hours
(h) Chlordane NRC Limit
(i) Estimated from structural similarity of 2,4,5-T
(j) USEPA, 1975
(l) Sax, 1984
(m) Calculated from TLV

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TABLE 1-6 (Continued)

SUMMARY OF PARAMETERS FOR INDICATOR CONSTITUENTS

CONSTITUENTS	Log Koc[d] log(ml/g)	Henry's Law[f] Constant (atm-m³/mol)	LD50[i] Oral mg/kg	LD50[i] Dermal mg/kg	TLV[e] mg/m³	Potency[d] Slope (mg/kg/day)⁻¹	Acceptable[m] Chronic Intake mg/kg/day
Benzo-(b)-Fluoranthene	5.74	1.19 E-05	-	2720	-	-	-
Chrysene	5.30	1.05 E-06	-	-	-	-	-
Ideno (1,2,3-cd) pyrene	6.20	6.86 E-08	-	-		PC	-
Di-n-octyl Phthalate			6513	-	-	NC	-
bis (2-ethylhexyl) phthalate	-	-	31000	25000	-	6.84 E-04	2.0 E-02
Butyl Benzyl Phthalate	-	-	14000	-	-	NC	-
4-Nitrophenol	-	-	350	-	-	NC	-
Volatiles							
Benzene	1.92	5.59 E-03	3800	-	30	0.52	8.6E-2
Toluene	2.48	6.37 E-03	5000	14000	375	NC	1.1
Xylene	2.38	7.04 E-03	4300	-	435	NC	1.2
Styrene	-	-	5000	-	215	NC	6.1 E-1
Ethyl Benzene	3.04	6.43 E-03	3500	5000	435	NC	1.2
Chloroform	1.49	2.87 E-03	800	-	50	0.081	1.0 E-2
Methylene Chloride	1.56	4.4 E-02	167	-	350	NC	1.0
1,1,1-Trichloroethane	2.18	1.44 E-02	10300	-	1900	NC	5.4
Carbon Tetrachloride	2.04	2.41 E-02	2800	5070	30	0.13	8.6 E-2
Trichloroethene	1.75	1.17 E-02	1140	-	45	0.20	1.3 E-1
Tetrachloroethene	1.76	3.81 E-06	200	8800	335	0.051	9.6 E-1
Chlorobenzene	2.52	3.72 E-03	2900	20000	350	NC	1.0
Bromodichloromethane	-	-	430	-	1050	NC	3.0
4-methyl-2-pentanone	-	-	2080	-	205	NC	5.8 E-1
Vinyl Acetate	-	-	2920	-	30	NC	8.6 E-2

(a) Primary drinking water standard 40 CFR 141 ([illegible] mg/l x 2.0 l/70 kg)
(c) Clement Associates, 1985
(d) USEPA, 1986, NC = Non-Carcinogen
(e) ACGIH, 1986
(f) NRC 1982
(g) Calculated from NRC recommended [illegible] in humans
(h) [illegible] NRC limits
(i) Estimated from structural similarity of 2,4,5-T
(j) USEPA, 1985
(l) Sax, 1984
(m) Calculated from TLV

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TABLE 1-7

GROUPING OF IDENTIFIED COMPOUNDS

Probable Carcinogens	Indicator Chemical	Members
Class 1	DDT	DDE
		DDD
		DDT
Class 2	Toxaphene	Toxaphene
		BHC
		Chlordane
		Heptachlor
		Heptachlorepoxide
Class 3	Arsenic	Arsenic
Class 4	Dieldrin	Dieldrin
PAH	Benzo(a)pyrene	Benzo(a)pyrene
		Hexachlorobenzene
		Fluoranthene
		Pyrene
		Benzo(a)Anthracene
		Benzo(b)Fluoranthene
		Chrysene
		Ideno (1,2,3-cd) pyrene
Phthalates	Di-n-Octyl phthalate	Di-n-Octyl phthalate
		bis (2-ethylhexyl) phthalate
		Butyl benzyl phthalate
Aromatic Hydrocarbons	Benzene	Benzene
		Toluene
		Xylenes
		Styrene
		Ethylbenzene
Chlorinated Hydrocarbons	Chloroform	Chloroform
		Methylene Chloride
		1,1,1-Trichloro-ethane
		Carbon Tetrachloride
		Trichloroethene
		Tetrachloroethane
		Chlorobenzene
		Bromodichloromethane

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TABLE 1-7 (Continued)

GROUPING OF IDENTIFIED COMPOUNDS

Probable Carcinogens	Indicator Chemical	Members
Nitrophenol	4-Nitrophenol	4-Nitrophenol
Solvents	4-Methyl-2-pentanone	4-Methyl-2-pentanone Vinyl acetate
Organophosphorus	Parathion	Parathion Bolstar Chlorpyrifos Diazman Dimethoate EPN Naled Methyl Parathion Fenthion
Herbicides	2,4,5-T	2,4,5-T 2,4,5-TP
Organochlorine Pesticides (Class C)	Endrin	Endrin Endosulfan Sulfate Methoxy Chlor Endrin Ketone

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TABLE 1-8

SUMMARY OF REMEDIAL INVESTIGATION SAMPLING

Constituent	Media	Number of Locations Sampled	Number of Locations Identified	Maximum Concentration mg/kg	Maximum Concentration mg/l
Chlorinated Hydrocarbons (Chloroform)	Ground water	12	2		.007
	Surface water	17	4		
	Soil	27	21	0.095	
	Sediment	14	4	0.87	
	Air	4	1	0.026	
Aromatic Hydrocarbons (Benzene)	Ground water	12	0		
	Surface water	17	0		
	Soil	27	12	.022	
	Sediment	14	2	.008	
	Air	4	4	0.053	
Solvents (4-Methy-2-pentanone)	Ground water	12	1	.010	.010
	Surface water	17	4		
	Soil	27	6	.030	
	Sediment	14	1	.133	
Organophosphorus (Parathion)	Ground water	12	0		
	Surface water	17	0		
	Soil	203	24	2.63	
	Sediment	14	4		
Herbicides (2,4, 5-T)	Ground water	12	0		
	Surface water	17	9		
	Soil	47	2	0.251	
	Sediment	14	1	.047	
Phthalates (di-n-Octylphthalate)	Ground water	12	5		.007
	Surface water	17	4		
	Soil	25	11	0.73	
	Sediment	14	4		
	Air	4	2	0.024	

TABLE 1-8 (Cont.)

SUMMARY OF REMEDIAL INVESTIGATION SAMPLING

Constituent	Media	Number of Locations Sampled	Number of Locations Identified	Maximum Concentration mg/kg	Maximum Concentration mg/l
PAH	Ground water	12	0		
(Benzo(a)pyrene)	Surface water	17	0		
	Soil	25	6	1.1	
	Sediment	14	0		
Dieldrin	Ground water	12	0		
(Class IV)	Surface water	17	4		
	Soil	203	8	2.3	
	Sediment				
Toxaphene	Ground water		0		
(Class II)	Surface water	17	1		1.90
	Soil	203	130	1113	
	Sediment	14	1	.400	
DDT	Ground water	12	0		
(Class I)	Surface water	17	0		
	Soil	203	175	2502	
	Sediment	14	2	1125	
Endrin	Ground water	12	0		
(Class 0)	Surface water	17	0		
	Soil	203	11	15	
	Sediment				
Arsenic	Ground water	12	0		
	Surface water	7	2	.097	
	Soil	66	52	2.0-1450	
	Sediment	7	7	2.7-12.0	
Nitrophenols	Ground water	12	0		
(4-nitrophenol)	Surface water	17	4		
	Soil	25	1	0.11	
	Sediment	14	4		

The selection of indicator chemicals is based on the number of samples containing contaminants, the relative concentrations, and the relative severity of toxicological effects. An indicator chemical is chosen that is representative of a group of compounds with similar chemical and toxicological characteristics. After a review of Tables 1-6, 1-7 and 1-8, it was determined that the phthalates, aromatic hydrocarbons, chlorinated hydrocarbons, organophosphorus pesticides, solvents, and herbicides were not present in sufficient concentrations at sufficient sample locations to be a public health problem. In addition, the relative lower order of toxicity of these compounds was included in the decision not to consider these compounds. The probability of exposure is small and toxicity of these compounds is low. Therefore, a low degree of hazard exists for these compounds at CCA.

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The selected indicator chemicals chosen to represent the Public Health Hazard at this site were classified into five (5) categories. These categories are listed below, along with an identified indicator chemical for each class:

CLASS	INDICATOR
0	Endrin
1	DDT
2	Toxaphene
3	Arsenic
4	Dieldrin
A/BN	Benzo(a)pyrene

Table 1-7 contains the listings of the compounds covered by each class.

Detailed discussions of the selected indicator compounds follow. The information for these discussions was summarized from Priority Toxic Pollutants: Health Impacts and Allowable Limits (Sittig, 1980) and Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites (Clement Associates, 1985).

1.4.3.1 Class IV - Dieldrin

Dieldrin was chosen to represent the Class IV chemicals because of its strong carcinogenic potential and its relatively high concentration at several locations.

Dieldrin is the epoxide degradation product of aldrin as well as being a commercial pesticide. Both aldrin and dieldrin are carcinogenic in two species of animals (rats and mice), and are very toxic to mammalian species (oral LD_{50} = 50 mg/kg and dermal LD_{50} = 100 mg/kg). Dieldrin is readily absorbed through skin and chronic toxic effects through skin exposure have been reported. Both chemicals are acutely toxic to aquatic life with LC_{50} values ranging from 1 to 46 ug/l. Dieldrin has been associated with large scale bird and mammal kills in areas treated with this pesticide.

Aldrin is converted to dieldrin in the environment through photolysis and biodegradation processes. Dieldrin is quite persistent in the environment and is readily absorbed by organic matter in the soil. It is slowly removed by photolysis and biodegradation processes.

The strong carcinogenic potential and acute toxicity of dieldrin is cause for a human health concern. The CAG has classified Dieldrin as a Category B2 carcinogen. The potential pathways for human exposure at the CCA site are soil ingestion, dermal soil contact, and inhalation of soil particulates.

1.4.3.2 Class III - Arsenic

Arsenic (As) was chosen to represent Class III compounds because of its reported carcinogenicity, its toxicity, and because it was the major toxic metal found in significant concentrations. Arsenic is not a metal in a strictly defined sense and many of the chemical properties of arsenic compounds are closely related to those of phosphorus compounds. Most naturally occurring arsenic exists as As_2O_3 and As_2O_5 salts. Because of the frequent use of organic arsenic compounds and herbicides, they are often found at hazardous waste sites. In addition, arsenic is readily converted between As(III), AsO_3^{3-}, As, and AsO_4^{3-}. Also, the organic arsenicals can be converted to the inorganic forms.

Because this element can exist in a number of states, toxicological descriptions and public health evaluations can be very complicated. Arsenic has been described as a human carcinogen from two different types of exposures: 1) inhalation of arsenic dusts by industrial workers has been identified as a cause of lung cancer; and 2) the appearance of skin cancer was observed among Taiwanese whom consumed water contaminated with arsenic. Arsenic has been found to be teratogenic, fetogenic, and embyrogenic in several animals species and has been implicated in multiple malformations among children born to occupationally exposed women. AsO_3^{3-} is considered to be the most toxic form found in the environment. The CAG has classified arsenic a Category A carcinogen.

Arsenic's transport through the environment is related to its oxidation states and the extent to which it is complexed with organic compounds. Conversion between these oxidation states is accomplished by natural chemical processes and biometabolism. Several forms of bacteria have the capability to convert inorganic arsenic compounds to organic compounds. Since the arsenic salts are relatively soluble in water, inorganic arsenic can be quite mobile. On the other hand, many arsenic compounds will bind strongly to soil constituents. The potential pathways of human exposure are ingestion of soil particles and inhalation of airborn soil particulates.

1.4.3.3 Class II - Toxaphene

Toxaphene was chosen to represent Class II compounds because it was found at more locations and at higher concentrations than the other chemicals of Class II.

Toxaphene is an isomeric mixture of chlorinated camphene. Five to six major isomers are usually found and the distribution of isomers varies with different manufacturers and the degree of weathering. Toxaphene has been shown to be carcinogenic in two species of animals (rats and mice). With a minimum lethal dose of 40 mg/kg, it is more toxic to humans than DDT. In acute exposures it is a central nervous system stimulant. Chronic exposures can result in kidney disease. It is readily absorbed through the skin, but the majority of reported human toxic effects have been from oral exposures. The CAG has classified toxaphene as a Category B2 carcinogen. Toxaphene has a high degree of toxicity to aquatic organisms, resulting in fish kills from spill incidents.

An assessment of the environmental fate and transport of toxaphene is difficult because of the presence of many isomers. Photolysis, oxidation, and hydrolysis do not appear to be important fate processes. It is a persistent chemical, and due to its relatively high vapor pressure (as compared to other chlorinated pesticides) volatilization may be an important transport mechanism. Absorption onto soil particles occurs readily and is an important mechanism for removal from water. It is not biodegraded in aerobic environments, but under anaerobic conditions biodegradation may occur. Absorption by biota is rapid and bioaccumulation occurs in aquatic organisms. For the Crystal City Airport Site, sediment transport by erosion may be of concern.

1.4.3.4 Class I - DDT

DDT was chosen to represent the Class I organochlorine pesticides because of the chemical mother-daughter relationship between DDT, DDE and DDD.

DDT and its degradation products DDE and DDD are cyclic organochlorine hydrocarbons which have been shown to be carcinogenic in one species of animals (mice). In addition, they have been shown to be reproductive toxins in mammals and are responsible for decreased reproductive success in many fish-eating bird species. DDT is only moderately toxic to humans, although deaths and other toxic effects are reported to have occurred as a result of exposure to large quantities of the pesticide. No evidence of cancers or other chronic toxic effects has been found in multiple epidemiology studies of pesticide workers. DDT, DDE, and DDE are relatively moderately absorbed through the skin. The CAG has classified DDT as Category B2 carcinogen. DDT is quite toxic to fresh water invertebrates and fishes.

DDT, DDE, and DDD have been shown to be very persistent in the environment. Photolysis is thought to be the major degradation pathway, although some bacteria and fungi have demonstrated an ability to metabolize these pesticides. The importance and utility of these mechanisms are unknown. The ultimate product of biotransformation is bis (2-chlorophenyl) methanone and the toxicology of this product is unknown. From its chemical and physical characteristics, it is suspected that DDT, DDE, and DDD are readily absorbed by soil particles. Volatilization and sediment movement are thought to be the major environmental transport processes.

The potential human exposure pathways for DDT from this site are soil ingestion, direct dermal contact with soil, and inhalation of soil particles.

1.4.3.5 Class O - Endrin

The organochlorine pesticide endrin was chosen to represent the Class O pesticides because it is the most toxic of these pesticides in this group and was found at more locations than the other compounds in its group. The organo-phosphorous pesticides are also included in Class O because they were found infrequently and at low concentrations. All of the Class O chemicals are non-carcinogenic. Endrin is a chlorinated cyclodiene insecticide that is an isomer of dieldrin. Unlike dieldrin, endrin is not a potential carcinogen, but is highly toxic to mammals and aquatic organisms with one of the lowest oral mouse LD_{50} values (4.5 mg/kg). It has been shown to be a reproductive toxin and is bioaccumulated by aquatic organisms. It apparently is not readily adsorbed through the skin.

Endrin has been shown to be quite persistent in the environment. Photolysis to delta-keto endrin and endrin aldehyde is an important process. From the chemical characteristics and structure of endrin, it is suspected that endrin binds readily to soil particles.

Given the physical characteristics of the Crystal City Airport site, the environmental disappearance of endrin will occur through photoylsis and soil migration from erosion. Exposure to human populations can occur through soil ingestion and inhalation of airborn soil particles.

1.4.3.6 Semi-Volatile Organic Compounds - Benzo(a)pyrene

The semi-volatile organic compounds are also refered to as acid/base neutral extractable (A/BN) organic compounds. Benzo(a)pyrene was chosen to represent the semi-volatile or A/BN compounds because of its high carcinogenic potential. Benzo(a)pyrene and the other compounds in this class are byproducts of the breakdown of motor oils at engine operating temperatures and may be present at locations where used motor oils have been dumped.

Benzo(a)pyrene belongs to a class of compounds known as polycyclic aromatic hydrocarbons. Structurally, it is five benzene rings fused together. Because it is a large molecule, it has a low volatility and is not readily absorbed through the skin. However, animal skin painting studies have shown that skin tumors result from exposure to benzo(a)pyrene. In addition, animals exposed to particulate matter containing benzo(a)pyrene (such as smoke particles) have developed lung cancers. Benzo(a)pyrene is considered to be a potential human carcinogen. The chronic toxicity of benzo(a)pyrene has not been established. The two most important exposure routes for humans are exposure through tobacco smoke and uncontrolled emissions from combustion processes. The CAG has classified benzo(a)pyrene as a Category B2 carcinogen.

The transport and fate of benzo(a)pyrene and the other polycyclic aromatic hydrocarbons (PAH) has not been established. Photolysis and biodegradation are thought to be important steps in both formation and degradation. The ultimate fate is unknown. It is suspected that the PAH compounds are very persistently bound to soils. The most likely exposure routes to humans from this site are soil ingestion and inhalation of airborn particulates.

1.4.3.7 Other Compounds

Herbicides, other than those containing arsenic, were not included in these groups because of the extremely infrequent detection of herbicides at the site, and because of their relatively low toxicity. For the same reasons, the organo-phosphorus pesticides were not included in this evaluation. The volatile organic compounds (VOC) were not included in these groups because they were only detected in very low concentrations (less than 0.1 mg/kg) in all cases.

1.4.4 ACCEPTABLE DOSE RATES

Acceptable dose rates (mg/kg/day) were calculated for the chemicals having a potential carcinogenic effect by dividing the risk of 10^{-6} by the potency slope (Number of excess cancers/(mg/kg day)$^{-1}$. An alternative method of presenting powers of 10 (i.e., 10^{-6}) is to present them as E-6. The term 10^{-6} and E-6 mean the same thing in this report. The Acceptable Chronic Intake (ACI) (mg/kg/day) for the non-carcinogens and/or the chronic non-carcinogen toxic effects of the carcinogenic were obtained from a variety of sources. <u>Chemical, Physical, and Biological Properties</u>

of Compounds Present at Hazardous Waste Sites (Clement Associates, 1985), Superfund Public Health Evaluation Manual (USEPA a, 1986), and Health Effects of the Priority Pollutants (Sittig, 1980) were the prime sources for toxicological data. In the absence of other reliable data, the Threshold Limit Value (TLV) for an inhalation exposure was used to calculate an ACI. This is based on the presumption that these values are a safe chronic intake for a worker over years of exposure. The ACI using this approach was then calculated by:

$$ACI = \frac{TLV\ (20\ m^3/day)}{(70\ kg)*100}$$

This assuming an average of 70 kg body weight and breathing 20 m^3 of air per day.

Different inhalation exposure values were used for chlordane, heptachlor, and dieldrin. The National Resource Council (NRC, 1982) recommended a household exposure limit for chlordane, heptachor and dieldrin to be less than 5 mg/m^3, 2 ug/m^3 and 1 ug/m^3 respectively. These limits were used in place of the TLV's to calculate ACT values for these compounds. Table 1-5 displays these calculated values of ACI for all non-carcinogenic effects.

1.4.5 PATHWAY MODELING

Simple algebric equations were chosen to model the exposure pathways for the site. The guidance used to develop these equations was found in the Superfund Public Health Evaluation Manual (USEPA a, 1986), the Superfund Exposure Assessment Manual (USEPA c, 1986), and the Endangerment Assessment Handbook (USEPA a, 1985). The concept behind the models is as follows:

$$Risk = \frac{Potency\ (Quantity\ of\ Soil)(Conc.\ of\ Soil)(Absorption)(Time\ Exposed)}{Body\ Weight\ (Conversion\ Factors)}$$

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To evaluate the hazard associated with the non-carcinogenic effects of these chemicals a Hazard Index (HI) was computed as follows:

$$HI = \frac{\text{(Quantity of Soil)(Conc. of Soil)(Absorption)(Time Exposed)}}{\text{ACI (Body Weight) (Conversion Factors)}}$$

For the purposes of this Public Health Evaluation a HI of less than 1.0 indicates that there is a minimal chance of toxic effects from exposure to site soil. A HI from 1.0 to 5.0 indicates that there is a probable result of toxic effects from exposure to site soil. A HI value of 5.0 or greater indicates a highly probably result of toxic effects and a cause of Public Health concern.

The consideration of pathways and potential receptors was directed by the Region VI EPA, who determined that future use of the airport will be minimal (USEPA a, 1987). In addition, access to the airport will be restricted by the use of fencing, which is included in all remedial alternatives. These considerations effectively limit on site exposure to adults. The EPA also directed this evaluation to consider only the inhalation exposure pathway when considering the local residents as receptors.

Most of the parameters in the models are the best estimated values for a 70 kg human. The only exception would be that, for residential inhalation pathway, the receptors would have body weight of 30, 70, and 90 kg to cover the different receptors of child, woman, and man. The parameters for quantity of soil ingested or absorbed, the fraction of contaminant absorbed from the soil, slope potency factor, and ACI were established by a review of the literature and other risk assessments. Because all these parameters are assumptions relating to the standard 70 kg human, a range of parameter estimates was developed and the median value was used as the parameter in the model. Specific guidance was given by Region VI EPA for some of the parameter estimates (USEPA b, 1987). This guidance will be discussed for each parameter.

The assumptions common to all pathways is presented first, and then specific estimates for other parameters for each pathway by compound is presented. Table 1-9 presents the parameters used in the pathway models and their definitions.

1.4.6 COMMON ASSUMPTIONS

All the pathway models have parameters whose estimated values are independent of pathway and compound. These parameters are the fraction of year exposed to the site (SF) and the fraction of life time exposure (LF). In the EPA letter (USEPA a, 1987) casual exposure is defined as 10 to 15 days per year on site. In addition, at EPA's direction exposure durations of 220 days and 365 days also were considered. The duration of 220 days represents a full time worker at the airport and 365 days represents continuous exposure on site. These exposure durations result in SF values of 0.041, 0.603 and 1.000. A normal lifetime is assumed to be 70 years (USEPA a, 1986) and for casual exposure it was assumed that a person would only be exposed to the site for 20 years of their adult life. This resulted in a LF estimate of 0.286.

The estimates for SF and LF in the residential inhalation exposure pathway were derived by assuming that a resident would be present in the housing area half, three-quarters, or all of an exposure year. This results in a range of SF estimates of 0.50, 0.75, and 1.00. In addition, the body weight range for the residents would be 30 to 90 kg (66 lb. to 198 lb.) and they would be exposed for half of their 70 year life span (LF = 0.5). The exception would be for the 30 kg body weight person (child) who would be at the residence for 15 years (LF = 0.214).

1.4.7 INHALATION PATHWAY

The critical assumption for inhalation of on site soil/sediment, Tables 1-10 and 1-11, is the concentration of airborne particulates. Measurement of total suspended particulates (TSP) during Phase I of site investigation

TABLE 1-9

DEFINITION OF TERMS AND ASSUMPTIONS

AC = Air concentration of particulate matter.

BW = Body weight (adult = 70 kg).

DA = Dust adherence factor.

FA = Absorption factor for transfer of compound from air to blood.

FD = Absorption factor for transfer of compound from skin to blood.

FI = Absorption factor for transfer of compound from gut to blood.

FS = Fraction of skin surface covered with soil.

LF = Fraction of 70 year life exposed to compound.

POT = Cancer potency slope factor - no. of excess cancers.

RISK = The probability of excess cancers due to exposure to a chemical.

SC = Soil concentration.

SI = Soil ingestion rate.

SF = Fraction of a year a person is exposed to a chemical.

VB = Volume of air breathed in a day (20 m^3/day)

1) AC - Casual exposure range - 0.05 mg/m^3
 - Residential exposure range - (0.018 gm/m^3)

2) DA - Day Soils (USEPA c, 1986)

3) FA - Arsenic - literature values ranged from 0.2 to 0.3 (Median = 0.25)
 - Organic - literature values ranged from 0.35 to 0.65 (Median = 0.50)

4) FD - Arsenic - minimal absorption = .001
 - Organic - value varies according to the ratio of oral LD_{50} to dermal LD_{50}

5) FI - Arsenic - literature values ranged from 0.2 to 5.0 (Median = 0.24)
 - Organic - literature values ranged from 0.25 to 0.75 (Median = 0.50)

6) FS - 5% of skin surface

7) LF - Casual exposure - 20 years exposure out of 70 years
 - Residential - 50 years exposure out of 70 years

8) SI - Directed value of 0.1 gm per day (USEPA a, 1987)

9) SF - Values ranged from 0.041 to 1.00

TABLE 1-10

ESTIMATION OF THE RISK OF EXCESS CANCER
FROM OCCASIONAL EXPOSURE TO AIRPORT SOIL
CONTAINING OBSERVED MAXIMUM CONTAMINATION

INHALATION PATHWAY

$$\text{EQUATION: RISK} = \frac{SC(SF)(LF)(VB)(AC)(FA)POT}{1{,}000{,}000\ (BW)} = \frac{SC(SF)(0.286)(20)(0.050)(FA)POT}{1{,}000{,}000\ (70)}$$

COMPOUND	EXPOSURE DAYS	POTENCY $(mg/kg.day)^{-1}$	SC mg/kg	FA	SF	LF	RISK
DDT	15	0.34	2052	0.50	0.041	0.286	5.8E-8
(Class I)	220	0.34	2052	0.50	0.603	0.286	8.6E-7
(Cat. B2)	365	0.34	2052	0.50	1.000	0.286	1.4E-6
Toxaphene	15	1.1	1113	0.50	0.041	0.286	1.0E-7
(Class II)	220	1.1	1113	0.50	0.603	0.286	1.5E-6
(Cat. B2)	365	1.1	1113	0.50	1.000	0.286	2.5E-6
Arsenic	15	50	1450	0.25	0.041	0.286	3.0E-6
(Class III)	220	50	1450	0.25	0.603	0.286	4.5E-5
(Cat. A)	365	50	1450	0.25	1.000	0.286	7.4E-5
Dieldrin	15	50	2.3	0.50	0.041	0.286	9.6E-9
(Class IV)	220	50	2.3	0.50	0.603	0.286	1.4E-7
(Cat. B2)	365	50	2.3	0.50	1.000	0.286	2.3E-7
Benzo(a)pyrene	15	11.5	1.1	0.50	0.041	0.286	1.1E-9
	220	11.5	1.1	0.50	0.603	0.286	1.6E-8
(Cat. B2)	365	11.5	1.1	0.50	1.000	0.286	2.6E-8
TOTAL	15						3.2E-6
	220						4.8E-5
	365						7.8E-5

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TABLE 1-11

ESTIMATION OF THE RISK OF EXCESS CANCER
FROM EXPOSURE TO AIRPORT SOIL
CONTAINING OBSERVED MAXIMUM CONTAMINATION

RESIDENTIAL INHALATION PATHWAY

EQUATION: $RISK = \frac{SC(SF)(LF)(VB)(AC)(FA)POT}{1,000,000\ (BW)} = \frac{SC(SF)(20)(0.018)(FA)POT}{1,000,000\ (BW)}$

COMPOUND	EXPOSURE DAYS	POTENCY $(mg/kg.day)^{-1}$	SC mg/kg	FA	SF	LF	BW	RISK
DDT	183	0.34	2052	0.50	0.50	0.500	90	3.5E-7
(Class I)	274	0.34	2052	0.50	0.75	0.500	70	6.7E-7
(Cat. B2)	365	0.34	2052	0.50	1.00	0.214	30	9.0E-7
Toxaphene	183	1.1	1113	0.50	0.50	0.500	90	6.1E-7
(Class II)	274	1.1	1113	0.50	0.75	0.500	70	1.1E-6
(Cat. B2)	365	1.1	1113	0.50	1.00	0.214	30	1.6E-6
Arsenic	183	50	1450	0.25	0.50	0.500	90	1.8E-5
(Class III)	274	50	1450	0.25	0.75	0.286	70	2.0E-5
(Cat. A)	365	50	1450	0.25	1.00	0.214	30	4.6E-5
TOTAL	183							1.9E-5
	274							2.1E-5
	365							4.8E-5

found a particulate range of 0.300 to 1.100 mg/m^3 with an average of 0.720 mg/m^3. Sampling locations and methods are described in the RI report. The current primary Ambient Air Quality Standards as found in 40 CFR 50 are 0.075 ug/m^3 for the annual geometric mean and 0.260 mg/m^3 for the 24 hour maximum value. In a discussion and review of TSP data taken from the continental United States (USEPA, 1981), it was stated that 50 percent of the monitoring sites in the continental United States had TSP values of less than 0.060 mg/m^3. The EPA Region VI area was noted as having median value of 0.065 mg/m^3 and the median of the 90th percentile was 0.110 mg/m^3. El Paso and Dallas were noted as having a maximum 24 hour value range of 0.205-0.691 mg/m^3. In addition to the above considerations of TSP concentrations, not all air particulates are of respirable size and not all air particulates are derived from on site contaminated soil. An estimate of site surface area contaminated with indicator compounds is 33 percent. In addition, it was assumed that 50 percent of the TSP was non-respirable (i.e., median diameter greater than 10 um). This results in a conversion factor of 0.167 (0.5 x 0.33) to convert TSP concentrations to respirable, contaminant containing concentrations.

For on site casual exposures it was decided to use 0.300 mg/m^3 as the median TSP concentration. Multiplying by the conversion factor of 0.167, this results in effective respirable, contaminant containing TSP concentration of 0.05 mg/m^3. For the residents of the housing area, the EPA Region VI median 90 percent estimate (0.110 mg/m^3) was used as the median TSP concentration. Using the 0.167 conversion factor, the effective respirable, contaminant containing TSP estimate is 0.018 mg/m^3.

A secondary assumption for the inhalation pathway is the fraction of contaminant (FA) that is absorbed into the blood stream from the air particles in the lungs. To arrive at estimates of FA, a review was conducted of available literature (EBASCOa, 1986; EBASCOb, 1986; NRC, 1982, USEPA a, b, c, 1986; Clemente, 1985). The following ranges were derived:

Compound	Range	Median
Arsenic	0.2 - 0.3	0.25
Benzo(a)pyrene	0.35 - 0.65	0.50
DDT	0.35 - 0.65	0.50
Toxaphene	0.35 - 0.65	0.50
Dieldrin	0.35 - 0.65	0.50

Table 1-9 and Table 1-10 present the risk calculations for the casual inhalation exposure pathway and the residential exposure pathway.

1.4.8 DIRECT CONTACT PATHWAY

The first critical assumption for direct contact with soil and sediment, Table 1-12, is the parameter FD, fraction of soil concentration absorbed through the skin into the blood. Estimating dermal absorption even under controlled conditions is difficult due to variations in skin surfaces, conditions of the skin and temperature, and individual skin characteristics. For example, the palms of the hand may absorb 5 percent of a chemical while the scrotum will absorb 100 percent of the same chemical. With the exception of the arsenic compounds, all the indicator compounds identified at this site are absorbed readily through the skin. Benzo(a)pryrene presents a special case in that polyaromatic hydrocarbons have been shown to cause skin cancers in animals. FD was estimated for this modeling effort by deriving a relative absorption coefficient. To estimate this relative coefficient, the oral LD50's were compared to the Dermal LD50's and the percentage of oral absorption was calculated. FD is then expressed as a percentage of oral absorption. The following values were derived. From reviewing previous superfund risk assessments of organic compounds, a range of 0.1 to 1.0 for FD has been observed.

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Compound	FD
DDT	0.08
Toxaphene	0.10
Dieldrin	0.17
Benzo(a)pyrene	0.13

The second critical assumption for the direct contact pathway is the quantity of soil adhering to the skin. This is a function of the percent of skin surface area exposed and the adherence of the soil to the skin. The Superfund Public Health Evaluation Manual (USEPA a, 1986) suggests a range of dust adherence factors of 2.77 mg/cm^2 for clay soil DA represents the milligrams of dust/soil adhering to skin surface area. The percent of skin surface area exposed to the soil was assumed to be 5 percent (face, neck, and arms).

Table 1-12 presents the risk calculations for the casual direct contact pathway.

1.4.9 INGESTION PATHWAY

There are two critical assumptions for the ingestion pathway as presented in Table 10. One is the amount of soil ingested per day (SI), and the other is the fraction of chemical absorbed by the gut (FI). A review of the literature and other Superfund risk assessments was performed. One estimate of SI was found to be 0.1 (Kimbrough, 1984) and Region VI EPA requested that this value be used for the FI parameter (USEPA a, 1987). Estimates of FI for arsenic ranged from 0.2 to 0.50 and estimates of FI for organochlorine compounds ranged from 0.3 to 0.75 with similar values for Benzo a)pyrene. A value of 0.24 was selected for arsenic and 0.50 for the organic compounds. Table 1-13 presents the equation, parameters, and calculations for the ingestion pathway.

1.4.10 RESULTS

General - After reviewing the results of the pathway modeling and the site investigation data, it was determined that arsenic, benzo(a)pyrene, DDT, Toxaphene and Dieldrin may have a potential public health impact.

An HI was computed for Endrin which was present in the highest concentration of the non-carcinogenic compounds. The HI was 0.001, which represents a very low order of hazard. Therefore, the remainder of this Public Health Evaluation will focus on the compounds discussed in the previous paragraph.

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TABLE 1-12

ESTIMATION OF THE RISK OF EXCESS CANCER
FROM OCCASIONAL EXPOSURE TO AIRPORT SOIL
CONTAINING OBSERVED MAXIMUM CONTAMINATION

DERMAL CONTACT PATHWAY

EQUATION: $RISK = \frac{SC(SF)(LF)(TS)(FS)(DA)(FD)POT}{1{,}000{,}000\ (BW)} = \frac{SC(SF)(0.286)(18150)(0.05)(2.77)(FD)POT}{1{,}000{,}000\ (70)}$

COMPOUND	EXPOSURE DAYS	POTENCY (mg/kg-day)$^{-1}$	SC mg/kg	FD	SF	LF	RISK
DDT	15	0.34	2052	0.08	0.041	0.286	2.5E-5
(Class I)	220	0.34	2052	0.08	0.603	0.286	3.5E-4
(Cat. B2)	365	0.34	2052	0.08	1.000	0.286	5.7E-4
Toxaphene	15	1.1	1113	0.10	0.041	0.286	5.2E-5
(Class II)	220	1.1	1113	0.10	0.603	0.286	7.6E-4
(Cat. B2)	365	1.1	1113	0.10	1.000	0.286	1.3E-3
Arsenic	15	50	1450	0.001	0.041	0.286	9.2E-6
(Class III)	220	50	1450	0.001	0.603	0.286	1.4E-4
(Cat. A)	365	50	1450	0.001	1.000	0.286	2.2E-4
Dieldrin	15	50	2.3	0.17	0.041	0.286	8.2E-6
(Class IV)	220	50	2.3	0.17	0.603	0.286	1.2E-4
(Cat. B2)	365	50	2.3	0.17	1.000	0.286	2.0E-4
Benzo(a)pyrene	15	11.5	1.1	0.13	0.041	0.286	6.9E-7
	220	11.5	1.1	0.13	0.603	0.286	1.0E-5
(Cat. B2)	365	11.5	1.1	0.13	1.000	0.286	1.7E-5
TOTAL	15						9.5E-5
	220						1.4E-3
	365						2.3E-3

TABLE 1-13

ESTIMATION OF THE RISK OF EXCESS CANCER
FROM OCCASIONAL EXPOSURE TO AIRPORT SOIL
CONTAINING OBSERVED MAXIMUM CONTAMINATION

INGESTION PATHWAY

$$\text{EQUATION: RISK} = \frac{SC(SF)(LF)(SI)(FI)POT}{1{,}000{,}000\ (BW)} = \frac{SC(SF)(0.286)(0.1)(FI)POT}{1{,}000{,}000\ (70)}$$

COMPOUND	EXPOSURE DAYS	POTENCY $(mg/kg.day)^{-1}$	SC mg/kg	FI	SF	LF	RISK
DDT	15	0.34	2052	0.50	0.041	0.286	5.8E-6
(Class I)	220	0.34	2052	0.50	0.603	0.286	8.6E-5
(Cat. B2)	365	0.34	2052	0.50	1.000	0.286	1.4E-4
Toxaphene	15	1.1	1113	0.50	0.041	0.286	1.0E-5
(Class II)	220	1.1	1113	0.50	0.603	0.286	1.5E-4
(Cat. B2)	365	1.1	1113	0.50	1.000	0.286	2.5E-4
Arsenic	15	15	1450	0.24	0.041	0.286	8.7E-5
(Class III)	220	15	1450	0.24	0.603	0.286	1.3E-3
(Cat. A)	365	15	1450	0.24	1.000	0.286	2.1E-3
Dieldrin	15	50	2.3	0.50	0.041	0.286	9.6E-7
(Class IV)	220	50	2.3	0.50	0.603	0.286	1.4E-5
(Cat. B2)	365	50	2.3	0.50	1.000	0.286	2.4E-5
Benzo(a)pyrene	15	11.5	1.1	0.50	0.041	0.286	1.1E-7
	220	11.5	1.1	0.50	0.603	0.286	1.6E-6
(Cat. B2)	365	11.5	1.1	0.50	1.000	0.286	2.6E-6
TOTAL	15						1.0E-4
	220						1.6E-3
	365						2.5E-3

1.4.10.1 Inhalation of Airborne Particles - The modeling performed for this pathway assumed that 50 percent of the particulates in the air were derived from contaminated soil and that 33 percent of the particulates were contaminated with the highest concentrations of chemicals. Benzo(a)pyrene was found in three of 26 sample locations and only one spot had an elevated concentration. Dieldrin was found in 12 of 201 sample locations with only three locations having elevated concentrations. Therefore benzo(a)pyrene and dieldrin would not be present in air borne particulates in high concentrations. In addition, the calculated risk estimates were less than 10^{-6} because of their soil concentrations. Because of these two conditions (low risk estimates and found infrequently), benzo(a)pyrene and dieldrin are not likely to be public health hazards through inhalation exposure. Since arsenic, DDT and toxaphene are present in high concentrations in numerous locations throughout the airport, it is assumed that the particulates in air from the airport and at the nearby residential area will contain significant concentrations of these compounds. If a person is exposed to on site soil for 15 days or less, the inhalation exposure pathway is not a significant hazard to human health with risks of 3.2 E-6 or less. However, for longer exposure periods, 220 days or more, the inhalation exposure pathway is potentially hazardous to human health for both on site exposure and residential exposure. The combined risk estimates are 4.8 E-5 for on site exposure and greater than 1.9 E-5 for residential exposure.

1.4.10.1 Direct Contact to Soil and Sediment - As noted in the above discussion for airborne particulates, benzo(a)pryrene is not present as an overall site contaminant and does not pose a public health hazard through the direct contact pathway both from the low frequency of appearance and low risk estimates. Table 1-12 displays the maximum soil concentrations of the chemicals at the site, and the estimated risks, for the direct contact pathway. It is apparent that persons exposed to the soil containing Arsenic, DDT, and Toxaphene at the airport are under excessive risk (greater than 1 E-5) for 15 days exposure. This represents a public health concern. The contaminants of concern are DDT and toxaphene. However, for longer exposure periods (greater than 220 days), arsenic, DDT, Toxaphene and dieldrin all represent a public health concern with risk estimates greater than E-4.

Ingestion of Soil and Sediment - Table 1-13 presents the risk modeling for the ingestion pathway. As before, benzo(a)pyrene is not a significant contributor to overall risk. All risk estimates for benzo(a)pyrene are below 1 E-6. Toxaphene (with a risk of 1.0 E-5) potentially represents a public health hazard through the ingestion pathway for the 15 days exposure. For the longer exposure period there is a proportionally greater risk. Arsenic at 220 days exposure has a risk estimate of 1.3 E-3.

Runoff Water and Sediment - There was one sampling event during the RI of storm related runoff water with 3 samples being taken. One of the samples had an arsenic concentration of 94 ug/l with the other two at or near the detection limit of 10 ug/l. A north tributary stream sediment sample was found to have an arsenic concentration of 12 mg/kg with background arsenic concentration being 2-5 mg/kg. This, plus a finding of DDT in soils/sediments at the north fence line of 23 mg/kg suggests that the contaminants are migrating off site through water/sediment transport. Due to the intermittent nature of this storm-related process and the lack of confirmational environmental samples off site, no quantitative health evaluation can be performed. The current information (other stream/sediment samples) suggests that surrounding areas have not been contaminated to a significant extent. However, if no on site remediation is performed, there will be continuing migration of material off site.

1.4.11 SUMMARY

Casual exposure to the unremediated on site soils represents a public health concern. Table 1-14 summarizes the risks by the three pathways for arsenic, DDT, and toxaphene. Even though inhalation exposure appears to

TABLE 1-14

COMBINED RISK ESTIMATES FOR CASUAL EXPOSURE TO ON-SITE CHEMICALS

COMPOUND	EXPOSURE DAYS	INGESTION	DERMAL CONTACT	INHALATION	TOTAL RISK
DDT	15	5.8E-6	2.5E-5	5.8E-8	3.1E-5
(Class I	220	8.6E-5	3.5E-4	8.6E-7	4.4E-4
(Cat. B2)	365	1.4E-5	5.7E-4	1.4E-6	5.9E-4
Toxaphene	15	1.0E-5	5.2E-5	1.0E-7	6.2E-5
(Class II)	220	1.5E-4	7.6E-4	1.5E-6	9.1E-4
(Cat. B2)	365	2.5E-4	1.3E-6	2.5E-6	1.6E-3
Arsenic	15	8.7E-5	9.2E-6	3.0E-6	9.5E-5
(Class III)	220	1.3E-3	1.4E-4	4.5E-5	1.4E-3
(Cat. A)	365	2.1E-3	2.2E-4	7.4E-5	2.3E-3
Dieldrin	15	9.7E-7	8.2E-6	9.6E-9	9.1E-6
(Class IV)	220	1.4E-5	1.2E-4	1.4E-7	1.3E-4
(Cat. B2)	365	2.4E-5	2.0E-4	2.3E-7	2.2E-4
TOTAL	15	1.0E-4	9.5E-5	3.2E-6	2.0E-4
	220	1.6E-3	1.4E-3	4.8E-5	3.0E-3
	365	2.5E-3	2.3E-3	7.8E-5	4.9E-3

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carry minimal risk, it was included in the total risk estimates, as a person on site is likely to be exposed via skin contact with soil, ingestion of soil, and inhalation of soil particles simultaneously. In addition, a person on site will not be exposed to toxaphene, arsenic, or DDT alone, but in some combination. Therefore the risks for each substance by pathway can be added. Since maximum soil concentrations were used, this represents a worst case exposure. The Superfund Public Health Evaluation Manual (USEPA a, 1986) also suggests that risks from combined exposures to different chemicals can also be added. Therefore, an estimate of the risk range for the combined pathways and chemicals is 2.0 E-4 for 15 days, 3.0 E-3 for 220 days, and 4.9 E-3 for 365 days. Risk ranges of 1 E-4 to 1 E-7 are to be considered for remedial action alternatives (USEPA a, 1986). A risk of 1 E-6 is generally treated as an acceptable risk.

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Table 1-11 previously displayed the summarized risk range of residential exposure. As the risk range is 1.9 E-5 to 4.8 E-5, it appears that exposure of residents in the housing area via the inhalation of particulates contaminated with chemical also may be of concern. Since the maximum soil concentration was used to calculate these risk estimates and the air borne particulate concentration was assumed to be 0.110 mg/m^3, the actual risk to the residential population may be lower. The actual risk will depend on the source of airborne particulates (site or surrounding areas) and the airborne particulate concentration.

1.5 Public Health Evaluation for Remedial Action

Region VI EPA has directed a clean up level of 100 mg/kg for toxaphene (USEPA e, 1987). In addition, they have suggested a clean up level of 100 mg/kg for arsenic and DDT. In subsequent conferences by TWC, Region VI EPA, and Ebasco an agreement was reached that a 100 mg/kg total contaminant concentration would be used as a clean up limit (USEPA b, 1987). Using the same assumptions as for the previous risk calculations, a risk estimate was prepared for 100 mg/kg and 33 mg/kg final soil concentrations for each of the major contaminants. The results of these calculations are presented in Table 1-15.

TABLE 1-15

RISK ESTIMATES FOR CASUAL EXPOSURE TO
ON SITE CHEMICALS AT RECOMMENDED CLEANUP LEVELS

COMPOUND	SC	EXPOSURE DAYS	INGESTION	DERMAL CONTACT	INHALATION	TOTAL RISK
DDT	100	15	2.7E-7	1.2E-6	2.8E-9	1.5E-6
(Class I	100	220	4.1E-6	1.7E-5	4.2E-8	2.1E-5
(Cat. B2)	100	365	7.0E-6	2.8E-5	7.0E-8	2.5E-5
Toxaphene	100	15	9.2E-7	3.7E-6	9.2E-9	4.6E-6
(Class II)	100	220	1.4E-5	5.5E-5	1.4E-7	6.9E-5
(Cat. B2)	100	365	2.3E-5	9.0E-5	2.2E-7	1.1E-4
Arsenic	100	15	6.0E-6	6.3E-7	2.3E-7	6.8E-6
(Class III)	100	220	8.9E-5	9.3E-6	3.1E-6	1.1E-4
(Cat. A)	100	365	1.5E-4	1.5E-5	5.1E-6	1.7E-4
DDT	33	15	9.0E-8	4.0E-7	9.0E-10	5.0E-7
(Class I	33	220	1.4E-6	5.7E-6	1.4E-9	7.0E-6
(Cat. B2)	33	365	2.3E-6	9.3E-6	2.1E-9	8.3E-6
Toxaphene	33	15	3.7E-7	1.2E-6	3.7E-9	1.5E-6
(Class II)	33	220	4.5E-6	1.8E-5	4.8E-8	2.3E-5
(Cat. B2)	33	365	7.7E-6	3.0E-5	7.3E-8	3.7E-5
Arsenic	33	15	2.0E-6	2.1E-8	7.7E-8	2.3E-6
(Class III)	33	220	3.0E-5	3.1E-6	1.0E-6	3.7E-5
(Cat. A)	33	365	5.0E-5	5.0E-6	1.7E-6	5.9E-5
TOTAL	33	15	2.5E-6	1.8E-6	8.2E-8	4.4E-6
	33	220	3.6E-5	2.7E-5	1.1E-6	6.4E-5
	33	365	6.0E-5	4.4E-5	1.8E-6	1.1E-4

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The combined risk for all pathways and contaminants is 4.4 E-6 for a total contaminant concentration of 100 mg/kg and an annual exposure rate of 15 days per year. Over 50% of the risk is due to arsenic with a combined pathway risk of 2.3 E-6. This is an acceptable risk for human health effects, given only 15 days per year activity at the site.

At a soil concentration of 100 mg/kg, the combined pathway risk was 1.5 E-6, 4.6 E-6, and 6.8 E-6 for DDT, toxaphene and arsenic respectively. The risk range for the 100 mg/kg cleanup would then range from 1.5 E-6 (DDT being the only contaminant), to 6.8 E-6 (arsenic being the only contaminant) with 4.4 E-6 being the overall risk estimate.

The combined risk estimate for a full worker (220 days per year exposure) is 6.5 E-5. As discussed above the risk range is from 2.1 E-5 (DDT being the only contaminant) to 1.1 E-4 (arsenic being the only contaminant). This is an unacceptable level of risk for public health. Clearly, site access must be limited. The 100 mg/kg total contaminant clean up level and a limitation of 15 days per year for site exposure would protect users and workers at the site.

A similar set of calculations was made for residential inhalation exposure using soil concentrations at 100 mg/kg. Table 1-16 presents the risk estimates. The risk range is from 4.4 E-8 (DDT only) to 6.4 E-6 (arsenic only). The overall risk for the three major contaminants at a total contaminant concentration is 2.2 E-6. This is an acceptable level of risk for public health exposure.

TABLE 1-16

RISK ESTIMATES FOR RESIDENTIAL INHALATION EXPOSURES
TO ON SITE CHEMICALS AT RECOMMENDED CLEANUP LEVELS

		RISK FOR EXPOSURE DAYS		
COMPOUND	SC	183	274	365
DDT	100	1.7E-8	3.3E-8	4.4E-8
Toxaphene	100	5.5E-8	1.1E-7	1.4E-7
Arsenic	100	2.5E-6	4.8E-6	6.4E-6
DDT	33	5.9E-9	1.1E-8	1.3E-8
Toxaphene	33	1.8E-8	3.5E-8	5.0E-8
Arsenic	33	8.3E-7	1.6E-6	2.1E-6
Total	100	8.5E-7	1.6E-6	2.2E-6

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2.0 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

There are a large number of remedial action technologies which are appropriate for consideration at hazardous waste sites. This section first enumerates all technologies which have been identified. For convenience, they are grouped by general response action categories. A primary screening is then performed to select only those general categories of technologies considered applicable at the CCA site. The specific technologies within the selected categories are then subjected to a secondary screening to select those technologies which are feasible and appropriate for inclusion within remedial alternatives. The remedial alternatives are formulated, and a tertiary screening of alternatives is performed based on a detailed evaluation of health risks, regulatory compliance, technological feasibility and comparative costs. The results of the alternatives analysis are then summarized.

2.1 PRIMARY SCREENING AND IDENTIFICATION OF GENERAL RESPONSE ACTIONS

Selection of promising technologies for final detailed analysis includes an evaluation of the literature sources, current vendor information, regulatory requirements, health-based risk determinations, and technological conclusions. The primary screening proceeds by evaluating generalized categories of technology and comparing them to the site-specific conditions. Ten general response actions and the associated technology categories that were retained after primary screening was performed are presented in Table 2-1. The initial list of response actions before primary screening is presented in Appendix B. Alternatives discarded during primary screening are presented in Table 2-2. The general response categories are discussed further in Section 2.2. Screening criteria for the technologies on the list includes a judgment concerning applicability of the technology under the constraints of the following factors:

- Environmental and Public Health risk
- Technological application to site-specific conditions
- Relative cost

TABLE 2-1
TECHNOLOGIES SELECTED BY PRIMARY SCREENING
FOR CRYSTAL CITY AIRPORT SITE

---

1. No Action

    Monitoring
        Public Drinking Water
        Surface Streams

2. Containment
    Capping

3. On Site Removal
    Soils
    Drums
    Liquid Wastes
    Contaminated Structures

4. Off Site Removal
    Soils
    Sediment
    Liquid Wastes

5. On Site Disposal
    Contaminated Liquids
        Temporary Storage
        Reuse/Recycle

    Contaminated Solids
        Land Application
        Landfill
        Temporary Storage (Waste Pile)

    Treated Liquids
        Reuse/Recycle (Water Supply, Irrigation)
        Temporary Storage

    Treated Solids
        Land Application or Backfill
        Landfill
        Reuse/Recycle (Construction Material)
        Temporary Storage

6. Off Site Disposal

    Contaminated Liquids
        Discharge to Municipal or Industrial Treatment Facility
        Discharge to Water Body
        Deep Well Injection

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TABLE 2-1 (Continued)
TECHNOLOGIES SELECTED BY PRIMARY SCREENING
FOR CRYSTAL CITY AIRPORT SITE

Contaminated Solids
- Land Application
- Landfill

Treated Liquids
- Discharge to Municipal or Industrial Treatment Facility
- Discharge to Water Body
- Injection
- Reuse/Recycle (Water Supply, Irrigation)

Treated Solids
- Land Application or Backfill
- Landfill
- Reuse/Recycle (Construction Material)
- Temporary Storage

7. On Site Treatment

Chemical
- Neutralization
- Precipitation
- Activated alumina adsorption
- Ion exchange
- Coagulation/flocculation
- Chemical oxidation
  - a. hydrogen peroxide
  - b. ozonation
  - c. permanganate
  - d. chlorination
- Reduction
- Hydrolysis
- Chemical dechlorination
- Ultraviolet radiation
- Catalytic hydrogenation
- Electrodialysis

Immobilization
- Solidification
- Stabilization
- Fixation

Physical
- Soil Washing/Solvent Extraction
- Flow equalization
- Sedimentation
- Activated carbon adsorption
- Reverse osmosis/membrane separation/dialysis
- Liquid-Liquid extraction
- Gravity flotation

TABLE 2-1 (Continued)
TECHNOLOGIES SELECTED BY PRIMARY SCREENING
FOR CRYSTAL CITY AIRPORT SITE

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7. On Site Treatment (cont.)
    - Steam distillation
    - Air stripping
    - Steam stripping
    - Filtration
    - Ultrafiltration
    - Dissolved air flotation
    - Evaporation
    - Dewatering
    - Mechanical Aeration
  - Thermal
    - Incineration
    - Pyrolysis
    - Wet Oxidation
  - Biological
    - Activated Sludge
    - Digestion
  - Land Treatment
    - Land Farming

8. Off Site Treatment
  - Thermal
    - Incineration
    - Pyrolysis
  - Chemical
  - Physical
  - Biological

9. In Situ Treatment
  - Biological
  - Chemical
  - Physical
    - Soil aeration
    - Solvent flushing
    - Mining with surfactant
    - Permeable bed treatment
    - Vaporization
  - Thermal
  - Immobilization

10. Institutional
  - Land Use Restrictions
  - Water Use Restrictions

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FOR YOUR INFORMATION

One page of a document included in the administrative record was inadvertently omitted from microfilming and was not stamped with a unique document number. This page is physically included in the document. The number "001321" was not stamped on a page included in the three-hundred and thirty four (334) page document dated July 17, 1987 (Document No. 001244-001595). The document is complete and in order.

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TABLE 2-2
POTENTIAL REMEDIAL TECHNOLOGIES
DISCARDED FROM CONSIDERATION IN PRIMARY SCREENING

1. CONTAINMENT

A. Containment Barriers

1. Gas/Vapors

a. Soil Bentonite Slurry Wall
b. Cement Bentonite Slurry Wall
c. Grout Curtains
d. Steel Sheet Piling

2. Particulates

a. Native Material
b. Clay
c. Chemical Sealants/Stabilizers
d. Asphalt
e. Concrete
f. Synthetic Membranes
g. Multimedia
h. Windscreens

3. Sediments

a. Curtains
b. Cofferdams
c. Pneumatic Barriers

2. COLLECTION/DIVERSION

A. Gas/Vapors

1. Pipe Vents (Passive)
2. Trench Vents (Passive)
3. Active Gas Collection

B. Surface Water

1. Dikes and Berms
2. Ditches and Trenches
3. Terraces and Benches
4. Chutes and Downpipes
5. Seepage Basins
6. Sedimentation Basins
7. Levees
8. Addition of Freeboard
9. Floodwalls

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TABLE 2-2
POTENTIAL REMEDIAL TECHNOLOGIES
DISCARDED FROM CONSIDERATION IN PRIMARY SCREENING

1. CONTAINMENT

A. Containment Barriers

1. Gas/Vapors

a. Soil Bentonite Slurry Wall
b. Cement Bentonite Slurry Wall
c. Grout Curtains
d. Steel Sheet Piling

2. Particulates

a. Native Material
b. Clay
c. Chemical Sealants/Stabilizers
d. Asphalt
e. Concrete
f. Synthetic Membranes
g. Multimedia
h. Windscreens

3. Sediments

a. Curtains
b. Cofferdams
c. Pneumatic Barriers

2. COLLECTION/DIVERSION

A. Gas/Vapors

1. Pipe Vents (Passive)
2. Trench Vents (Passive)
3. Active Gas Collection

B. Surface Water

1. Dikes and Berms
2. Ditches and Trenches
3. Terraces and Benches
4. Chutes and Downpipes
5. Seepage Basins
6. Sedimentation Basins
7. Levees
8. Addition of Freeboard
9. Floodwalls

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TABLE 2-2 (Continued)
POTENTIAL REMEDIAL TECHNOLOGIES
DISCARDED FROM CONSIDERATION IN PRIMARY SCREENING

3. LAND SURFACE MODIFICATION

A. Grading

1. Spreading
2. Scarification
3. Tracking
4. Contour Furrowing

B. Revegetation

1. Grasses
2. Legumes
3. Shrubs
4. Trees (Conifers, Hardwoods)

4. ON- OR OFF- SITE DISPOSAL

A. CONTAMINATED LIQUIDS

1. Thermal Destruction

B. CONTAMINATED SOLIDS

1. Thermal Destruction

5. ON- OR OFF-SITE TREATMENT[1]

A. THERMAL

1. Molten Salt (S)
2. Molten Glass (S)
3. High Temperature Fluid Wall (S,W,L,S,D)
4. Infrared Combustion (S)
5. Industrial Boiler or Furnace (S)
6. Vitrification (S)

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TABLE 2-2 (Continued)
POTENTIAL REMEDIAL TECHNOLOGIES
DISCARDED FROM CONSIDERATION IN PRIMARY SCREENING

6. <u>In Situ Treatment</u>

A. PHYSICAL

1. Solidification (W,L,S,D)
   a) Cement - Based
   b) Lime - Based
   c) Thermoplastics
   d) Organic Polymers
   e) Self-Cementation
2. Soil Amendment (S)

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1/ Treatment technologies are keyed to types of materials that can potentially be handled as follows: G - Gas/Vapor; P - Particulates; W - Surface Waters; L - Leachate/Groundwater; S - Solid Wastes/Soils; and D - Sediments

2.1.1 Environmental and Public Health Considerations

The screening process for environmental and public health effects will evaluate, on a preliminary basis, the beneficial effects weighed against the harmful effects of implementation. Judgment will be applied to rule out technologies which appear to have adverse environmental or public health consequences of implementation.

2.1.2 Technological Application to Site-Specific Conditions

The majority of technologies will be ruled out for the reason of incorrect application to the specific problem at the site. For example, the technologies which treat wastewater are excellent treatment methods which will work on liquid waste streams, but cannot be applied to a problem of soil contamination.

In the discussion concerning the development of alternatives, other technological reasons are identified for ruling out specific treatment technologies. The use of biological treatment techniques may be very appropriate for certain biodegradable wastes. However, due to the characteristics of the specific wastes present at the CCA site, biological treatment is not considered to be effective because the contaminants are inhibitors of biological activity.

Other reasons for elimination include considerations of site access, process implementability, construction related constraints, and potential increased risks associated with the remedy itself, among others.

2.1.3 Relative Cost

The cost of a cleanup technology is also a factor of concern in the primary screening step. The costs generated are not intended to be rigorous or detailed, but are to be within a range of +100% to - 50%. Technologies are

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considered feasible for analysis if their estimated costs are not more than an order of magnitude higher than an alternative technology which performs to the same approximate extent.

Cost estimates for the final alternatives are more detailed and within a range of +50% and -30%. These costs are generated on the basis of best available information at the time of evaluation. Costs of cleanup and disposal of hazardous wastes have undergone significant changes over the past 10 years, and future costs are difficult to project. Therefore, present worth evaluation of cost data is also included to indicate the costs associated with cleanup under assumptions appropriate in the current time frame.

2.2 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section presents a discussion of the individual technologies evaluated. Descriptions and secondary screening discussion are provided to clarify why a particular technology was selected for further evaluation or eliminated.

2.2.1 No Action

The no action response category is presented here to form a baseline for relative evaluations of other technologies. No additional cleanup would be undertaken; the site would be left as it now exists. Although no additional cleanup would be done, monitoring activities are needed to periodically assess contaminant migration at the site. If monitoring results indicate significant migration, the decision to do more cleanup would be re-evaluated.

- <u>Monitoring</u>

  Monitoring includes the periodic withdrawal and subsequent chemical analysis of water samples.

- **Description**

  A long-term monitoring program would be implemented to provide updated information on the migration of contaminants or their degradation with time. Public drinking water supplies and surface waters would be sampled on a routine basis.

- **Secondary Screening**

  A no action alternative evaluation is required to complete the Feasibility Study. The decision to do no additional remedial activities may be a viable alternative, considering the nature and effectiveness of the Immediate Removals (IR) implemented to date. In later sections of this report, additional health-based evaluations are used to determine whether the no action alternative is feasible or appropriate. In keeping with the requirements of the National Contingency Plan (NCP) and the Superfund Amendments and Reauthorization Act (SARA), no action will be further considered. The acceptability of the no action technology will be judged in relation to the assessment of known site risks, and by comparison with other remedial action technologies.

2.2.2 Containment

Containment is a response category in which little or no treatment occurs and the contaminants are enclosed, isolated from potential receptors. Migration of contaminants is controlled by the continued maintainence of the containment structure. In Appendix B, containment techniques for contaminated soil are outlined. Capping, either in place or after consolidation, is the only containment technology in this category appropriate for this site.

Capping

Capping the site with an impermeable barrier will mitigate the exposure hazard by isolating the contaminants from potential receptors. This will also prevent migration of contaminated materials by physically isolating them from forces of migration, including rainfall percolation, storm water runoff, and wind.

- o **Description**

  All of the choices of capping materials listed in Appendix B appear to be appropriate for further evaluation, including the following:

  a) native materials
  b) clay
  c) chemical sealants/stabilizers
  d) asphalt
  e) concrete
  f) synthetic membranes
  g) multimedia

- o **Secondary Screening**

  If the contaminated soils are capped in place, the site will require an ongoing program of maintenance in perpetuity, because capping does not alter the toxicity or quantity of the contaminated soil. As described in the RI, the organic contaminants are persistent in the environment. Arsenic, while potentially transportable, maintains its hazardous characteristics indefinitely. Although maintenance of the cap is expected to be required forever, for cost analysis purposes, the duration of maintenance is assumed to be 30 years in this analysis. With satisfactory annual maintenance, major cap failure or replacement would be unlikely.

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The useful life of each of the cap materials can be affected by the elements (sunlight, temperature, rainfall, erosion, subsidence, etc.) and by the contaminants within the soil. The effectiveness of the cap performance is related to the physical and chemical properties of the cap material (permeability, chemical resistance, etc.) and how these properties may change with age.

Some cap materials will perform more effectively than others. All of the suggested materials will reduce the present threat from contact with the contaminated soil. Native materials and clay may have lower initial costs, but higher maintenance cost due to their susceptibility to erosional forces. Other cap materials, such as asphalt, concrete, synthetic membrane or a multimedia cap, may require less maintenance.

The use of capping as a containment technology may be viable for some portions of the Crystal City Airport Site. There are insufficient grounds at this time to dismiss capping as infeasible or inappropriate. In keeping with the Superfund Amendments and Reauthorization Act (SARA) interim guidelines, containment technologies will be further considered during the detailed evaluations of alternatives. The acceptability of the capping alternative will be judged in relation to the assessment of known site risks, and by comparison with other remedial action alternatives.

2.2.3 On Site Removal

On site removal has been defined, for the purpose of this report, as the removal of on site material from its current location. In many of the alternative technologies, the on site contaminated materials must first be mechanically removed from their current location for further handling or processing. Removal technologies are identified in Appendix B. Of the five categories of material for which removal technologies would apply (soils, drums, liquid wastes, structures, and sediments), all but one was found to be applicable to the Crystal City Airport Site. Sediments are defined as soil eroded by natural runoff and deposited within surface water bodies. As there are no surface water bodies on site, there are no on site sediments, and technology for sediment removal was eliminated.

Soils

On site contaminated soils would require removal before further processing of treatment or disposal, except in the case of in situ treatment or capping.

Description

On site soils would be removed by excavation, using conventional earth moving and construction equipment.

Secondary Screening

The contaminated soil to be removed is principally at the surface, since contaminant levels exceeding the cleanup limit of 100 ppm were not found in samples collected below a depth of 1.5 feet. Due to the fact that the contaminants are so close to the surface, excavation of the soil should be easy to accomplish using readily available earth moving equipment. During excavation, measures would be taken to control dust and minimize airborne contamination. Soil excavation is an appropriate technology for the site and is retained for further consideration.

Drums

There are four locations on the CCA site where drums and other site wastes were placed in below ground excavations. These areas are in the eastern central portion of the site, in the vicinity of the windsock. As part of the Feasibility Study, these three areas are to be cleaned up. It is known with certainty that 90 drums of solid wastes were placed in temporary, below-ground storage during the Remedial Investigation in October, 1986, and in February, 1987. The total number of drums of potentially highly concentrated wastes, and the amount of highly contaminated soils placed in the other two excavations during the IR action conducted in the fall of 1983 can be estimated at between 50 - 70 partially full drums and about 40 cubic yards of contaminated soil and lime. These materials may require excavation and removal for treatment or disposal. The removal of drums and other wastes from these three excavations would be combined with applicable disposal and/or treatment technologies (other than in situ treatment processes or capping).

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Description

The excavations are located in an accessible area of the site and can be removed with conventional excavation equipment, including loader, backhoe, dozer, drum grappler, slings, and other common earth moving equipment. The drums placed in excavations during the IR may be in poor condition. Removal of these drums and the highly contaminated soils must be conducted with caution to prevent accidental release of contaminants.

Secondary Screening

The removal of the materials from the on site excavations is a necessary step in many of the remedial alternatives, and can be conducted with conventional removal technology. This technology is retained for further consideration.

Liquid Wastes

There are no contaminated surface waters on the site (pits, ponds, lagoons, streams, or lakes). There is the possibility that storm runoff waters collected during the Remedial Action (RA) and decontamination waters generated during the RA would require treatment or disposal. These liquids must be collected and controlled, and addressed within the selected disposal and/or treatment technologies.

Description

Collection of contaminated liquids requires provision for temporary on site storage and transfer of these materials, as well as treatment unit processes, as appropriate.

Secondary Screening

Because the contaminated liquids will be generated as part of the cleanup, the RA would provide for collection and further handling of these contaminated liquids. This technology is retained for further evaluation.

Structures

Samples collected from the surfaces of building structures indicated the presence of contaminants. Most building structures on site are in poor condition and would be removed along with the other site wastes.

Description

Building demolition would be undertaken by standard construction demolition techniques. Some of the smaller, more dilapidated buildings are wooden frame with thin metal siding, and have suffered damage from wind and aging. These could be easily razed with a bulldozer. The larger hangar buildings are of metal frame construction with heavier siding. Since demolition of these larger buildings would require labor-intensive cutting of building structural members prior to removal, decontamination of the buildings by high pressure, high temperature, chemical cleaning agents, or abrasives, will be evaluated.

Secondary Screening

The demolition/decontamination of building structures is a necessary part of site remediation and is retained for further evaluation.

2.2.4 Off Site Removal

Off site removal has been defined, for the purpose of this report, as the removal of off site material from its current location. Removal of off site materials for remediation would be necessary only for contamination in excess of cleanup limits described in other sections of this report. Outlined in Appendix B are five categories of off site wastes amenable to removal technologies. Only one was found to be applicable to the CCA site. There are no off site drums and contaminated structures identified for removal, and there are no immediately adjacent contaminated surface waters (pits, ponds, lagoons, lakes, or streams); therefore, these categories were eliminated.

The principal mechanism for off site contamination is from rainfall runoff. The contamination present in the on site surface soils constitutes the source, and stormwater erosion of the source provides the driving force for off site migration. Removal of the source material would eliminate continued off site migration.

Soils

Off site removal of contaminated soils in drainage pathways could be combined with other disposal and/or treatment technology (not including in situ options).

Description

Off site soils found to be contaminated in excess of cleanup limits would be removed for further processing for treatment or disposal by conventional construction excavation methods.

Secondary Screening

Because the contaminants are at or close to the surface, excavation of the soil should be easy to accomplish using readily available earth moving equipment. During excavation, dust control measures will be taken to minimize airborne contamination. Where required, off site soil removal is an appropriate part of the total site remediation, and is retained for further consideration.

2.2.5 On Site Disposal

On site disposal has been defined, for the purpose of this report, as disposal of contaminated material without removing it from the site. There are four categories of on site disposal technologies outlined in Appendix B. These categories are specified by the quality of the waste (contaminated or treated) and its form (liquid or solid). At the CCA site, contaminated soils, drummed solids and unreclaimable contaminated building rubble are candidates to be disposed of. In addition, waste waters generated during the cleanup operation (decontamination wash water, collected storm water and process waste water) will have to be treated or disposed of. All of the technology categories were found to be appropriate and retained for further consideration.

Contaminated Liquids

The on site disposal technologies in this category are for the treatment, storage or disposal of the contaminated liquids on site. On site injection was eliminated from further consideration due to the fact that no acceptable injection well currently exists on site. Siting a new injection well is not considered to be feasible due to the close proximity of the site to an existing public drinking water well, and the impracticality of development of a new injection well for a one time use on this site.

The only pertinent technologies remaining within this category for on site disposal of contaminated liquids are temporary storage and recycle/reuse.

- Temporary Storage

Description

Temporary ponds and/or tanks can be used to collect and store contaminated liquids prior to further treatment or disposal. Temporary storage would be part of the management plan for storm water runoff, decontamination wash water, and process waste water generated by treatment alternatives.

Secondary Screening

Temporary storage of liquids would be part of any chosen alternative (except no action). Each alternative would involve the collection and storage of storm runoff and wash water used to decontaminate personnel and equipment during the site cleanup. Contaminated liquids generated as process waste waters would also require some form of temporary storage. The specific method of storage would be determined, based on expected volumes of waste to be stored. The techology involved in liquid storage is retained for further consideration.

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Description

Collected liquids on the site may be used in subsequent processing phases within the remedial action. Reuse of the liquids or recycling may represent a convenient method of processing both the contaminated solids and the generated liquids in a subsequent treatment or disposal alternative.

Secondary Screening

Reuse or recycling is possible when combined with certain other technologies such as slurrying of soil for soil washing, or for scrubbing of flue gas from an incinerator. Therefore, this technology is retained for further consideration.

Contaminated Solids

The on site disposal technologies in this category are those which treat, store or dispose of the contaminated solids on site. Land application involves spreading the material over land and working it into the soil. Traditionally, land application has been used for sewage sludge, which is both biodegradable and beneficial to the soil with respect to agriculture. Land application relies on the action of microbiological inhabitants of either the waste material or the soil to which it is applied. Land application of the specific pesticide wastes involved at CCA is determined to be an inappropriate technology and has been ruled out because the degradation of the contaminants would be slow, therefore permitting contaminated soils to remain subject to erosional forces. The technologies remaining for on site solids disposal are landfilling and temporary storage.

- Landfill

Description

Landfilling is a commonly practiced remedial technology, although this technology does not alter the chemical content of the wastes. The landfill option can be combined with other treatment technologies which modify the chemical or physical characteristics of the waste to reduce toxicity, mobility or quantity. On site landfilling can be accomplished using readily available resources. This technology can be combined with capping to properly isolate contaminated materials.

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Secondary Screening

Landfill technology can be evaluated alone, or in conjunction with additional treatment or off site disposal. Landfilling is a standard, commonly practiced technology which may be viable for the CCA Site. Landfill technology will be retained and evaluated in relation to the known site risks, regulatory constraints, and other remedial technologies.

- Temporary Storage

Description

Site wastes may be required to be stored as a temporary measure during the construction of the selected RA. Storage technology involves the use of temporary waste piles to store contaminated solids prior to treatment and/or disposal.

Secondary Screening

Temporary storage piles may be needed as part of the selected treatment alternative (except in situ treatment); therefore this technology is retained for further evaluation.

Treated Liquids

For the liquids which have undergone treatment as part of the remedial action, there are three options presented in Appendix B. On site disposal by deep well injection was discussed previously and rejected. Temporary storage remains a viable choice, along with reuse/recycle.

- Reuse/Recycle

  Description

  Liquid wastes would be reused or recycled to the fullest extent possible to reduce the quantities for disposal or treatment.

  Secondary Screening

  This technology is retained for evaluation because it is ideally suited to the conditions at the site and would be utilized if the treatment of contaminated liquids is to be part of the alternative.

- Temporary Storage

  Description

  This technology involves the use of temporary ponds/tanks to collect/store treated liquids prior to off site disposal or reuse/recycle.

  Secondary Screening

  Storage would be part of any alternative involving the treatment of contaminated liquids for reuse/recycle during site cleanup. The method of storage (ponds, tanks, etc.) would be determined, based on volumes of liquids to be stored and site operational constraints.

Treated Solids

On site disposal technologies, indicated in Appendix B, are available for final disposition of treated wastes at this site. Such methods would be used to store or dispose of the treated solids on site. All of the listed technologies are appropriate and will be evaluated in this screening process.

- o Land Application

Description

After treatment, the soils can be reapplied to the area from which they were removed, providiug the treatment process reduced the level of contamination to an acceptable level.

Secondary Screening

This technology is expected to be part of all on site treatment alternatives except in situ treatment.

- o Landfill

Description

Construction of an on site landfill is commonly practiced as a remedial technology, although this technology does not further alter the chemical or physical nature of the treated wastes. On site landfill construction can be implemented using readily available resources. This technology would be combined with capping to isolate the material.

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Secondary Screening

On site landfill of the treated wastes can be readily accomplished with conventional technology. The use of treatment technology would further reduce the toxicity or mobility of the wastes prior to disposal.

o Reuse/Recycle

Description

After treatment, the solids may potentially be used for items such as construction materials, etc. This would represent a reuse or recycling of the treated solids. Some construction debris (structural members) may be directly reused after removal of surface contamination.

Secondary Screening

Reuse/Recycling of treated solids is an appropriate technology to be applied to this site as a treatment alternative, if there is a need for construction materials on the site.

o Temporary Storage

Description

Waste piles would be used for temporary storage of treated solids prior to disposal.

Secondary Screening

Storage for treated solids would be part of all on site treatment alternatives, except in situ treatment, and is therefore retained for further consideration.

2.2.6 Off Site Disposal

Off site disposal has been defined, for the purpose of this report, as disposal of contaminated material at a location that is not on site. There are four categories of off site disposal technologies outlined in Appendix B. These categories are specified by the quality of the waste (contaminated or treated) and its form (liquid or solid). Cleanup of the CCA Site will include contaminated soils, drummed solids, building rubble, and waste waters generated during the cleanup operation (decontamination wash water, collected storm water and process waste water), which would have to be disposed of. These wastes would be collected and transported to an off site location for disposal at licensed facilities capable of handling the waste materials. All of the technology categories were found to be appropriate and are retained for further consideration.

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Contaminated Liquids

Off site temporary storage and reuse/recycle were both eliminated during the primary screening. Neither of these technologies offer any advantage over their on site counterparts and both have the disadvantage of increased risk of accident due to double handling of the waste.

Discharge to a municipal or industrial treatment facility off site, without treatment, is not appropriate because the contaminants in question would pass through, or interfere with, conventional treatment systems. Such a discharge would not meet pretreatment standards for any publicly owned treatment works. Discharge to a municipal or industrial treatment facility off site is thus eliminated from further consideration.

Discharge to a surface water body is totally inappropriate in that it directly contradicts the short and long term surface water objectives delineated in Section 1.3.

The only pertinent techology remaining within this category for off site disposal of contaminated liquids is deep well injection.

o Deep Well Injection

Description

This technology involves transportation of the contaminated liquids to an off site commercial deep injection well for disposal.

Secondary Screening

This technology does not reduce the toxicity of the waste, but isolates it by means of injecting the waste liquids, using a properly designed and monitored deep well, into a suitable belowground geological reservoir.

This technology may be viable for disposal from the CCA Site and it will be further considered during the detailed evaluation of alternatives. At that time, the acceptability of this disposal technology will be judged in relation to the assessment of the known site risks and other alternative remedial technologies.

Contaminated Solids

Contaminated solids would be removed in bulk for off site disposal. Off site temporary storage was eliminated from consideration during the primary screening. Off site land application is inappropriate for two reasons. Firstly, it could be utilized on site without engendering the added health risks of double handling of the contaminated material. Secondly, as previously discussed, the contaminants are persistent and resist degradation. Land application off site is thus eliminated. The only pertinent technology remaining within this category for off site disposal of contaminated solids is landfill.

- Landfill

Description

An off site, lined landfill would be used to permanently store the contaminated solids. This technology is commonly combined with the capping technology, in compliance with RCRA, to properly isolate the contaminated waste.

Secondary Screening

This technology does not reduce the toxicity of the waste, but isolates it by placing the wastes in a securely constructed and monitored cell at a commercial disposal facility.

This technology may be viable for disposal of some or all of the wastes at the CCA Site. There are no grounds at this time to eliminate off site landfill technology as infeasible or inappropriate, and it will be further considered during the detailed evaluation of alternatives. At that time, the acceptability of this technology will be judged in relation to the assessment of the known site risks and other alternative remedial technologies.

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Treated Liquids

The technologies in this category store or dispose of the treated liquids at an off site location. Off site temporary storage was eliminated from further consideration because it would require double handling of the waste. This could result in an accident with potential impact on public health and the environment. In addition, double handling of the waste is costly.

The technologies remaining within this category for off site disposal of treated liquids are discharge to municipal/industrial treatment facilities, discharge to surface waters, deep well injection, and reuse/recycle.

- Discharge to Municipal/Industrial Treatment Facility

Description

Liquid wastes generated from remedial actions could undergo treatment to allow for discharge to a municipal/industrial treatment facility. At CCA the treatment facility likely to receive the treated wastes would be the Crystal City municipal wastewater treatment plant.

Secondary Screening

Discharge of treated liquids to the municipal wastewater treatment plant would be possible if an alternative involving the on site treatment of contaminated liquids was selected. A detailed analysis of the city treatment plant is required to determine the impact of such a discharge, both from an operational and a regulatory framework.

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- Discharge to Surface Water Body

Description

If the treatment of wastewaters was adequate to meet direct discharge requirements, the effluent could be directly discharged to the local stream, in this case, the Espantosa Slough.

Secondary Screening

Direct discharge would be possible if an alternative involving significant on site treatment of contaminated liquids to acceptable levels was selected.

- Deep Well Injection

Description

Injection would involve the collection and transportation of treated liquids to an off site location for discharge to a commercial deep well, permitted to receive such materials. Depending on the level of treatment required, deep well disposal may or may not be appropriate.

Secondary Screening

Deep well injection could be feasible if treated liquid wastes do not meet direct discharge requirements or limits required by the local municipal treatment plant, and reuse is not possible.

- Reuse/Recycle

Description

The reuse or recycling of treated liquid wastes off site is possible, assuming the liquid wastes have been treated adequately to render them harmless. Alternatives include irrigation and water supply. Off site transport, such as pumping or tank trucks, would be required.

Secondary Screening

Although off site reuse or recycling of treated liquid wastes is an attractive alternative, it will always have an economic disadvantage relative to on site reuse/recycle. However, off site reuse/recycle will be incorporated to the extent possible.

Treated Solids

The off site disposal technologies in this category store or dispose of the treated solids off site. Because on site remedies generally have a cost advantage, even for contaminated materials, it is not considered likely that off site disposal of treated solids, by land application, landfill, or temporary storage, would be selected. All of the alternatives for off site handling of treated solids are therefore eliminated except for reuse/recycle. Some of the treatment technologies could result in solids which could be used as construction materials, or directly as building materials (structural steel) after decontamination.

- Reuse/Recycle

Description

This technology involves the decontamination or treatment of solids on the site and reuse/recycle for construction materials.

Secondary Screening

Reuse/recycle makes economic and engineering sense and will be incorporated to the extent possible in all alternatives evaluated for selection.

2.2.7 On Site Treatment

On site treatment is defined, for the purpose of this report, as the use of technology that degrades, removes, or immobilizes contaminants. It includes a centrally located on site treatment unit to which contaminated material is brought. There are six categories of treatment technologies outlined in Appendix B, biological, chemical, physical, immobilization, thermal, and land treatment. Four were found that might be applicable to the on site treatment of soils, drummed materials and building rubble at the CCA site.

Biological treatment technologies, in which microorganisms are utilized to degrade the contaminants, are generally ineffective in destroying pesticide residues. These technologies can be divided into two general categories; aerobic and anaerobic (digestion). Technologies of both categories function by enhancing the degradation of waste constituents. This is done by improving environmental parameters and/or mixing the waste with a specific microbial population. If the microbes of choice are indigenous to the waste, then environmental parameters are improved to increase microbial activity. Conversely, if the microbes required are an enrichment culture, they are separately introduced into the environment to act specifically on a compound or group of compounds. In most cases, a combination of both methods is used to reduce or eliminate a specific compound or group of chemicals.

Biological treatment technologies have been used mainly for the treatment of aqueous waste streams contaminated at low to moderate levels with non-halogenated organics and some halogenated organics (Camp, Dresser, and McKee, 1986). Shock loadings (abrupt changes in input waste stream characteristics) render biological reaction inoperative. The varying concentrations of numerous organic contaminants at the CCA site makes it unlikely that biological treatment systems would work at all, let alone effectively. In addition, the arsenic contamination (as discussed in the AI) is not amenable to biological degradation. For these reasons, biological treatment is eliminated.

Land treatment is the direct application of contaminated solids to the land (spreading), and treatment using tilling and environmental exposure (land farming). These techniques have been found to be slow and ineffective in destroying pesticide residues of the type found at the site; therefore, land treatment has been ruled out.

The four remaining categories of technologies retained in this screening process for investigation are: immobilization, chemical, physical, and thermal.

Immobilization

The technologies in this category reduce the mobility of the wastes. Materials are added to the wastes which combine physically or chemically to retard the further migration of the contaminants. Stabilization, solidification, and fixation are grouped together as immobilization for purposes of the screening procedure, based upon similarity in processes and terminology. Several of the available immobilization technologies were investigated and found to be applicable and feasible.

- Stabilization, solidification, and fixation

Description

These immobilizaton processes are used primarily for retardation of the migration of contaminants. Most of the commercially available treatments involve the addition of a proprietary chemical to the wastes to produce a solid from which the contaminants cannot escape. These treatments can be carried out using backhoes, cement mixers, and dump trucks. Usually, batch processes are performed to immobilize the waste as it is excavated, and to allow stability tests on the final product of each batch before disposal.

Secondary Screening

Many commercial immobilization treatments are available. Most applicable are the ones which can handle wastes containing organics while maintaining an acceptable leachability rate.

Implementation of any of these treatments would require laboratory and/or pilot-scale testing in order to determine that the chemical and physical properties of the solidified material are adequate. Other constituents in the soil, such as fine organic particles, solvents, soluble salts, and sulfates can reduce the effectiveness of the treatments. Immobilization technologies were determined to be feasible and are retained for further consideration.

Chemical

The technologies in this category are those in which chemicals are used to cause reactions to destroy or degrade the contaminants. Chemical treatment technologies have limited effectiveness in destroying the organic pesticide/herbicide residues found at the site. Several processes, however, have undergone recent research efforts and may have some potential. They include chemical oxidation with UV radiation, chemical reduction, hydrolysis, and dechlorination. Chemical oxidation and chemical reduction may not fully destroy the contaminants and may produce other toxic products of reaction. Hydrolysis is not proven to be effective with chlorinated hydrocarbons. Dechlorination processes have not been developed past the pilot/laboratory test stages. Other processes without apparent potential include neutralization, precipitation, activated alumina adsorption, ion exchange, coagulation-flocculation, catalytic hydrogenation and electrodialysis. Neutralization only changes pH out of the hazardous range. Precipitation only removes metals and some inorganic anions; organics can inhibit this process. Activated alumina adsorption has been used for defluoridation of alkylates but not for use on organochlorines (Perry, 1963). Ion exchange and electrodialysis are only effective on charged inorganic ions and dissociated organic acids and amines. Coagulation/flocculation are only effective for suspended solids from liquids. Catalytic hydrogenation, the replacement of a double-bonded oxygen with a single-bonded hydrogen and a single-bonded hydroxyl, is not appropriate for organochlorines. Therefore chemical treatment has been ruled out for the treatment of organic contaminants at this site.

Chemical treatment is, however, quite effective in reducing the arsenic levels of aqueous wastes, assuming the arsenic can be converted to that form. Several processes have been proven to be effective. They include chemical oxidation and precipitation.

- Chemical Oxidation

Description

Chemical oxidation is used primarily for the treatment of dilute waste streams containing oxidizable organics and arsenic (USEPA, 1985). At the CCA Site, arsenic could be oxidized to a less soluble form, thus causing precipitation of an arsenic salt. Oxidation reactions can be carried out using simple, readily available equipment. Storage vessels, metering equipment, and contact vessels with agitators are the principal equipment requirements. Oxidation processes can generally be carried out on a continuous basis.

Secondary Screening

Several chemical oxidants are available, the most applicable being hydrogen peroxide and ozone. Potassium permanganate is not as strong an oxidant and has no demonstrated effectiveness with these contaminants. Chlorination, using either sodium hypochlorite or chlorine gas, would be possible for the treatment of the arsenic. However, it is not appropriate in this case, due to the potential for interfering reactions with the other organic contaminants in the wastes. Oxidation using hydrogen peroxide is accomplished by the addition of a predetermined amount of concentrated peroxide solution to the contaminated waste in the reaction chamber (Hager, 1986). Ozonation requires the generation of ozone on site. The 2 to 3 percent ozone that is generated is directly infused with the wastes in the reaction chamber (Zeff, 1986).

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Materials to be treated would have to be fed as a slurry and may require large vessels (or slower feed rates) and long detention times. Implementation of oxidation processes would require laboratory and/or pilot-scale testing in order to determine the appropriate oxidant feed rates and reactor retention times in accordance with the specific chemical composition of the contaminated waste and desired treatment results. Chemical oxidation alone would not be used to treat the contaminants at this site, because these treatment methods may not react with some of the wastes, such as chlorinated organics, or they may produce other toxic products. Other constituents which may be in the waste, such as dissolved metals, particulate matter, and other organics, can reduce the effectiveness of these oxidation processes if present in high concentrations. Both of these oxidation processes were determined to be feasible, given the existing information, and are retained for further consideration.

o Chemical Precipitation

Description

Co-precipitation by addition of a polyvalent coagulent such as ferric sulphate, chloride or hydroxide at neutral pH will give up to 98% removal of arsenic down to 0.05 mg/l (0.05 ppm), or sometimes less. Up to five times the stoichiometric requirement may be needed. The other main treatment process is formation of insoluble sulphide by addition of sodium or hydrogen sulphide at neutral pH. If arsenite is present this must always be oxidised to arsenate, for example with chlorine.

The most effective, but apparently least used, method is precipitation with lime at around pH 12, when over 90% removal of arsenic may be achieved (Bridgwater and Mumford, 1979).

Secondary Screening

Several different chemicals are available to precipitate arsenic from liquid wastes, assuming it can be converted to that form. Chemical precipitation is retained for further consideration.

Physical

Physical treatment technologies do not detoxify or destroy the contaminants, but instead remove the contaminants by transferring them from the soil to a media which is more conducive to handling, further treatment, and/or disposal. During this screening process, the eighteen physical treatment technologies listed in Appendix B were investigated for applicability to the CCA Site conditions. These are soil washing/solvent extraction, flow equalization, sedimentation, activated carbon adsorption, reverse osmosis, membrane separation, dialysis, liquid-liquid extraction, gravity flotation, steam distillation, air stripping, steam stripping, filtration, ultrafiltration, dissolved air flotation, evaporation, dewatering, and mechanical aeration. Only the the soil washing/solvent extraction process was found to adequately remove dilute quantities of arsenic and organic compounds from large quantities of solids on a continuous basis. In addition, only carbon adsorption was found to be able to selectively remove dilute quantities of organic hydrocarbons from a liquid waste on a continuous basis. Many of the physical technologies, such as flow equalization, filtration, ultrafiltration dissolved air flotation, gravity flotation, sedimentation, and dewatering, are applicable only to the removal of suspended solids from a solution. Steam distillation, evaporation and air and steam stripping are limited to the separation of contaminants from liquid solutions based on the boiling point of its components. The reverse osmosis/membrane separation/dialysis technologies are restricted to aqueous solutions and are nonselective. Liquid-liquid extraction has been used to remove phenols, formic acid, acetic acid, and the metals zinc, copper, and nickel (Bridgwater and Mumford, 1977) from aqueous solutions. Appropriate liquid solvents for organochlorines and arsenic have not been identified. Mechanical aeration is generally associated with aerobic biological treatment, which has already been eliminated. The technology suitable for arsenic and organic compound removal at this site is soil wash/solvent extraction. For treating organic contaminated liquids, carbon adsorption may be applicable.

- Soil Wash/Solvent Extraction

Description

Soil wash/solvent extraction may be used for the removal of organic pesticides and arsenic from contaminated soils, using a liquid or pressurized gas medium as the washing solution. It can also be used in conjunction with other processes (incineration) to extract arsenic from the treated solids (ash). The washing solution is then treated for the removal of the contaminants via a conventional separation process. Soil washing can be carried out in either a single stage or two stage process using a contactor vessel or washing unit to separate the contaminant from the soil, and process feed systems. Process by-products would be recovered in downstream equipment designed to dewater the washed soil, to dry the washed soil, and to recover the washing solution. These processes can normally be continuous.

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Secondary Screening

Several soil washing processes are available for the extraction of organic pesticides/herbicides. The most applicable of these processes are organic solvent based processes such as the OH M extraction (Methanol), Soilex (kerosene/water), or Acurex processes. Soil washing using water or water based solvents with chelating agents or surfactants was found to be ineffective at extracting organics. Arsenic, on the other hand, is best removed using water with an oxidizer (such as hydrogen peroxide) as the solvent. As a result, the removal of organic materials and arsenic could not be accomplished simultaneously. The contaminants, after the solvent has been recovered, can then be disposed of off site or treated on site (incineration, etc.). Due to the great variance in the type organic waste and the limited effectiveness at removing such wastes from the soil, it may be difficult to formulate a suitable washing fluid to handle the varying conditions. Implementation of one of these treatments would first require laboratory and/or pilot-scale testing in order to determine the appropriate solvent and contact times in accordance with the specific chemical composition of the contaminated material and the desired treatment results. Based on these facts, it was determined that aqueous soil washing was feasible for extraction of arsenic, but was ruled out as not feasible for organic waste extraction. To remove organic contamination from the soil matrix would require solvent extraction.

9 Carbon Adsorption

Description

The activated carbon process is used primarily for the removal of trace organic hydrocarbons from a liquid stream by adsorbing the hydrocarbon molecules to the carbon. This process can be carried out, using standard waste water treatment equipment, on a continuous basis to treat the contaminated liquid waste.

Initial Screening

This process works well removing trace amounts of organic hydrocarbon. Its effectiveness is reduced when high amounts of suspended solids are present. Implementation of this process would require laboratory and/or pilot-scale testing in order to determine the appropriate feed rates and detention times.

Thermal

The technologies in this category treat the contaminated waste by thermally destroying or detoxifying the contaminants. Three thermal treatment technologies, pyrolysis, wet oxidation, and incineration, were investigated during this screening. All but one was found to be not applicable for the contaminants of concern here. Pyrolysis was found to be a feasible and a proven technology, but the advanced electric reactor (AER, by J. M. Huber, Corp. was found to be the only commercially proven product. However, the J. M. Huber Corp. is no longer marketing the product for the hazardous waste business. Wet oxidation is only applicable to pumpable materials containing low concentrations of halogenated wastes. The applicable technology within this category for treating these wastes is incineration.

o Incineration

Description

Incineration is used primarily for the destruction and/or detoxification of the contaminants. At the CCA site, incineration would destroy these contaminants by combusting them under net oxidizing conditions. Incineration can be carried out using an incinerator and excavation equipment. Equipment to handle ash and scrub potentially harmful vapors and particles from the flue gas would also be needed. Also, a stack, equipment

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to vent the flue gas from the scrubber up the stack, heat recovery/conservation equipment, and a scrubber waste treatment system (for the harmful contaminants collected by the scrubber liquid) would be needed. These processes can be carried out on a continuous basis to treat the contaminated soil as it is excavated.

Secondary Screening

Several incineration processes are available, the most applicable being rotary kiln and infrared. Liquid injection is considered feasible in this application. The fluidized bed process, offered by Waste-Tech Services, is not available for superfund projects. The circulating bed combustion process is still in the design stage and has had limited use in the incineration of hazardous waste. Both the rotary kiln and infrared are field tested and proven mobile technologies which are available in commercial scale. Implementation of either of these incineration processes would require laboratory and/or pilot-scale testing in addition to test burn(s) to determine the appropriate feed rates and detention times needed to efficiently and effectively treat the site specific contaminants to a desired level of cleanup.

2.2.6 Off Site Treatment

Off site treatment is defined, for the purpose of this report, to include the removal of contaminated material to an off site unit where the contaminants are degraded, removed, or immobilized. There are six categories of treatment technologies outlined in Appendix B. They are biological, chemical, physical, immobilization, thermal and land treatment. Immobilization and land treatment were eliminated during primary screening, because their off site application has no advantages over on site application, and would require double handling of the waste and the associated risk of accidental environmental exposure. For the same reason, chemical, physical, and biological treatment technologies are also eliminated from further consideration. There is only one commercially operated thermal treatment facility within reasonable proximity (within Texas) of the CCA site, the Rollins Environmental Services Inc. incinerator in Deer Park.

Thermal

The technologies in this category treat the contaminated waste by thermally destroying or detoxifying the contaminants. Of the three technologies possible, only incineration is available commercially within reasonable proximity of the CCA site. All others were eliminated from further investigations.

- Incineration

Description

Incineration is used for thermal destruction and/or detoxification of the contaminants by combusting them under net oxidizing conditions. Off site incineration also includes on site removal technology.

Secondary Screening

Only the rotary kiln process at the Rollins facility is commercially available within reasonable proximity of the CCA site. Implementation of this process would require laboratory and/or pilot-scale testing in addition to test burn(s).

2.2.9 In Situ Treatment

In situ treatment is defined, for the purpose of this report, as the degradation, removal, or immobilization of contamination without removal of the contaminated material from its present location. There are five categories of in situ treatment technologies retained in Table 2.1, but only one was found that might be applicable at CCA, the in situ treatment of the soils. Immobilization, chemical treatment, and physical treatments have not been shown to be feasible for in situ treatment of these contaminants as it is not possible to get a good, uniform, well distributed treatment.

Biological treatment, in which microorganisms are utilized to degrade the contaminants, is generally ineffective for destroying these wastes as the treatment is not performed in a controlled environment. Several processes are being developed which show potential. However, none of these processes have been developed past the laboratory test stage. Therefore, biological treatment has been ruled out.

Therefore, the only category of technology considered in this screening process is thermal. 1001357

Thermal

The technologies in this category treat the contaminated waste by thermally destroying or detoxifying the contaminants. Of the processes available, only vitrification is developed to a point that it could be made available within the foreseeable future.

In-situ radio frequency (RF) heating is accomplished by inserting tubular electrodes into bore holes, or by laying horizontal electrodes over the surface of the soil, and then energizing the electrodes with an RF power source. The electrode pattern is selected based on the depth of penetration and temperature required. The operating frequency selection is based on the electromagnetic characteristics of the soil. The treated area must be enclosed by a vapor/gas collection system. RF heating, however, is still in the laboratory stage, and may not achieve the necessary temperatures for destruction of the CCA site organic contaminants. Therefore, RF heating is eliminated from further consideration.

o Vitrification

Description

The in situ vitrification process utilizes electrical current passed between electrodes placed in the ground to convert soil and other materials to stable glass. Vitrification can be carried out using a system of electrodes, a gas collection/treatment system and support electrical/sampling/control systems. The in situ vitrification process is a batch process used to treat blocks of contaminated soil, one at a time.

Initial Screening

In situ vitrification has been successfully demonstrated in laboratory and bench testing. In addition, it has been demonstrated in pilot testing. It has not been demonstrated commercially to date. Implementation of this process would require laboratory and/or pilot scale testing in order to determine the appropriate design parameters in accordance with the specific chemical composition of the contaminated soils and desired treatment results. The in situ vitrification process was determined to be feasible given the existing information available and is retained for further consideration.

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2.2.10 Institutional Controls

Institutional controls are either local or state regulations that can be promulgated and enforced to protect the public health in the vicinity of a hazardous waste site before, during, or after remediation. In light of the situation at the CCA Site, temporary or permanent relocation of the surrounding residents is not warranted. To date, only land use restrictions have been implemented to protect the community from access to the site.

Land Use Restrictions

The site is currently fenced and locked. The fencing needs to be repaired. Additional restrictions could widen the margin of safety. Such additional restrictions might include total runway closure or tighter control on access gate keys. To address public health concerns, land use restrictions are retained for further consideration.

Water Use Restrictions

Based on sampling results and an assessment of health effects, there is no risk to human health or the environment associated with ingestion and dermal contact of public drinking well water or off site streams. Imposing water use restrictions would widen the margin of safety; however, there is little basis for imposing water use restrictions. In order to properly address public health concerns, water use restrictions are retained for further consideration.

2.2.11 Conclusions

The technologies which survived the secondary screening process have been listed on Table 2-3, and are arranged in the table by response action categories, as they were in Table 2-1.

2.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES AND TERTIARY SCREENING

The technologies screened in Section 2.3 above provide the basis for the development of remedial action alternatives. In this section, the technologies are grouped into preliminary remedial alternatives which cover a range of remediation from no action to complete treatment of all contamination above the EPA limits (Section 2.3.3.1). The technologies comprising each preliminary remedial alternative are described, the public health and environmental considerations are discussed, and preliminary cost estimates are provided. Following the description of the alternatives, the

TABLE 2-3

REMEDIAL TECHNOLOGY SELECTED BY SECONDARY SCREENING
FOR CRYSTAL CITY AIRPORT SITE

1. No Action
    Monitoring
        Public drinking water
        Surface streams

2. Containment
    Capping

3. On Site disposal
    Contaminated Liquids
        Temporary Storage
        Reuse/Recycle
    Contaminated Solids
        Landfill
        Temporary Storage (Waste Pile)
    Treated Liquids
        Reuse/Recycle (Water Supply, Irrigation)
        Temporary Storage
    Treated Solids
        Land Application or Backfill
        Landfill
        Reuse/Recycle (Construction Material)
        Temporary Storage

4. Off Site Disposal
    Contaminated Liquids
        Deep Well Injection
    Contaminated Solids
        Landfill
    Treated Liquids
        Discharge to Municipal or Industrial Treatment Facility
        Discharge to Water Body
        Injection
        Reuse/Recycle (Water Supply, Irrigation)
    Treated Solids
        Land Application or Backfill
        Landfill
        Reuse/Recycle (Construction Material)
        Temporary Storage

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TABLE 2-3 (Continued)

REMEDIAL TECHNOLOGY SELECTED BY SECONDARY SCREENING
FOR CRYSTAL CITY AIRPORT SITE

5. On Site Removal
   - Soil
   - Drums
   - Liquid Wastes
   - Contaminated Structures

6. Off Site Removal
   - Soil

7. On Site Treatment
   - Chemical
     - Precipitation
     - Chemical oxidation
       - a. hydrogen peroxide
       - b. ozonation
       - c. permanganate
       - d. chlorination
   - Immobilization
     - Stabilization
     - Solidification
     - Fixation
   - Physical
     - Soil Washing/Solvent Extractio
     - Activated carbon adsorption
   - Thermal
     - Incineration

8. Off Site Treatment
   - Thermal
     - Incineration

9. In Situ Treatment
   - Physical
     - Solvent flushing
   - Thermal
     - Vitrification

10. Institutional
    - Land Use Restrictions
    - Water Use Restrictions

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tertiary screening is conducted. The purpose of the screening step is to identify those alternatives of sufficient merit to undergo detailed evaluation. This is achieved by eliminating preliminary remedial alternatives that have significant adverse environmental or public health impacts, or that are an order of magnitude higher in cost than other alternatives providing similar environmental and public health benefits. Those alternatives not eliminated are carried forward as final candidate alternatives to be described in detail in Section 4.0.

2.3.1 Development of Preliminary Remedial Alternatives

All of the remedial alternatives developed for the CCA site must address some or all of the remedial objectives established in Section 1.3. Prior to assembling the preliminary remedial alternatives, pertinent regulations and cleanup levels have been identified which determine the completeness of remediation. Then, preliminary remedial alternatives are developed on the basis of operation and performance compatibility and acceptable engineering practices that attain, to varying degrees, the remediation requirements and cleanup levels.

100136 2

2.3.1.1 Development of Remedial Response Criteria

In this section, pertinent regulations and the cleanup levels are presented.

The goal to protect human health and the environment, and Section 121 of CERCLA, as amended by SARA in 1986, require that applicable or relevant and appropriate regulatory standards (ARAR's) be met. Federal and State of Texas requirements, advisories, and guidances are to be considered when planning and performing hazardous waste site remediation. A detailed listing of these requirements and considerations is presented in Appendix C. "Applicable" requirements are those Federal and State requirements that would be directly applicable to the response action. "Relevant and Appropriate" requirements are those Federal and State requirements which do not directly apply to CERCLA sites, but are sufficiently similar that their application is appropriate. For the CCA Site, the pertinent remedial requirements are presented below:

<u>Federal Laws and Regulations</u>

- Resource Conservation and Recovery Act (RCRA) (42 USC 6901), Subtitle C:
  - containers (40 CFR 264.175)
  - landfills(40 CFR 264.300 - 264.339 and 265.300 - 265.316)
  - incinerators (40 CFR 264.340 - 264.999 and 265.340 - 265.369)

- Safe Drinking Water Act (SDWA) (42 USC 300):
  - Drinking Water Standards (40 CFR 141), including enforceable maximum contaminant levels (MCLs).

Contaminant	MCL (mg/l)
endrin	0.0002
lindane	0.004
methoxychlor	0.1
toxaphene	0.005
chloro-phenoxys 2,4-D	0.1
-silvex	0.01
total trihalomethanes	0.10
arsenic	0.05

- Clean Water Act (CWA) (33 USC 1251):
  - National Pollutant Discharge Elimination System (NPDES) (40 CFR 122)

- Clean Air Act (CAA) (72 USC 7401):
  - National Emission Standards for Hazardous Air Pollutants (NESHAPS)

- Water Quality Criteria (WQC)
  - Human Health Standards (EPA-440/5-080)

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Contaminant	Criteria (mg/l)
toxaphene	0.71
DDT	0.024
endrin	0.001
arsenic	2.2
chlordane	0.46
chloroform	0.00019
dieldrin	0.071
heptachlor	0.28

Texas State Laws and Regulations

- Water Quality Act for waters of the State of Texas.
- National Pollutant Discharge Elimination System Permit Program (delegated to the State of Texas). Applicable if treated water is discharged through an outfall into State surface waters.
- Underground Injection Control Program. Applicable if treated water is reinjected into the ground for contaminant migration control.
- Texas Solid Waste Disposal Act. Applicable to potential disposal of treated waste on or off site within the State of Texas.
- Texas Clean Air Act. Applicable for discharging pollutants into the atmosphere from a new source.

2.3.1.2 Combination of Applicable Technologies Into Preliminary Remedial Alternatives

In this section, the applicable remedial technologies listed and screened in Section 2.3 are combined into preliminary alternatives. In developing the alternatives, it first must be recognized that the technologies are not, for the most part, utilized independently. Rather, several complementary technologies must be assembled to provide a complete treatment system. For example, incineration treats the contaminated soil, but contains no provision for managing the scrubber waste water. Therefore, scrubber waste water treatment and disposal must accompany incineration to form a complete operation. Also, a complete operation may address only one aspect of the contamination or one remedial objective. Therefore, other technologies are required to form a comprehensive remedial alternative.

The process implemented by EPA for formulating alternatives entailes prioritization of objectives, recognizing that different levels of remediation are associated with different degrees of cost and benefit. Five categories of alternatives were established as part of the NCP, prior to the Superfund Amendments and Reauthorization Act of 1986 (SARA), and constitute the contract requirements with the TWC. They are presented below:

1) No Action.

2) Alternatives in which applicable or relevant public health and environmental standards are not attained, but the major human and environmental health concerns are addressed.

3) Alternatives in which all applicable or relevant public health and environmental standards are attained.

4) Alternatives in which all applicable or relevant public health and environmental standards are exceeded.

5) Alternatives in which the contaminated materials are treated or disposed, as appropriate, in an off site hazardous waste facility approved by the U.S. Environmental Protection Agency.

SARA places new requirements on the RI/FS process. The interim guidance memorandum, EPA 9355.0-19, dated 12/24/86, calls for categories of alternatives as presented below.

1) No Action.

2) Containment option involving little or no treatment.

3) Treatment alternatives, including innovative technologies.

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In order to satisfy the NCP, SARA and the TWC Contract, the following categories of alternatives will be used:

1) No Action.

2) On site containment alternative which does not attain applicable or relevant public health or environmental health standards, but will reduce the likelihood of present or future threat from the hazardous substances. This alternative will be called Containment Without Treatment. The ARAR's that will not be met include RCRA and CERCLA as amended by SARA.

3) On site treatment alternative which attains applicable and relevant public health or environmental standards. This will be called Treatment Technology.

4) On site treatment alternative which exceeds applicable relevant public health or environmental standards. This will be called Best Demonstrated Available Technology and may be considered a walk away alternative.

5) Off site treatment or disposal.

It is stipulated in the existing NCP, which is currently being revised, that remedial alternatives representing each of these categories be developed and evaluated unless such alternatives are infeasible.

To provide the maximum flexibility in developing and evaluating remedial alternatives, wastes at the Crystal City Airport Site are divided into four categories:

1) Contaminated soil
2) Contaminated liquids
3) Drums of waste
4) Contaminated structures/buildings

The conditions of the above waste categories and their distribution throughout the site are sufficiently different for each category that a single, all-encompassing remedial action may not be applicable.

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Specif[illegible], contaminated soils and other solids are not amenable to treatment technologies for aqueous solutions, and, similarly, contaminated liquids are not well suited to typical soil treatment technologies. Therefore, each remedial alternative is a combination of technologies for each category.

The list of preliminary remedial alternatives is presented in Table 2-4. The list encompasses the range of alternatives required in the NCP, SARA, and the TWC Contract, with the understanding that some alternatives may be implemented to virtually any degree. Multiple combinations of the listed alternatives are possible. The format used facilitates the identification of the most viable alternatives. The screening of area-specific alternativ[illegible] not significantly influenced by the way in which they are ultimately combined. That is, if a particular criteria excludes an alternative, that same criteria would exclude that alternative regardless of what other alternatives were coupled with it. Thus, the format used maximizes the flexibility in assembling and evaluating multiple alternatives.

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2.3.2 Description and Evaluation of Preliminary Alternatives

In the following section, descriptions of the preliminary alternatives listed in Table 2-4 are given in sufficient detail to perform the initial health and cost screening. Since the technologies are described in Section 2.3, their applicability is only briefly mentioned here. In accordance with NCP specifications, the alternatives listed in Table 2-4 are classified as source control or management of migration measures, or as both. Next, the potential human health and environmental implications of each alternative are discussed. These are evaluated according to the remedial objectives identified in Section 1.5. Last, a description of the major cost elements and rough

TABLE 2-4

PRELIMINARY REMEDIAL ALTERNATIVE LIST

CRYSTAL CITY AIRPORT SITE

ALT. NO.	TECHNOLOGY: SOILS	DRUMS	LIQUIDS	BUILDINGS	OTHER	REMEDIATION CATEGORY: NO ACTION	CONTAINMENT WITHOUT TREATMENT	ON SITE DISPOSAL	ON SITE TREATMENT	OFF SITE TREATMENT/ DISPOSAL
1	None	None	None	None	Land use restrict, monitor	X				
2	Cap	Cap	Off site inject	Decontaminate/ Demolish On site landfill (w/o liner)	Land use restrict, monitor		X	X		X
3	On site RCRA landfill	On site RCRA landfill	Off site inject	Decon/Demol On site RCRA landfill	Land use restrict, monitor		X	X		X
4	On site immobil w/landfill	On site immobil w/landfill	On site immobil w/landfill	Decon/Demol On site immobil w/landfill	Land use restrict, monitor				X	
5	On site immobil w/landfill	On site immobil w/landfill	Off site inject	Decon/Demol Off site landfill	Land use restrict, monitor				X	X
6	On site immobil w/landfill	On site immobil w/off site landfill	Off site inject	Decon/Demol Off site inciner.	Land use restrict, monitor				X	X
7	In situ vitrif.	Off site landfill	Off site inject	Decon/Demol Off site landfill	Land use restrict, monitor				X	X
8	In situ vitrif.	Off site landfill	Off site inject.	Decon/Demol Off site inciner.	Land use restrict, monitor				X	X
9	In situ vitrif.	Off site inciner.	Off site inject.	Decon/Demol Off site inciner.	Land use restrict, monitor				X	X
10	In situ vitrif.	Off site inciner.	Off site inject.	Decon/Demol Off site landfill	Land use restrict, monitor				X	X
11	On site inciner. w/ash solid., land applic., and revegetate	On site inciner.	On site inciner., [illegible], chem. precip., carbon adsorp. and discharge to water body	Decon/Demol On site inciner.	Land use restrict				X	X

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TABLE 2-4 (Continued)

PRELIMINARY REMEDIAL ALTERNATIVE LIST

CRYSTAL CITY AIRPORT SITE

ALT. NO.	TECHNOLOGY: SOILS	TECHNOLOGY: DRUMS	TECHNOLOGY: LIQUIDS	TECHNOLOGY: BUILDINGS	TECHNOLOGY: OTHER	REMEDIATION CATEGORY: NO ACTION	REMEDIATION CATEGORY: CONTAINMENT WITHOUT TREATMENT	REMEDIATION CATEGORY: ONSITE DISPOSAL	REMEDIATION CATEGORY: ONSITE TREATMENT	REMEDIATION CATEGORY: OFFSITE TREATMENT/ DISPOSAL
12	On site inciner. w/ash wash, land app., &c., and scrubber	On site inciner.	On site inciner., recycle/reuse, chem. precip., and well inject	Decon/Demol Off site landfill	Land use restrict				X	X
13	Off site inciner.	Off site inciner.	Off site inject.	Decon/Demol Off site inciner.	Land use restrict					X
14	Off site inciner.	Off site inciner.	Off site inject.	Decon/Demol Off site landfill	Land use restrict					X
15	Off site inciner.	Off site landfill	Off site inject.	Decon/Demol Off site inciner.	Land use restrict					X
16	Off site inciner.	Off site landfill	Off site inject.	Decon/Demol Off site landfill	Land use restrict					X
17	Off site landfill	Off site landfill	Off site inject.	Decon/Demol Off site landfill	Land use restrict					X
18	Off site landfill	Off site landfill	Off site inject.	Decon/Demol Off site inciner.	Land use restrict					X
19	Off site landfill	Off site inciner.	Off site inject.	Decon/Demol Off site landfill	Land use restrict					X
20	Off site landfill	Off site inciner.	Off site inject.	Decon/Demol Off site inciner.	Land use restrict					X
21	On site Flushing	On site Flushing	Off site Incineration	Decon/Demol On site flushing	Land use restrict				X	X
22	On site consolidation with capping	Cap	Off site inject.	Decon/Demol On site consolidation with capping	Land use restrict., monitor		X	X		

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estimates of present worth are provided with an accuracy of -50 percent to +100 percent. A 4 percent discount factor for a 30-year time period is used for recurring operation and maintenance costs. This 4 percent factor represents the interest rate difference between inflation and the cost of money. Every alternative includes land use restrictions in that installation and maintenance of a fence is assumed necessary. Less easily quantified costs, such as decreased property values, and lower cost items are considered in the detailed evaluations in Section 4.0.

001370

Alternative 1 - No Action

- **Description**

  In this alternative, no new or additional remedial activities will be conducted. Limited access to the site will be continued. The public drinking water supply and streams will be monitored periodically.

- **Environmental and Public Health Implications**

  With no additional remedial action, contamination is untreated and migration continues indefinitely through the surface water runoff pathway. Drainage patterns in the NW and SE corner become contaminated. In addition, waters along the Espantosa Slough and northern airport ditch could potentially become contaminated. If contaminated water is chronically ingested, it could cause adverse health impacts. Thus, the no action alternative may result in adverse human health impacts and added contaminant releases to off site soil and potentially to surface waters/sediments. None of the remedial objectives are achieved.

- **Costs**

  Costs include installation and repair of the Crystal City Airport fencing and ongoing monitoring of the public drinking water and streams.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$142,619	$22,000	$523,043

0001371

Alternative 2 - Containment Without Treatment - Capping

- **Description**

  In this alternative, the contaminated soil and buried drums will be capped in place (left undisturbed) with a non-RCRA asphalt pavement cap. All contaminated liquids generated (decontamination wastewater and collected rainfall) will be temporarily stored on site and will then be disposed of off site using deep well injection at an approved commercial facility. The buildings will be decontaminated and left standing, whe e possible, or demolished. Reclaimable construction materials will be decontaminated for reuse. Debris which can not be reused will be buried on site in an unlined cell and capped. Limited access to the site will be continued. In addition, public drinking water supply and surface streams will be monitored periodically.

- **Environmental and Public Health Implications**

  With this remedial action, soil and drum contamination on site is not reduced and no contaminants are detoxified, but the migration is reduced significantly. As long as the cap is maintained and not disturbed, limited access to the site would provide good human health protection. This alternative meets all remedial objectives except the long term soils objective.

- **Costs**

  The following dollar figures for Alternative 2 include the costs for Alternative 1, the materials and installation of the caps, excavation of the building rubble landfill, demolition and decontamination of buildings, and liquid waste collection, temporary storage and disposal costs (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$1,833,024	$29,871	$2,349,330

0240V

1001372

Alternative 3 - Containment Without Treatment - Landfill

- Description

  In this alternative, the contaminated soil, drums and unreclaimable building rubble are placed in an on site, double-lined landfill with a compatibly engineered cap. To prevent fugitive dust during excavation, dust suppression measures will be employed. All contaminated liquids generated (decontamination wastes and collected rainfall) will be collected, temporarily stored on site, and disposed of off site using deep well injection at an approved commercial facility. Limited access to the site will be continued. The public drinking water supply and surface streams will be monitored periodically.

- Environmental and Public Health Implications

  With this remedial action, soil and drum contamination on site is not reduced and no contaminants are detoxified. The migration of contaminants is reduced significantly. As long as the landfill is maintained and not disturbed, limited access to the site should provide good human health protection. This alternative meets all remedial objectives except the long term soils objective.

- Costs

  Costs include the materials and installation of a lined, RCRA landfill with cap, demolition of the buildings, fencing around the landfill, cap maintenance and ongoing monitoring of the public drinking water supply and streams. In addition, it includes liquid waste collection, temporary storage and disposal costs (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$1,282,923	$23,009	$1,680,604

001373

0240V

Alternative 4 - Treatment Technology - Total Immobilization

- **Description**

  In this alternative, the contaminated soil, buried drums, liquid waste and non-reclaimable building rubble will be blended and immobilized using a stabilization, fixation or solidification process. To prevent fugitive dust during excavation, dust suppression measures will be employed. All contaminated liquids (decontamination wastes and collected rainfall) will be collected, temporarily stored on site, and recycled/reused prior to immobilization. The immobilized waste will be placed in an on site double-lined landfill with an appropriate cap. Limited access to the site will be continued. The public drinking water supply and surface streams will be monitored periodically.

- **Environmental and Public Health Implications**

  In this remedial alternative the contaminated materials are treated using immobilization technology. The toxicity of the wastes are not reduced but migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include the materials and installation of a double-lined (RCRA) landfill with cap, decontamination and demolition of the buildings, grinding up building rubble and drums, fencing around the site, landfill maintenance, and ongoing monitoring of the public drinking water supply and streams. In addition, it includes liquid collection and temporary storage costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$3,309,567	$23,339	$3,713,143

001374

0240V

Alternative 5 - Treatment Technology - Partial Immobilization - A

- Description

  This alternative is similar to Alternative 4 except the contaminated liquids will be disposed of off site using deep well injection and non-reclaimable building rubble will be removed to an off site commercial landfill.

- Environmental and Public Health Implications

  The contaminated materials are either treated using immobilization technology or are disposed of off site. Although the toxicity of the wastes is not reduced, migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include the materials and installation of a double-lined (RCRA) landfill with cap, grinding up of the drums, site fencing, landfill maintenance, and ongoing monitoring of the public drinking water supply and streams. In addition, it includes liquid collection and temporary storage, and disposal costs (including transportation costs and disposal fees). It also includes the cost to demolish the buildings and dispose of them off site (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$3,333,123	$23,281	$3,737,698

0260V

1001375

Alternative 6 - Treatment Technology - Partial Immobilization - B

- Description

  This alternative is similar to Alternative 4 except the liquid wastes will be disposed of off site using well injection and the contaminated building rubble will be disposed of at an off site, licensed commercial incinerator.

- Environmental and Public Health Implications

  The contaminated materials are either treated using immobilization technology or are disposed of off site. Although the toxicity of the wastes is not reduced, migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include the materials and installation of a double-lined (RCRA) landfill with cap, grinding up of the drums, site fencing, landfill maintenance, and ongoing monitoring of the public drinking water supply and streams. In addition, it includes liquids collection and temporary storage, and disposal costs (including transportation costs and disposal fees). It also includes the cost to demolish the buildings and dispose of them off site (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$3,447,795	$33,[illegible]	$3,8[illegible]0,363

0240V

1001376

Alternative 7 - Treatment Technology - In Situ Vitrification - A

- Description

In this alternative, the contaminated soil will be treated in place using the in situ vitrification process. The drummed wastes and non-reclaimable building rubble will be disposed of at an off site RCRA landfill. All contaminated liquids generated (decontamination wastes and rainfall) will be temporarily stored on site and disposed of off site using deep well injection. Limited access to the site will be continued. The public drinking water supply and streams will be monitored periodically.

- Environmental and Public Health Implications

The contaminated soils are treated and all other materials are disposed of off site. The toxicity of the soil is reduced, and migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

Costs include the total cost for a service company with vitrification equipment to mobilize on site and treat all the contaminated soil, fencing around the site and ongoing monitoring of the public drinking water and streams. It includes the costs of liquid collection, temporary storage, and disposal fees. It also includes the costs to demolish the buildings, dig up the drums, and dispose of these materials off site (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$6,204,650	$22,000	$6,563,000

0240Y

)001377

o Description

In this alternative, the contaminated soil will be treated in place using the in situ vitrification process. The drummed wastes will be disposed of at an off site commercial landfill and the buildings will be disposed at an off site commercial incinerator. All contaminated liquids generated (decontamination wastes and rainfall) will be collected, temporarily stored on site and disposed of off site using deep well injection. Limited access to the site will be continued. The public drinking water supply and streams will be monitored periodically.

o Environmental and Public Health Implications

The contaminated soils are treated and all other materials are disposed of off site. The toxicity of the soil and migration are significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

o Costs

Costs include the total cost for a service company with vitrification equipment to mobilize on site and treat all the contaminated soil, fencing around the site and ongoing monitoring of the public drinking water and streams. It includes the costs of liquid collection, temporary storage, and disposal fees. It also includes the costs to demolish the buildings, dig up the drums, and dispose of these materials off site (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$6,357,327	$22,000	$5,737,737

0260V

1001378

o Description

In this alternative, the contaminated soil will be treated in place using the in situ vitrification process. The drummed wastes and buildings will be disposed of at an off site RCRA incinerator. All contaminated liquids generated (decontamination wastes and rainfall) will be collected, temporarily stored on site and disposed of off site using deep well injection. Limited access to the site will be continued. The public drinking water supply and surface streams will be monitored periodically.

o Environmental and Public Health Implications

The contaminated soils are treated and all other materials are disposed of off site. The toxicity of the soil and migration are reduced significantly, providing good public health protection. This alternative meets all remedial objectives.

o Costs

Costs include the total cost for a service company with vitrification equipment to mobilize on site and treat all the contaminated soil, fencing around the site, and ongoing monitoring of the public drinking water supply and streams. It includes the costs of liquid collection, temporary storage, and disposal fees. It also includes the costs to demolish the buildings, dig up the drums, and dispose of these materials off site (including transportation costs and disposal fees

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$6,432,166	$22,000	$6,6[illegible]

Alternative 10 - Treatment Technology - In Situ Vitrification - D

- **Description**

  In this alternative, the contaminated soil will be treated in place using the in situ vitrification process. The buildings will be disposed of at an off site RCRA landfill and drummed wastes will be disposed of at an off site incinerator. All contaminated liquids generated (decon wastes and rainfall) will be collected, temporarily stored on site, and disposed of off site using deep well injection. Limited access to the site will be continued. The public drinking water supply and surface streams shall be monitored periodically.

- **Environmental and Public Health Implications**

  The contaminated soils are treated and all other materials are disposed of off site. The toxicity of the soil and the migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include the total cost for a service company with vitrification equipment to mobilize on site and treat all the contaminated soil, fencing around the site, and ongoing monitoring of the public drinking water supply and streams. It includes the costs of liquid collection, temporary storage, and disposal fees. It also includes the costs to demolish the buildings, dig up the drums, and dispose of these materials off site (including transporation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$6,279,493	$22,000	$6,659,920

Alternative 11 - Treatment Technology - Total Incineration

o Description

In this alternative, contaminated materials will be reduced to the proper size and incinerated. To prevent fugitive dust during excavation, dust suppression measures will be employed. The flue gas will be scrubbed of all potentially harmful vapors. The ash will be washed of all potentially harmful arsenic, dewatered and disposed of on site by land application. The scrubber and ash wash liquids, decontamination wastes and rainfall will be collected, treated by physical/chemical precipitation, temporarily stored, and recycled/reused. Blowdown and excess water (if any) will be treated by activated carbon adsorption and discharged to surface waters. The dewatered arsenic precipitate will be drummed and disposed of at an off site landfill. The spent activated carbon will be incinerated on site. Thus, no contamination in excess of cleanup limits will be left on site, and this alternative can be considered a walk away alternative. Limited access to the site is included.

o Environmental and Public Health Implications

All contaminated materials are treated on site. The organic hydrocarbon toxicity is reduced greatly, but the arsenic toxicity remains. The remaining toxic material is removed from all contaminated materials, segregated and disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

o Costs

Costs include the total cost for a service company with incineration/gas scrubbing equipment to mobilize on site, decontaminate and demolish the buildings, grind up all drums and unreclaimable buildings and treat all the contaminated materials. In addition it includes the cost to wash, dewater and land apply the ash. It also includes the cost to precipitate and dewater the arsenic, adsorb the other contaminants, drum and dispose of the arsenic sludge (including transportation costs to a facility 320 miles away and disposal fees), and fencing around the site.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$10,246,438	$22,000	$10,626,863

001382

Alternative 12 - Treatment Technology - Partial Incineration

- **Description**

  In this alternative, contaminated materials (soil, contaminated buildings, liquids and drums) will be reduced to the proper size and incinerated. To prevent fugitive dust during excavation, dust suppression measures will be employed. The flue gas will be scrubbed of all potentially harmful vapors. The ash will be washed of all potentially harmful arsenic, dewatered and disposed of on site by land application. The scrubber and ash wash liquids, decontamination wastes and rainfall will be treated by physical/chemical precipitation, temporarily stored and recycled/reused. Blowdown and excess water (if any) will be disposed of using off site deep well injection. The dewatered arsenic precipitate and spent activated carbon will be drummed and disposed of at an off site landfill. Limited access to the site will be included.

- **Environmental and Public Health Implication**

  All contaminated materials are treated on site or are disposed of off site. Toxicity of organic pesticides is reduced greatly, but arsenic remains. The remaining arsenic material is removed, segregated and disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include the total cost for a service company with incineration/gas scrubbing equipment to mobilize on site, decontaminate and demolish the buildings, grind up all drums and demolished buildings, and treat all the contaminated

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materials. In addition it includes the cost to wash, dewater and land apply the ash. It also includes the cost to precipitate and dewater the arsenic, adsorb the other contaminants, drum and dispose of the arsenic sludge/spent activiated carbon (including transportation costs and disposal fees). It also includes the cost of fencing around the site.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$18,903,081	$22,000	$19,283,505

<u>Alternative 13 - Total Offsite Disposal - A</u>

- Description

  In this alternative the contaminated soils will be excavated, the drums will be removed, the buildings demolished, and all of these materials will be disposed of at an off site commercial incinerator. To prevent fugitive dust during excavation, dust suppression measures will be employed. All contaminated liquids (decontamination wastes and rainfall) will be collected, temporarily stored on site, and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- Environmental and Public Health Implications

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include decontaminating and demolishing of the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$25,317,842	$22,000	$25,698,267

Alternative 14 - Total Off Site Disposal - B

- Description

  In this alternative the soils and drums will be excavated and disposed of at an off site commercial incinerator. To prevent fugitive dust during excavation, dust suppression measures will be employed. The buildings will be decontaminated or demolished. Unreclaimable building rubble will be disposed of at a commercial off site RCRA landfill. All contaminated liquids (decontamination wastes and rainfall) will be temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- Environmental and Public Health Implications

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include decontaminating and demolishing the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs to a landfill 320 miles away and disposal fees). It also includes the liquid collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$25,165,170	$22,000	$25,545,595

Alternative 15 - Total Off Site Disposal - C

- Description

  In this alternative the soils will be dug up, the buildings decontaminated or demolished, and the materials will be disposed of at an off site commercial incinerator. To prevent fugitive dust during excavation, dust suppression measures will be employed. The drums will be dug up and disposed of at an off site commercial landfill. All contaminated liquids (decontamination wastes and rainfall) will be collected, temporarily stored on site, and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- Environmental and Public Health Implications

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include decontaminating and demolishing the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$25,243,000	$22,000	$25,623,428

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Alternative 16 - Total Off Site Disposal - D

o Description

In this alternative the soils will be excavated and disposed of at an approved off site incinerator. To prevent fugitive dust during excavation, dust suppression measures will be employed. In addition, the drums will be removed, the buildings decontaminated or demolished, and the materials will be disposed of at an off site commercial landfill. All contaminated liquids (decontamination wastes and rainfall) will be temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

o Environmental and Public Health Implications

With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

o Costs

Costs include demolishing and decontaminating the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid waste collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$25,090,331	$22,000	$25,470,756

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Alternative 17 - Total Off Site Disposal - E

- **Description**

  In this alternative the soils and drums will be excavated, the buildings decontaminated or demolished, and all materials will be disposed of at an off site commercial landfill. To prevent fugitive dust during excavation, dust suppression measures will be employed. All contaminated liquids (decontamination wastes and rainfall) will be collected, temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- **Environmental and Public Health Implications**

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include decontaminating and demolishing the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid waste collection, temporary storage, and disposal costs (including transportation costs and fees), and site restoration, and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$7,125,935	$22,000	$7,506,379

0001389

0240V

Alternative 18 - Total Off Site Disposal - F

- **Description**

  In this alternative the soils and drums will be excavated and disposed of at an off site commercial landfill. To prevent fugitive dust during excavation, dust suppression measures will be employed. The buildings will be decontaminated or demolished. Unreclaimable building rubble will be disposed of at an off site commercial incinerator. All contaminated liquids (decontamination wastes and rainfall) will be temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- **Environmental and Public Health Implications**

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include decontaminating and demolishing the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid waste collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$7,278,626	$22,000	$7,659,05[illegible]

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Alternative 19 - Total Off Site Disposal - G

- Description

  In this alternative the soils will be excavated, the buildings decontaminated or demolished, and all of these materials will be disposed of at an off site double-lined (RCRA) landfill approximately 320 miles away. To prevent dust during excavation, dust suppression measures will be employed. The drums will be dug up and disposed of at an off site commercial incinerator. All contaminated liquids (decontamination wastes and rainfall) will be collected, temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- Environmental and Public Health Implications

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- Costs

  Costs include demolishing and decontaminating the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid waste collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$7,200,794	$22,000	$7,361,218

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Alternative 20 - Total Off Site Disposal - H

- **Description**

  In this alternative the soils will be excavated and all of the soils will be disposed of at an off site double-lined (RCRA) landfill. To prevent dust during excavation, dust suppression measures will be employed. In addition, the drums will be excavated, the buildings decontaminated and demolished, and all of these materials will be disposed of at an off site commercial incinerator. All contaminated liquids (decontamination wastes and rainfall) will be collected, temporarily stored on site and recycled/reused prior to disposal by off site deep well injection. Limited access to the site will be included.

- **Environmental and Public Health Implications**

  With this alternative, contaminated materials are disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include decontaminating and demolishing the buildings, excavating the soils and drums, and disposing of these materials off site (including transportation costs and disposal fees). It also includes the liquid waste collection, temporary storage, and disposal costs (including transportation costs and fees), and fencing costs.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$7,353,465	$22,000	$7,733,890

Alternative 21 - Soil Flushing - Innovative Technology

- **Description**

  In this alternative, contaminated materials will be reduced to the proper size and passed through the soil flushing treatment units. To prevent fugitive dust during excavation, dust suppression measures will be employed. The materials will be washed of chlorinated hydrocarbons and potentially harmful arsenic, dewatered and disposed of on site by land application. The wash liquids, decontamination wastes and rainfall will be collected, treated by physical/chemical precipitation, temporarily stored, and recycled/reused. Excess water (if any) will be treated by pH readjustment and discharged to surface waters. The dewatered arsenic precipitate will be drummed and disposed of at an off site landfill. The recovered organics will be disposed of at an off site incinerator. Limited access will be included.

- **Environmental and Public Health Implications**

  Contaminated materials are treated on site. The organic hydrocarbon and the arsenic toxicity are reduced greatly. The toxic material is removed from contaminated materials, segregated and disposed of off site. Migration is significantly reduced, thus providing good public health protection. This alternative meets all remedial objectives.

- **Costs**

  Costs include the total cost for a service company with soil flushing equipment to mobilize on site, decontaminate and demolish the buildings, grind up all drums and unreclaimable buildings and treat all the contaminated materials. In addition it includes the cost to dewater and land apply the material. It also includes the cost to precipitate and dewater the arsenic, drum and dispose of the arsenic sludge and the organic residues (including transportation costs and disposal fees) and the costs of fencing.

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$12,065,419	$22,000	$12,445,843

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Alternative 22 - Containment Without Treatment - Consolidation/Capping

- **Description**

  In this alternative, the contaminated soil, drums and unreclaimable building rubble are placed in an on site, consolidation cell with a RCRA cap. To prevent fugitive dust during excavation, dust suppression measures will be employed. All contaminated liquids generated (decontamination wastes and collected rainfall) will be collected, temporarily stored on site, and disposed of off site using deep well injection at an approved commercial facility. Limited access to the site will be continued. The public drinking water supply and surface streams will be monitored periodically.

- **Environmental and Public Health Implications**

  With this remedial action, soil and drum contamination on site is not reduced and no contaminants are detoxified. The migration of contaminants is reduced significantly. As long as the cap is maintained and not disturbed, limited access to the site should provide good human health protection. This alternative meets all remedial objectives except the long term soils objective.

- **Costs**

  Costs include the excavation of a consolidation cell, materials and installation of a RCRA cap, demolition of the buildings, fencing around the landfill, cap maintenance and ongoing monitoring of the public drinking water supply and streams. In addition, it includes liquid waste collection, temporary storage and disposal costs (including transportation costs and disposal fees).

Capital Costs	Annual Operation and Maintenance Costs	Present Worth
$1,148,604	$27,092	$1,468,481

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2.3.3 Tertiary Screening of Preliminary Remedial Alternatives

The preliminary alternatives described and evaluated in Section 2.3.2 are now screened according to environmental and public health considerations and order-of-magnitude cost. The cost factor was used to eliminate those alternatives which provide similar results, but not between treatment versus non-treatment alternatives. Table 2-5 summarizes the preliminary alternatives, listing the attainment of remedial objectives, compliance with regulatory standards, and present worth values. In the following sections, these factors are discussed, and those alternatives which do not pass this tertiary screening are eliminated from further consideration.

2.3.3.1 Environmental and Public Health Screening

The most important consideration in assessing the preliminary alternatives is protection of human health and the environment. Irrespective of cost, any alternative that does not sufficiently eliminate present or future health hazards should be discarded. Based on an assessment of site risks, USEPA established a cleanup limit for the CCA site at 100 mg/kg or parts per million. This limit is for the total concentration of the indicator chemicals toxaphene, DDT, and arsenic. During the Remedial Investigation it was assumed that toxaphene was the indicator chemical of greatest concern at the site; however, during the evaluation of site risks it became apparent that arsenic was also a major component of the site specific risks.

2.3.3.2 Conformance to NCP

As mandated in the NCP, alternatives spanning the range of all five categories must be investigated in the development of the preliminary alternatives. It was noted that the option of off site treatment of all wastes is infeasible due to the fact that treatment as effective could be performed on site without the risks associated with double handling of wastes and without the extra transport costs. The remaining categories are addressed in Table 2-5.

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TABLE 2-5
SUMMARY OF PRELIMINARY ALTERNATIVES BY REMEDIAL OBJECTIVES, NCP CATEGORIES AND PRESENT WORTH
CRYSTAL CITY AIRPORT SITE

PRE-LIMINARY ALTER-NATIVES	REMEDIAL OBJECTIVES: AIR-SHORT TERM	AIR-LONG TERM	SURFACE WATER SHORT TERM	SURFACE WATER LONG TERM	SOILS SHORT TERM	SOILS LONG TERM	NCP REMEDIATION CATEGORY: NO ACTION	CONTAINMENT WITHOUT TREATMENT	ON SITE DISPOSAL	ON SITE TREATMENT	OFF SITE TREATMENT DISPOSAL	PRESENT WORTH ($1000)
1	No	No	No	No	No	No	X					523
2	Yes	Yes	Yes	Yes	Yes	No		X	X		X	2,350
3	Yes	Yes	Yes	Yes	Yes	No		X	X		X	1,680
4	Yes	Yes	Yes	Yes	Yes	Yes				X		3,713
5	Yes	Yes	Yes	Yes	Yes	Yes				X	X	3,738
6	Yes	Yes	Yes	Yes	Yes	Yes				X	X	3,890
7	Yes	Yes	Yes	Yes	Yes	Yes				X	X	6,585
8	Yes	Yes	Yes	Yes	Yes	Yes				X	X	6,738
9	Yes	Yes	Yes	Yes	Yes	Yes				X	X	6,813
10	Yes	Yes	Yes	Yes	Yes	Yes				X	X	6,660
11	Yes	Yes	Yes	Yes	Yes	Yes				X	X	10,627
12	Yes	Yes	Yes	Yes	Yes	Yes				X	X	19,284
13	Yes	Yes	Yes	Yes	Yes	Yes					X	25,698
14	Yes	Yes	Yes	Yes	Yes	Yes					X	25,546
15	Yes	Yes	Yes	Yes	Yes	Yes					X	25,623
16	Yes	Yes	Yes	Yes	Yes	Yes					X	25,623
17	Yes	Yes	Yes	Yes	Yes	Yes					X	7,506
18	Yes	Yes	Yes	Yes	Yes	Yes					X	7,659
19	Yes	Yes	Yes	Yes	Yes	Yes					X	7,581
20	Yes	Yes	Yes	Yes	Yes	Yes					X	7,733
21	Yes	Yes	Yes	Yes	Yes	Yes				X	X	12,446
22	Yes	Yes	Yes	Yes	Yes	No						1,468

The NCP further stipulates that if all alternatives within an NCP category are eliminated in the preliminary health and cost screening, at least one alternative from that category must be carried forward and presented to the deciding party with an explanation for its elimination. In this case, the only category which has been eliminated is no action, which does not provide adequate health protection. Therefore, in accordance with the NCP requirements, the no action alternative has been carried forward. Inclusion of this alternative also provides a baseline for evaluating other alternatives.

2.3.3.3 Cost Screening

The final criterion for screening the preliminary alternatives is cost. Alternatives which provide an equivalent level of health protection as another alternative, yet are an order-of-magnitude more costly, may be eliminated. However, this screening step does not allow for eliminating alternatives which cost the same yet provide different levels of health protection.

The alternatives remaining after the health screening provide different levels of health protection. No action provides no health protection; the other alternatives adequately protect human health. Thus, despite the wide variation in costs, at this stage, no alternatives were eliminated based on costs.

2.3.4 Final Candidate Alternatives

The list of remaining, "final candidate" remedial alternatives is presented in Table 2-6. These alternatives are described in detail in the succeeding section, where the specific treatment and disposal operations are identified. Then, the alternatives are evaluated in Chapter 4.0.

TABLE 2-6
CRYSTAL CITY AIRPORT RI/FS
SELECTED ALTERNATIVES

ALTERNATIVE	KEY FEATURES
1. No Action (Alternative 1)	o No additional remedial measures o Site access restricted o Monitoring to detect contaminant migration
2. Containment without treatment - Capping (Alternative 2)	o Source control - isolation o Site access limited o Monitoring to detect source control failure o Operation and maintenance o Monitoring of surface waters
3. Containment without treatment - On site landfill (Alternative 3)	o Source control - isolation o Site access limited o Monitoring to determine landfill performance o Monitoring of surface waters
4. Containment with treatment - On site landfill with immobilization (Alternative 4)	o Source control - treatment and isolation o Site access limited o Monitoring to determine landfill performance o Operation and maintenance o Monitoring of surface waters
5. On site treatment - total incineration (Alternative 11)	o Source elimination - treatment o Site access limited
6. Off site removal and disposal (Alternative 17)	o Source elimination - removal o Site access limited
7. On site soil flushing (Alternative 21)	o Source elimination - treatment o Site access limited
8. Containment without treatment - Consolidation/capping (Alternative 22)	o Source control - isolation o Site access limited o Monitoring to detect source control failure o Maintenance o Monitoring of surface waters

Alternative 5 and 6 were eliminated because they have no advantage over Alternative 4 and have the disadvantage of requiring off site disposal of liquid wastes and contaminated building rubble. Alternatives 7 through 10 were eliminated because, except for contaminated soils, all wastes are to be disposed off site. Alternative 12 was eliminated because it has no advantage over Alternative 11, and it has the disadvantage of off site disposal of liquid wastes and contaminated buildings. Alternatives 13 through 16 were eliminated because they have no advantage over Alternative 11, and they have the disadvantage of off site incineration of contaminated soils. Alternatives 18, 19, and 20 were eliminated because they have no advantage over Alternative 3, and they have the disadvantage of off site landfill disposal of contaminated soils.

3.0 DESCRIPTIONS OF FINAL CANDIDATE ALTERNATIVES

The purpose of this section is to present a detailed description of the remedial alternatives that were selected during the initial screening presented in Section 2.0. These descriptions provide the basis for Section 4.0 which presents a detailed evaluation of technical, institutional, public health, and environmental considerations as well as costs for each selected alternative.

The description of each remedial alternative includes the following:

- The intent of the remedial alternative, such as management of migration;
- Key features of the alternative, i.e., description of the technologies and associated components making up the alternative;
- Preliminary conceptual design of major facilities, equipment and construction components;
- Performance information on technologies.
- Special engineering, safety, environmental, public health, and institutional considerations that affect the feasibility of each alternative;
- Maps depicting the locations or service boundaries of the alternatives;
- Both short-term and long-term operation, maintenance and monitoring requirements; and
- Aspects of the Crystal City Airport Site contamination that the alternative does not address.

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The descriptions and preliminary designs were developed to a level of detail sufficient to permit the development of cost estimates with an accuracy from -30 percent to +50 percent. However, these detailed descriptions should not be interpreted as final decisions. The conceptual design of the selected alternative(s) will be developed based on public input, current agency policies, and additional knowledge of the site and chosen technologies.

As indicated in Section 2.0, eight alternatives were chosen for the purposes of detailed evaluation. The detailed description of each alternative is preceded by an overview outlining the rationale for including the alternative for final evaluation. Table 2-6 presents a summary of the eight selected alternatives and their key features.

As discussed in Section 1.0, the remediation level of 100 mg/kg of the three indicator contaminants was established on the basis that exposure would be limited to 10 - 15 days per year. Usage other than as specified in Section 1.0 of this report may require a reevaluation of this remediation level. Each of the alternatives, with the exception of the no action alternative, would provide containment and/or treatment of soils in excess of the 100 mg/kg limit. It should be noted, however, that:

1. In order to satisfy the intent of the basis upon which the remediation level was established, it is necessary to impose land use restrictions to each alternative, including walk away alternatives like Alternatives 11, 17 and 21. Therefore, fencing, locked gates and posting of warning signs, would be required for each alternative. Expenses will occur for site management and maintenance of these items.

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2. Contamination below 100 mg/kg would not be eliminated or completely contained by any of the alternatives. With site use limited to 10 to 15 days per year, these levels are not considered a significant health threat, however, migration of low levels of contaminants from the site may continue after remediation.

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3.1 ALTERNATIVE 1 - NO ACTION

The no action alternative, with access to the site restricted by means of fencing, locked gates and posting of warning signs, is selected for evaluation of the conditions at the site without any further cleanup or mitigation measures. Health-based risks, associated with exposure to the existing contamination at the site, will form a baseline against which other alternatives can be compared.

Environmental monitoring would be conducted annually to assess the migration of contaminants into the surrounding environment. Storm water runoff and drainage ditch sediments would be sampled to determine whether migration of contaminants has occurred due to erosion. Public drinking water supply samples would be collected for analysis to ensure that the municipal water supply has not been contaminated.

The no-action alternative does not prevent future migration of contaminants, does not clean up the existing contamination and does not prevent accidental exposure to site contamination resulting from unauthorized or inadvertent use of the site.

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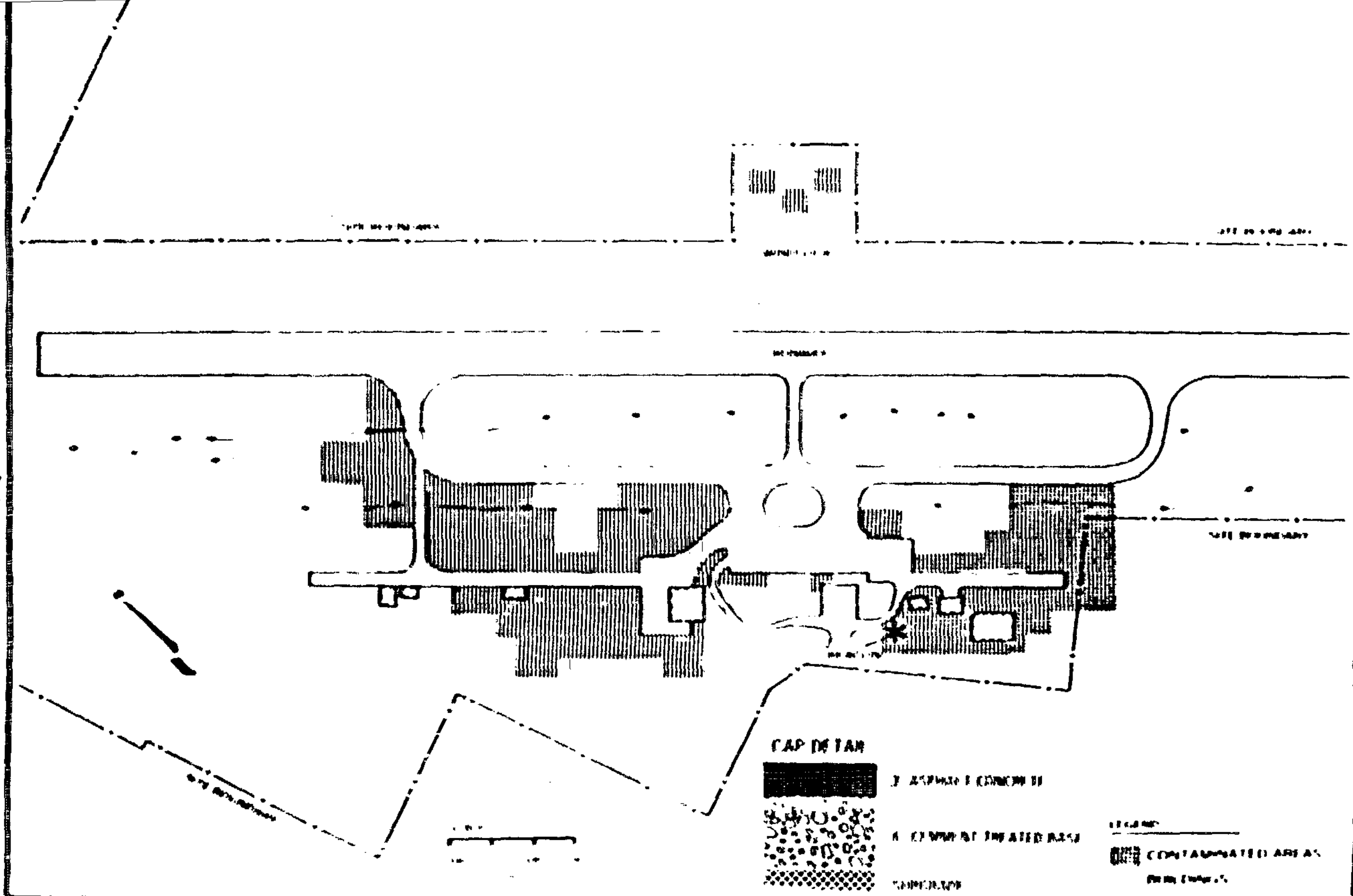
3.2 ALTERNATIVE 2 - CONTAINMENT - CAPPING

The purpose of capping is to isolate the areas of the site containing contaminants in concentrations greater than 100 mg/kg from the environment. This is accomplished by construction of a relatively impermeable barrier between the contaminants and the environment. A cap must be designed to contain contaminants in place and protect against the migration due to erosion by wind and water.

The capping alternative is a relatively simple action. All portions of the site where contamination has been found in excess of cleanup limits would be capped in place (see Figure 3-1). The areas of the site where wastes were buried during the two EPA response actions and during the RI would also be capped. The cap selected is a 3 inch asphalt concrete top coat above a 6 inch cement treated base (see Figure 3-1). This cap is similar to highway pavement. Buildings in contaminated areas will be decontaminated and left standing to the extent possible, or demolished and reclaimed. Any contaminated rubble remaining after building decontamination and demolition would be buried on site in an unlined landfill and capped. Liquids generated by personnel and equipment decontamination would be collected and disposed of at an off site commercial deep well injection facility. Since on site soils would not be excavated or disturbed during cap construction activities it would not be necessary to collect storm water runoff.

Work would proceed first with building decontamination, reclamation and debris removal. The second and major part of the remedial action involves construction of the cap on areas of the site where contamination in excess of cleanup limits has been identified. The third part of the action would be placement of a cap over the three landfill areas located near the windsock, on the eastern side of the runway. On completion of the cap construction activities, site restoration activities would be conducted including grading and vegetation of the cap materials.



AREAS TO BE CAPPED
CRYSTAL CITY AIRPORT

FIGURE 3-1

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Contaminated liquids and solids generated from site activities would be removed for proper disposal. Fencing improvements, repairs, and warning sign installation would be completed prior to demobilization.

Operation and maintenance requirements for a cap include restrictions on construction activities in the capped areas, limitations on site access, periodic inspections, and landscape and cap repair actions (grass cutting, erosion gully repair, etc.) This alternative has the largest area (about 8 acres) requiring cap maintenance of any of the alternatives.

The site does not have a near surface aquifer, therefore contamination of groundwater resources is not a pathway of concern. Capping contaminants in place results in an excellent barrier to all pathways of migration of the areas of the site containing contaminants in concentrations greater than 100 mg/kg but requires that the integrity of the cap be continuously maintained. The contained contaminants are not detoxified or reduced in quantity, but can be considered sealed in place because of the low permeability of the in situ soils and the absence of near-surface ground water. Without a driving force, the contained contaminants will tend to remain bound in the soil matrix. Because the soils are highly impermeable and there would be no groundwater, downward migration is not likely.

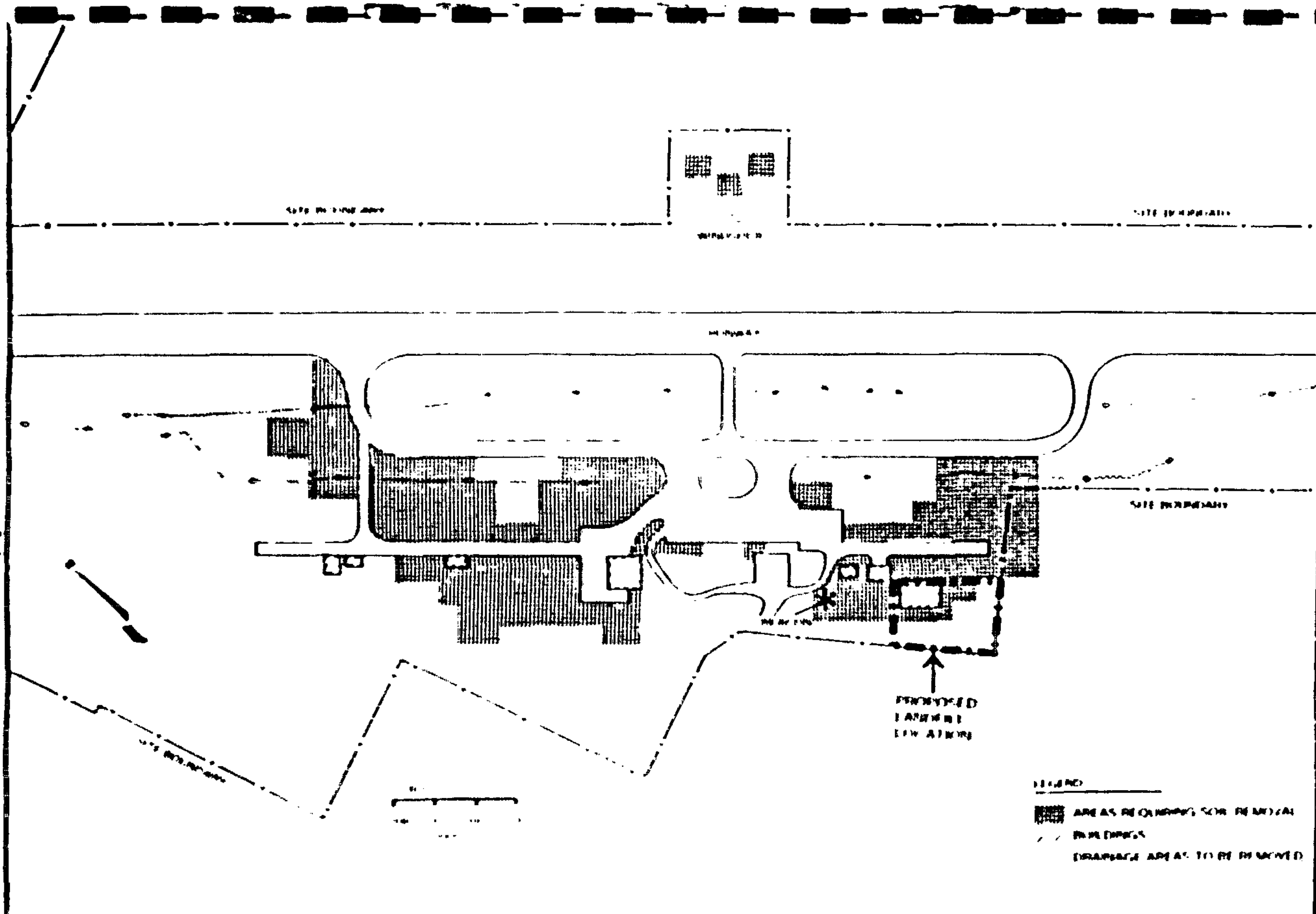
As discussed in the opening remarks of Section 3.0, this alternative will require fencing, locked gates and posting of warning signs. Because contaminated materials in excess of the cleanup limits will still be on site, monitoring of surface water and public drinking water supplies will also be required.

3.3 ALTERNATIVE 3 - CONTAINMENT WITHOUT TREATMENT - LANDFILL

Alternative 3 consists of the removal of soils contaminated in excess of 100 ppm of the three indicator contaminants (Toxaphene, DDT and Arsenic) and placement of the excavated soils in an on site landfill. The areas of the site to be removed are indicated on Figure 3-2. The areas of the site where wastes were buried during the EPA response actions and during the RI also would be excavated and placed in the landfill. Buildings in contaminated areas will be decontaminated and left standing to the extent possible, or demolished and the building materials reclaimed. All contaminated rubble remaining, after decontamination and reclamation, would be removed to the on site landfill. Because of the low permeability of the in situ soils, and the fact that ground water will always be well below the landfill, this site is an excellent location for such a facility.

During excavation and removal actions, decontamination wash water and rainfall runoff from contaminated areas and from the landfill would be collected. Re-use/recycle of this water would be practiced to the extent possible, or it would be disposed of by deep well injection at a commercial disposal facility. Construction activities would be planned so that areas which have undergone removal will not be re-contaminated by cleanup actions in other areas, and so that collection of rainfall runoff will be limited to the area immediately undergoing removal. This would help to minimize the collection, storage and handling of storm water which could become contaminated by contact with contaminated areas of the site.

The landfill would be designed in accordance with applicable RCRA requirements, including a double liner, leachate detection and collection systems, and a cap to prevent rainfall percolation and erosion. The double liner will include a primary synthetic liner and a secondary clay liner. The leachate detection and collection systems will include a 12 inch drainage layer with a hydraulic conductivity not less than 0.001



AREAS REQUIRING SOIL REMOVAL
CRYSTAL CITY AIRPORT

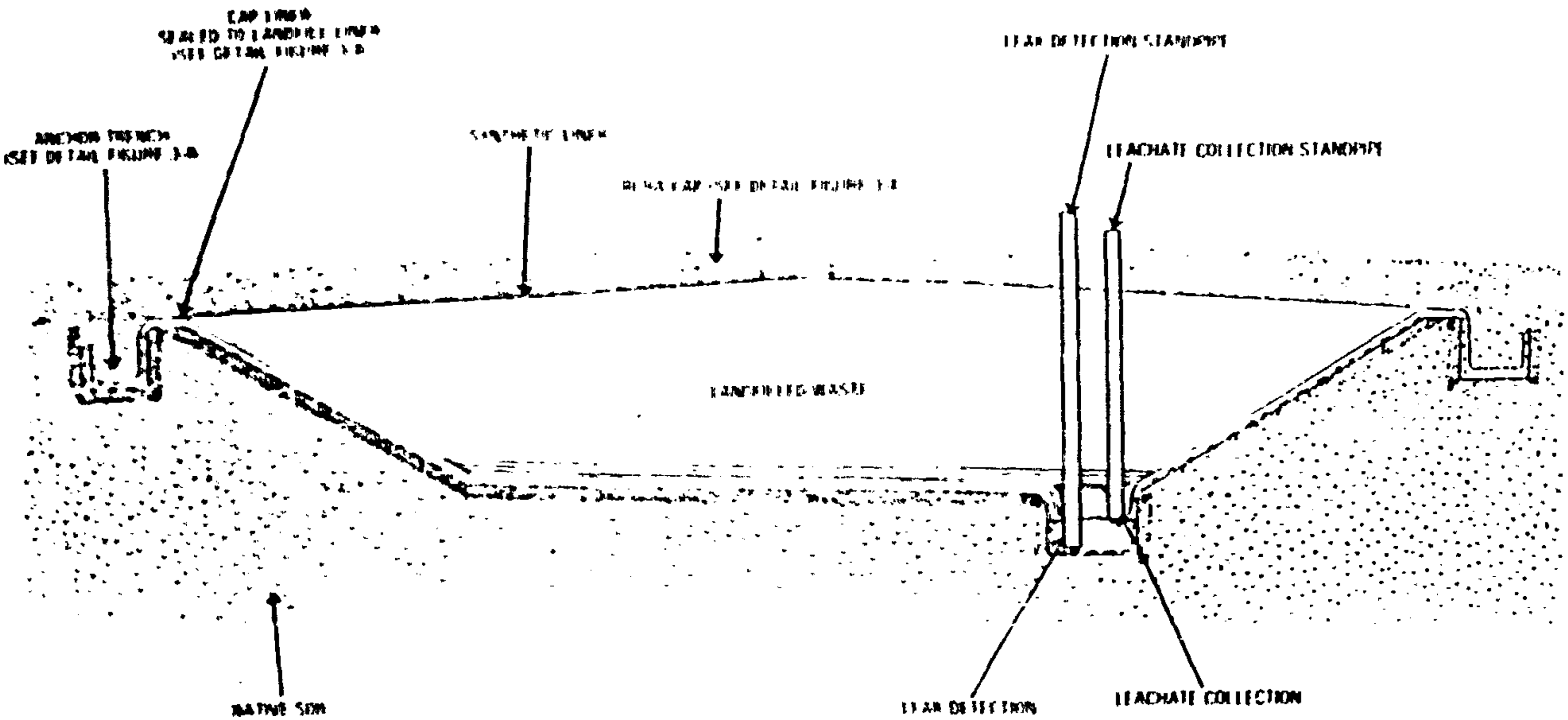
001410

FIGURE 3-2

centimeters per second and a minimum slope of 2 per cent, a graded granular or synthetic fabric filter above the drainage layer to prevent clogging, and a drainage tile system of appropriate size and spacing with a sump pump to remove leachate. The cap will include a vegetated top cover at least 24 inches thick, a middle drainage layer at least 12 inches thick, and a low permeability bottom layer of two components. The upper component will consist of a synthetic liner (20 mils minimum thickness) protected above and below by at least 6 inches of bedding material. The lower component will include at least 24 inches of compacted soil with a saturated hydraulic conductivity not to exceed .0000001 centimeters per second.

Work would proceed first with building decontamination, reclamation and debris removal, while concurrently excavating and preparing the proposed landfill site (Figure 3-3). The landfill location has been selected to avoid both paved areas and heavily contaminated areas while minimizing the distance that contaminated materials must be transported. The landfill would be sized to accommodate all RCRA lining materials, leachate collection, leak detection and operating systems (Figure 3-4), as well as the estimated volume of the contaminated soils. Total useful required volume is estimated to be about 13,500 cubic yards. Clean soils removed from the landfill excavation would be stockpiled for use as final grading fill in areas where on site removal has occurred, or as a final cap material (provided this soil meets material specifications for such use).

Areas of the site containing surface contamination greater than 100 mg/kg would be removed to a depth of 12 inches, followed by sampling to determine if the cleanup limits were met. On site removal would be coordinated in such a way that approximately half of the contaminated surface soil would be removed and placed in the landfill first. Building debris, drums and materials buried on site during previous cleanups and investigations would then be landfilled, followed by the remainder of the surface soils. In this manner the bulky and more highly contaminated materials can be placed between layers of less contaminated and more workable soils. This approach makes it less likely that the landfill liners would suffer mechanical damage during or after the remedial action.



PROJECT

CRYSTAL CITY AIRPORT
FEASIBILITY STUDY

CONCEPTUAL LANDFILL
DESIGN

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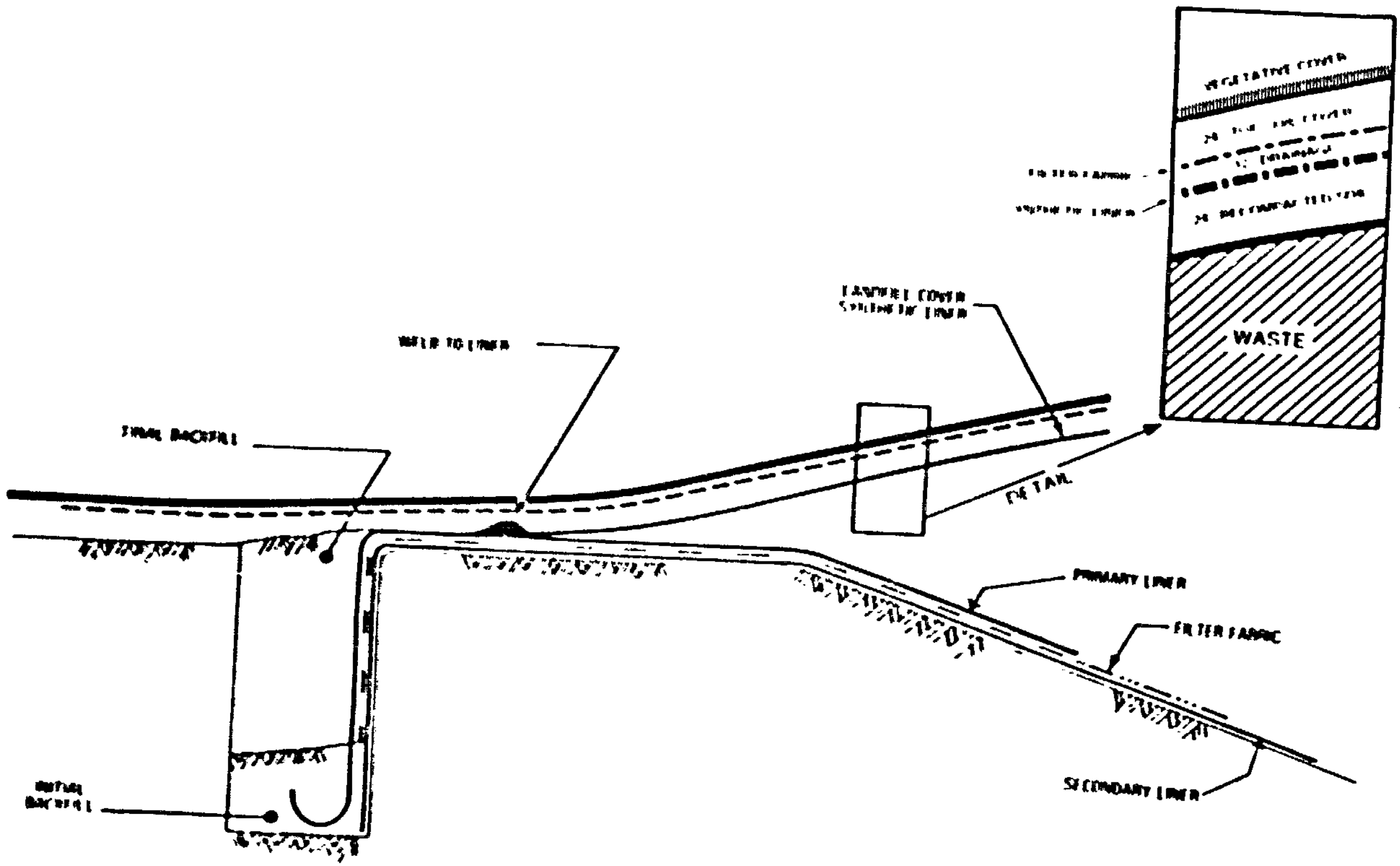
SCALE NOT TO SCALE

FIGURE 3-3

BM-01



PROJECT		SCALE NOT TO SCALE
CRYSTAL CITY AIRPORT FEASIBILITY STUDY	CAP LINING AND ANCHOR DETAIL	FIGURE 3-4

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3.4 ALTERNATIVE 4 - TOTAL IMMOBILIZATION WITH LANDFILL

In the context of this discussion, immobilization essentially refers to mixing the contaminated soil with water and fixation/solidification additives. The resulting mixture undergoes cationic exchange, abeorbtion, hydration and solidification. The technical objective of this alternative is to convert contaminated soil and water into materials exhibiting a very low susceptibility to leaching, and to subsequently landfill the solidified material in a secure on site landfill. Substantial reduction in the long-term risk of contaminant release is anticipated if contaminated soil and water can be treated to form material that is relatively inert, non-leachable, and has very low permeability. The principle components of this alternative are a small pug mill, a screw conveyer with screened hopper feed, front-end loader, bulk chemical storage, spreader/scraper and a compactor. The pug mill is a truck-mounted blender unit with a feed header system for metering soil, water and additives into the mixing zone. The other components are conventional construction equipment, selected based on ease of decontamination.

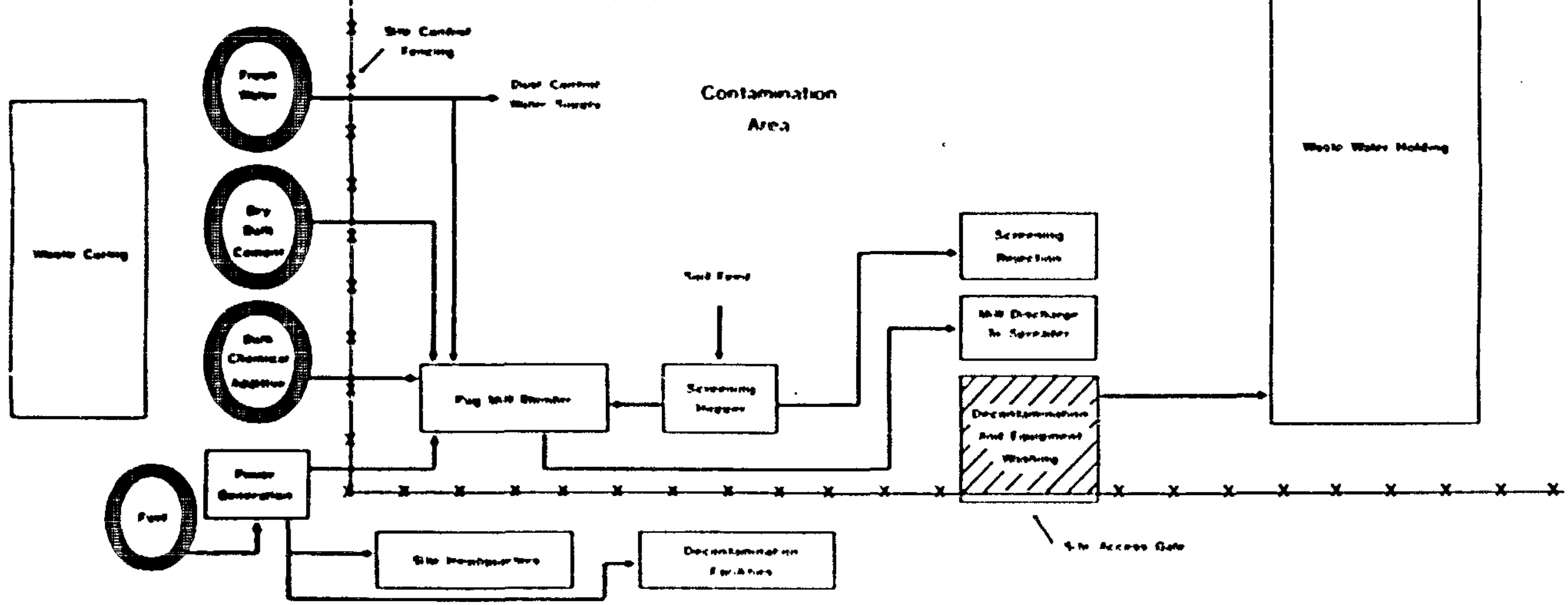
A conceptual schematic of the immobilization operation is shown in Figure 3-5. Site operations consist of excavation of contaminated soils and buried materials similar to Alternative 3. A front-end loader would systematically remove the contaminated soil and dump directly into a screened hopper. A 9" enclosed screw conveyor contiouously carries the soil into the mixing zone of the pug mill at a specified rate of delivery. Cement, fixating additives and water are added to the soil in optimum ratio's determined from laboratory studies. It is anticipated that the cement will act as a setting agent. The ratio of cement to water will determine the consistency of the product, i.e., whether it is monolithic or crumbly in texture. Fixating additives will limit the solubility of contaminants. Their dosage must be determined experimentally. After thorough mixing, the material from the mixing zone discharges to a spreader/scraper which then spreads the uncured cement like waste into 10"

Upon completion of excavation and landfill activities, a cap will be placed on top of the landfill. The cap will be designed in accordance with RCRA requirements to protect against rainfall infiltration and erosion. (Refer to cap detail, Figure 3-4).

During completion of the landfill cap, the areas of the site where removal occurred would be graded and revegetated. Accumulated liquids (decontamination wash water and collected rainfall) may be disposed of by deep well injection for small quantities, or treatment using portable physical/chemical and carbon adsorption unit processes followed by direct surface discharge for larger volumes. The liquid disposal decision is one which would be made at the completion of site work and is dependent on weather conditions during the action.

As discussed in the opening remarks of Section 3.0, this alternative will require fencing, locked gates and posting of warning signs. Operation and maintenance will require surveillance and repair of fencing and about 3 acres of cap, and observation of the leachate detection system. Because contaminated material in excess of the cleanup limits will still be on site, monitoring of surface waters and public drinking water supplies will still be required.

FIGURE 3-5 PROCESS FLOW DIAGRAM
IMMOBILIZATION



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to 14" sheets on a clean soil area adjacent to the mixing operation. The sheet is then compacted to the design density to increase the cured structural integrity. After curing for 12 to 24 hours, the hardened waste is first sampled and then subjected to an EP toxicity test using the toxicity characteristics leachate procedure (TCLP) to evaluate the acceptability of the immobilized material. Solid material that does not screen properly or is rejected will be containerized for removal to the secure landfill. Materials which do screen properly are then loaded into a transport using suitable equipment such as a front end loader or fork lift. The immobilized waste is then disposed of in an on site secure landfill according to the criteria set forth in Alternative 3. Based on data reported in the literature (Camp, Dresser and McKee, 1986), the addition of cement, water, and fixating additives can be expected to increase the volume of stabilized material over initial soil by 25 to 30%. Throughout the excavation and processing activities, a dust control program would be implemented consisting of fresh water spraying, particularly in the high traffic area of the excavation. Bulk material storage and power generation are outside the contaminated area and can be rapidly supplied with water, cement, chemicals or fuel as necessary without decontamination procedures. Auxiliary power, supplementing the pug mill generator would be provided to ensure that there would be no down time on the mill which might result in a solidified mixing zone or discharge piping. Runoff and decontamination water would be collected and held in temporary storage where the water can be recycled into the immobilization process.

Although tests have not been conducted to determine the performance of the immobilization process on contaminated soil from the CCA site, data are available demonstrating reduced leachability for both metals and organi on wastes from other sites that have been solidified. Table 3-1 presen the results of these tests, and demonstrates the reduced mobility of

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Table 3-1

Performance Data Using Hazcon Process for Immobilization

Compound	Concentration		
	Soil (Mg/L)	Solidified Waste Soil (1)	Leachate
Arsenic	11.8	-	.001 (2)
Benzene	1.0	0.1	.004 (3)
Toluene	1.0	0.1	.004 (3)
Ethyl Benzene	3.0	0.25	.008 (3)
Xylenes	3.0	0.27	.0016 (3)
2-Methylnaphthalene	100	25	2 (3)
Phenanthrene	68	20	2 (3)

(1) 20% to 50% contaminated soil in solid, only partial extraction obtained

(2) mg/l obtained from EP Toxicity Test

(3) Reported as mg leached per kilogram of solid

several contaminants. Arsenic is the only contaminant in Table 3-1 which is found at the CCA site. The organic compounds listed in Table 3-1 are not present at the CCA site, but are indicative of the effectiveness of the process. It is expected that testing will show the treatment method to be effective for the site-specific organic contaminants as well.

As discussed in the opening remarks of section 3.0, this alternative will require fencing, locked gates and posting of warning signs.

Operation and maintenance for the immobilization alternative is expected to be similar to that of Alternative 3 (on site landfill). It will include maintenance of the fencing and the landfill cap. It will also include monitoring of the leachate detection system, the surface waters and the public drinking water supply. Maintenance of the landfill cap will be more extensive than for Alternative 3 because the cap is about 30% larger.

001419

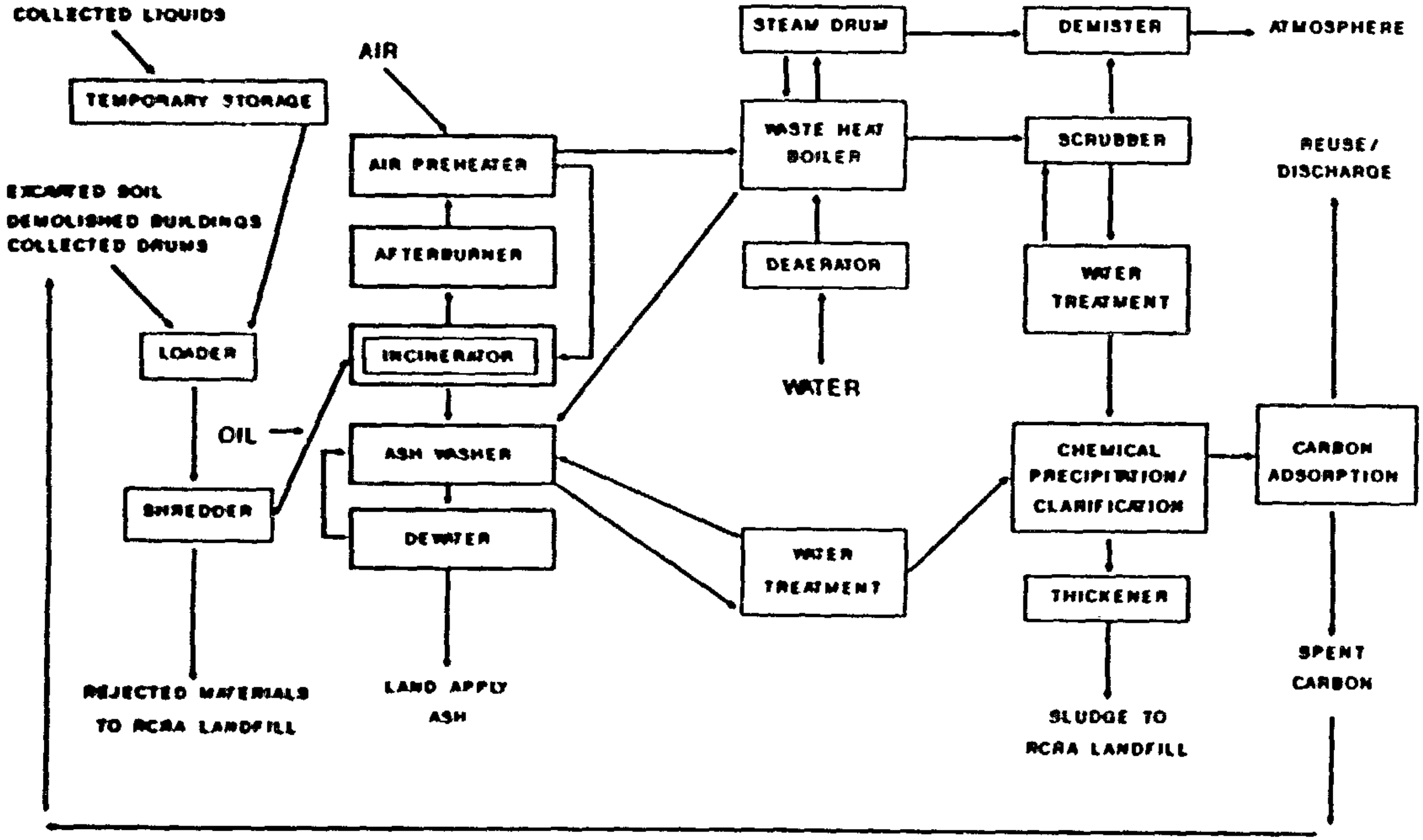
3.5 ALTERNATIVE 11 - TOTAL INCINERATION

The purpose of this alternative is to remove and destroy the organic contaminants in the soil, and to remove the arsenic from the soil for off site landfill. In this alternative, a mobile incinerator plant combined with appropriate exhaust gas and ash cleaning equipment would be placed on site. All excavated contaminated soil, removed drums, demolished building rubble, and contaminated liquids would be incinerated. In excavating the soil, water would be sprayed in working areas for dust control. The flue gas from the incinerator would be scrubbed of potential pollutants prior to release to the atmosphere. The ash from the incinerator would be washed of potential pollutants and then applied back to the land as fill material. Liquid wastes from the scrubbing and ash washing would be treated by chemical precipitation and carbon adsorption prior to discharge to a nearby stream. The wastes from the chemical precipitation process (precipitated arsenic sludge) would be disposed of at an off site landfill. Spent activated carbon would be returned to the incinerator. A generalized schematic diagram of this alternative is shown in Figure 3-6.

A loader/shredder would be used to prepare and feed solid materials into the incinerator by reducing it to an acceptable size. The loader/shredder would be capable of shredding whole metal drums, wooden and tin building material, lumps of clay and moderately sized rocks. Large rocks and metal objects which could not be shredded would be rejected, assumed contaminated and disposed at an off site RCRA landfill.

Contaminated liquids (rainfall in contaminated areas, decontamination wash water, and process wastewater) would be collected and routed to temporary storage. From there, the contaminated liquids would be pumped to the shredder to be mixed with the soil prior to feed to the incinerator. The prepared contaminated solids from the shredder would then be fed by metered conveyor to the incinerator.

FIGURE 3-6 PROCESS FLOW DIAGRAM INCINERATION



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The incinerator would be either a rotary kiln or infrared type, and sized to incinerate approximately 100 tons or more per day of solids. In the incinerator, the materials would reach a temperature of approximately 1800-1900°F (depending upon burn conditions). At these temperatures organic contaminants volatilize and are pyrolyzed to harmless compounds. However, it is anticipated that some arsenic compounds would not volatilize leaving arsenic contaminated ash. Those arsenic compounds which do volatilize may oxidize to another form of arsenic which may be more or less toxic than the original form.

The flue gas from the incinerator would pass through an afterburner which heats the gas to 2000-2400°F (depending upon the burn conditions). At these conditions, most of the chlorinated hydrocarbon contaminants still present would be destroyed. From the afterburner, the flue gas passes through an air preheater and waste heat boiler to cool the flue gas prior to scrubbing. The cooled flue gas enters the scrubber where any hydrocarbons or heavy metals such as arsenic that might be present are removed. The scrubbed flue gas is then heated using steam injection, moisture droplets are removed using a demister, and the gas is vented up the stack to the atmosphere.

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The contaminated ash from the incinerator is fed by screw conveyor to an ash washing contactor where arsenic compounds remaining in the ash are leached from the ash. The clean ash exiting the contactor is then pumped to a dewatering unit which removes the water from the ash and returns it to the contactor. The dewatered ash drops by gravity to dump trailers which would be used to take the ash to non-contaminated, excavated areas of the site, and regrade it to conform to original topography.

The waste heat boiler would be used to generate the steam which will be used to reheat the scrubbed flue gas. The blowdown from the waste heat boiler would be used in the ash washing system.

The scrubber system would consist of a scrubber, a clarifier, chemical feed equipment and a circulating system. As the absorbing media, water would be circulated through the system. To control pH, lime would be injected as needed. The clarifier would be used to settle any precipitate that may form after lime injection. The sludge collected in the clarifier will be pumped to the thickener. To control total dissolved solids, a portion of the circulating water would be removed as scrubber blowdown.

The ash washing system would consist of a contactor, a clarifier, chemical feed equipment and a circulating system. As the extraction solvent, water would be circulated through the system. To control pH and assist in extracting the arsenic, chemicals will be injected as needed. The clarifier would be used to settle any precipitate that may form after injection of the chemicals. The sludge collected in the clarifier would be pumped to the thickener. To control total dissolved solids, a portion of the circulating water would be removed as ash washer blowdown.

Blowdown from the scrubber and ash wash systems would be treated prior to discharge. Blowdown wastes will flow to a chemical precipitation/clarification unit in which arsenic will be precipitated and suspended solids/precipitate settled out. The sludge collected in the clarifier would then be pumped to the thickener.

The effluent from the clarifier would be then be passed through an activated carbon adsorption filter for removal of any hydrocarbon that may be present. The water would then be pumped through a series of two activated carbon contact vessels with a total residence time of about 15 minutes. The contaminants in the blowdown would sorb to the carbon as the water flows through. Influent and effluent water samples would be analyzed to measure treatment performance.

Activated carbon will generally remove the contaminants of concern to levels less than 1 ug/l, well below the health levels identified in the public health evaluation. The carbon eventually becomes saturated with contaminant ("spent" or "exhausted"). Because of the series configuration of the contact vessels, the leading contacter is exhausted first. A fresh load of activated carbon is delivered and, after the spent load is removed, the fresh load is hydraulically transferred to the vessel. The fresh bed is backwashed to remove carbon fines. The sequence of the flow of water through the two vessels is then reversed, so that the fresh bed is the second contact vessel and can more effectively remove contaminants. Approximately 7,000 pounds of carbon per month would be replaced, requiring a 20,000 pound truckload of carbon every three months. The spent carbon would be incinerated on site.

The treated water would then be discharged to a nearby stream. Water would be discharged to the creek through an outfall in a manner to prevent scouring of the creek bed.

Sludge from the scrubber clarifier, ash wash clarifier and blowdown treatment clarifier would be routed to a thickener which removes some of the water from the sludge and returns the water to the blowdown treatment clarifier. The sludge blowdown from the thickener would be disposed of at an off site RCRA landfill. Because of the relatively small amount of this material (about 1400 cubic yards), its off site disposal, which makes this a walk away alternative, is feasible.

Alternative 11 removes the toxicity of the organic hydrocarbons present in the soil being treated, but does not reduce the toxicity of the arsenic. The arsenic is removed from the contaminated materials, segregated and disposed of off site.

Because this alternative does not leave any contaminated materials on site in concentrations that exceed the cleanup limits, operation and maintenance requirements only include upkeep of the fencing and associated land use restriction appurtenances.

3.6 ALTERNATIVE 17 - TOTAL OFF SITE DISPOSAL

In this alternative, all contaminated soil, drums and demolished buildings would be disposed of at an off site RCRA landfill (Figure 3-2). All contaminated liquids would be disposed of at an off site injection well. The purpose of this alternative is to entirely remove contaminated material from the site within the required level of cleanup. Essentially, the criteria outlined for Alternative 3 would be followed for excavation and related site activities. The estimated quantities of contaminated materials required to be transported off site includes about 13,000 cubic yards of soil, 200 drums, about 20,000 gallons of contaminated liquids, and about 150 tons of building material. Transporting this material by truck will require on the order of 730 truck loads, each traveling approximately 320 miles. Transport of such an amount of material, for such a distance, increases the risk of an accidental spill relative to the other alternatives.

Contaminated liquids (i.e., rainfall in contaminated areas, decontamination water, etc.) would be collected in a ditch system and routed to temporary storage. From there, the contaminated liquids would be pumped to tank trucks and transported to an off site injection well facility.

In excavating the soil, water would be sprayed in working areas to control fugitive dust.

Alternative 17 does not reduce the toxicity of the site contaminants. The contaminated materials are disposed of off site. The potential exists for accidental spills of hazardous waste during transportation to the disposal site.

Alternative 17 is considered a walk away alternative, because no contaminated materials are left on site in concentrations exceeding the cleanup limits. Thus, the only operation and maintenance costs associated with Alternative 17 are the upkeep of the fencing and associated land use restriction appurtenances.

3.7 ALTERNATIVE 21 - SOIL FLUSHING - INNOVATIVE TECHNOLOGY

The purpose of this alternative is to remove the organic contaminants and arsenic from the soil, in a two-stage extraction process, for ultimate off site disposal. The treated solids from the processing plant (mainly soil), would be applied back to the land as fill material. The organic contaminants would be disposed of by off site incineration, and the arsenic would be disposed of by off site landfill. The distance to each of these off site facilities has been estimated to be about 320 miles. In this treatment alternative, a mobile processing plant, with appropriate contaminant recovery system, would be placed on site. Excavated contaminated soil, removed drums and demolished building rubble would be shredded to appropriate size and passed through the flushing system which would extract contaminants in two stages. The first stage is a critical pressure fluid extraction unit for removing organic contaminants. The choice of solvent gas would depend on pilot studies. Candidate solvents include carbon dioxide and propane. The second stage utilizes water, enhanced with the oxidizer hydrogen peroxide, to remove arsenic compounds. The resulting solution is treated by chemical precipitation prior to discharge to a nearby stream. The wastes from the chemical precipitation process (i.e., precipitated arsenic sludge) would be disposed of at a secure, RCRA compliant, off site commercial landfill. Because of the relatively small amount of this material (about 1400 cubic yards), off site disposal is feasible. A generalized schematic diagram of this alternative is shown in Figure 3-7.

A loader/shredder is used to prepare and feed solid materials into the processing plant by reducing it to an acceptable size. It will be capable of shredding whole metal drums, wooden and tin building material, lumps of clay and moderately sized rocks. Large rocks and metal objects which cannot be shredded will be rejected, assumed contaminated and disposed at an off site RCRA landfill.

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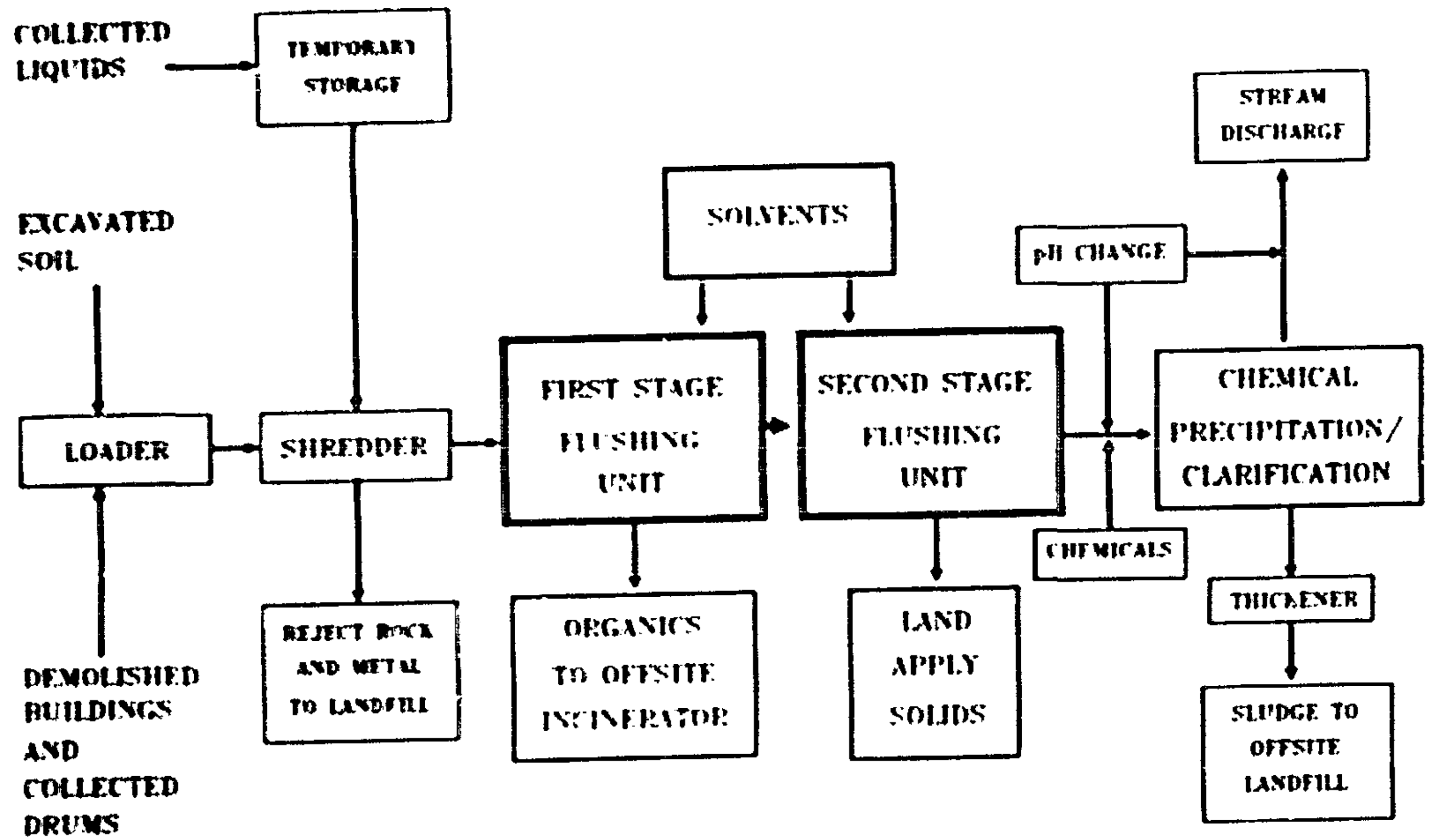
FIGURE 3-7 PROCESS FLOW DIAGRAM
SOIL FLUSHING



Contaminated liquids (rainfall in contaminated areas, decontamination wash water, and process wastewater) would be collected and routed to temporary storage. From there, the contaminated liquids would be pumped to the shredder to be mixed with the soil prior to feed to the processing plant. The prepared solids from the shredder would then be fed by metered conveyor to the processing plant. In excavating the soil, water would be sprayed in working areas for dust control.

The liquid extract exiting from the first stage of the processing plant is a concentrated waste organic hydrocarbon. It would be disposed of at an off site RCRA incinerator.

The liquid extract waste exiting from the second stage of the processing plant enter a chemical precipitation system which consists of a reaction tank, a flocculator tank, a clarifier, a solids thickener, and a pH readjustment tank. In the reaction tank, chemicals would be injected to raise the pH and precipitate the arsenic. The clarifier would be used to settle any precipitate that may form after injection of the chemicals. The sludge collected in the clarifier would be pumped to the thickener. The water would be sent to the pH readjustment tank where carbon dioxide would be used to return the pH to near neutral.

Sludge from the clarifier would be routed to a thickener which removes some of the water from the sludge and returns the water to the clarifier. The sludge blowdown from the thickener would be disposed of at an off site RCRA landfill.

The treated water would then be discharged to a nearby stream. Water is discharged to the creek through an outfall at a rate that would prevent scouring of the creek bed.

Alternative 21 does not reduce the toxicity of the contaminants at the site. They are removed from the contaminated materials, segregated and incinerated to the maximum extent possible, or disposed of off site. The volume of waste is significantly reduced by this alternative.

Alternative 21 is considered a walk away alternative, thus the only operation and maintenance that will be required is upkeep on the fencing and associated land use restriction appurtenances.

3.8 ALTERNATIVE 22 - CONTAINMENT - CONSOLIDATION/CAPPING

The purpose of consolidation/capping is to prevent exposure to the site contaminants. This is accomplished by consolidation of the contaminated soils on site at a single location and construction of a relatively impermeable barrier (cap) to minimize future migration of contaminants. The cap will be designed to contain the contaminants in place and protect against rain and wind erosion. The native soils below the consolidated contaminants are composed of relatively impermeable clays. The soils will function to contain and encapsulate the wastes after capping.

All soils containing in excess of a total of 100 ppm of the three indicator contaminants (Toxaphene, DDT and Arsenic) will be removed and placed in an on site consolidation cell. The areas of the site from which soils are to be removed are indicated on Figure 3-2. The materials that were buried during the EPA response actions and during the Remedial Investigation will either be excavated and placed in the consolidation cell or capped in place. Buildings in contaminated areas will be decontaminated and left standing to the extent possible, or demolished and the building materials reclaimed. All contaminated rubble remaining, after decontamination and reclamation, would be removed to the consolidation cell.

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During excavation and removal actions, decontamination wash water and rainfall runoff from contaminated areas and from the open consolidation cell will be collected. Re-use/recycle of this water would be practiced to the extent possible. Water remaining at the conclusion of site activities which could not be reused or recycled will be disposed of by deep-well injection at a commercial disposal facility. There are several such facilities within 400 miles from the CCA site. Construction activities will be planned so that areas in which contaminated soils have been removed will not be re-contaminated by cleanup actions in other areas. The collection of rainfall runoff will be limited to the area immediately undergoing removal. This will help to minimize the collection, storage and handling of storm water which could become contaminated by contact with disturbed areas of the site.

The consolidation cell will be sized to accommodate all unreclaimable building debris, all wastes from prior removal actions, wastes generated during RI activities and wastes generated during the Remedial Action itself. The consolidation cell will be located as shown on Figure 3-2. Construction details are shown on Figure 3-8. The cell will be approximately 180 x 180 feet, excavated to a depth of 15 feet. The cap will be designed in accordance with RCRA requirements and will consist of layers of compacted clay, synthetic membrane and runoff control materials as shown on Figure 3-3 and described in Section 3.3 for the on site RCRA landfill cap.

Work will begin with building decontamination, reclamation and debris removal, concurrent with excavation and preparation of the proposed consolidation cell (Figure 3-3). Clean soils removed from the cell excavation will be stockpiled for potential use as final grading fill in areas where on site removal has occurred, or as a final cap material (provided this soil meets material specifications for such use).

Removal of surface contamination will be accomplished by removing the top soil layer to a depth of 12 inches. Composite sampling will be performed after initial excavation to determine if the cleanup limits were met. Approximately half of the contaminated surface soil will be removed and placed in the consolidation cell. Building debris and the drums and materials buried on site during previous cleanups and investigations will then be placed in the cell first. The remainder of the surface soils will then be placed in the cell. In this manner the bulky and more highly contaminated materials can be placed between layers of less contaminated and more workable soils.

Upon completion of excavation and placement activities, an engineered cap will be placed on top of the cell. The cap will be specifically designed to protect against rainfall infiltration and erosion. (Refer to cap detail, Figure 3-4).

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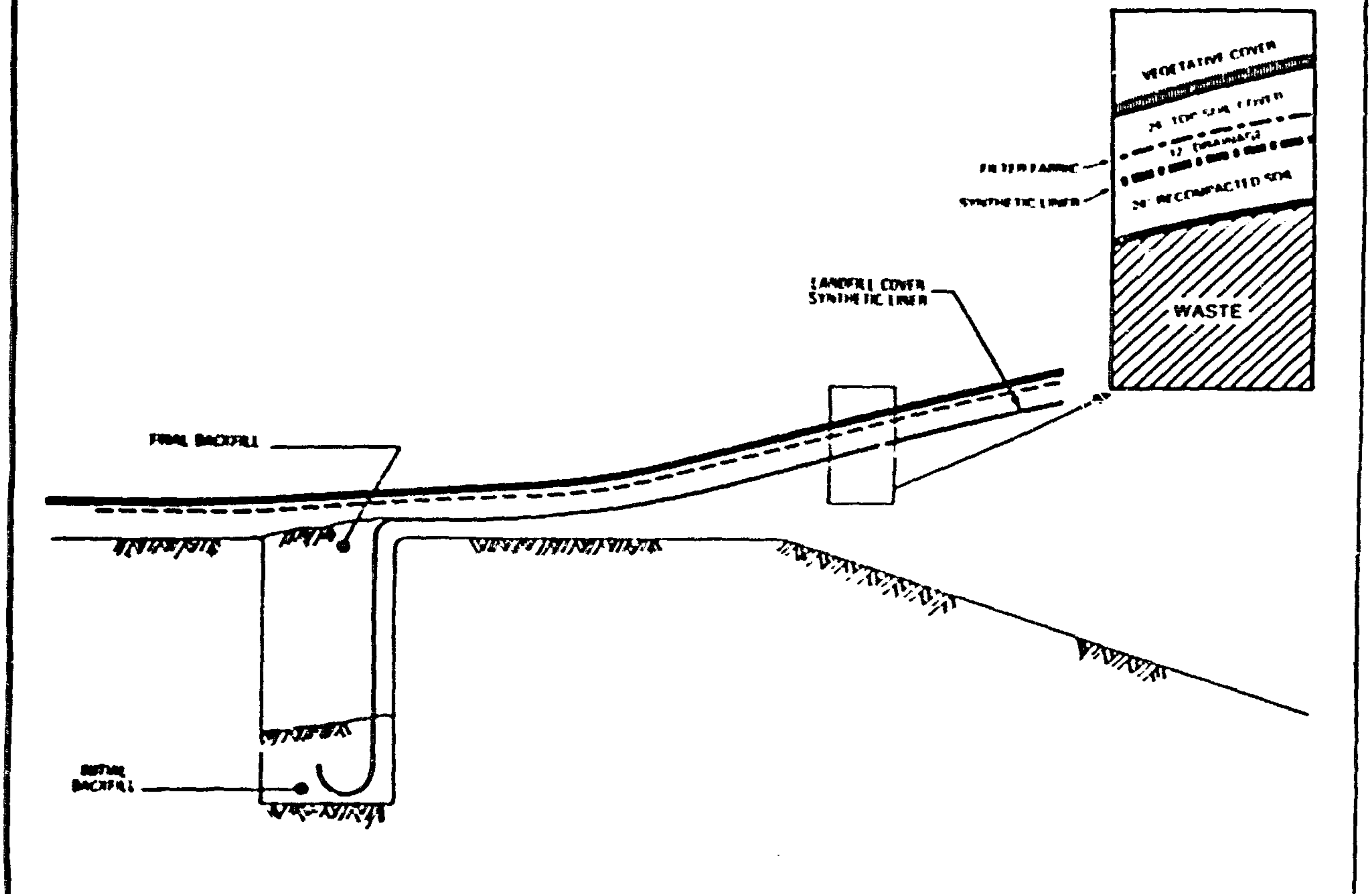

PROJECT		SCALE NOT TO SCALE
CRYSTAL CITY AIRPORT FEASIBILITY ST...	CONSOLIDATION CELL AND CAP DETAIL	
		FIGURE 3-8

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3-31

During completion of the cell cap, the remainder of the site will be graded and revegetated in areas where removal occurred. Decontamination wash water and collected rainfall, will require handling as hazardous waste. To the extent possible, the liquids will be reused and or recycled, in order to reduce the liquid volume requiring disposal. Depending on the remaining volume of liquids, disposal by deep well injection may be cost-effective for the remaining quantities. If large volumes of liquids remain, however, treatment using portable physical/chemical and carbon adsorption unit processes followed by discharge to surface water may be more cost effective. The liquid disposal decision is one which will be made at the completion of site work and is dependent on weather conditions during site activities.

The consolidation cell will be designed such that at completion the RCRA cap will be nearly level with surrounding land surfaces. It will be securely fenced (six foot chain link topped with barbed wire) and provided with warning signs. Access will be restricted to inspection and maintenance of the cap only. Restrictions imposed on the capped area include:

1. Deed restriction on use of the consolidation cell area in the future.

2. Restriction on any activity which would damage the integrity of the cap such as trenches, building foundations, etc.

3. Restriction on access only to personnel involved in inspection/maintenance of the cap, such as grass cutting, repair of erosion damage, and revegetation as necessary.

Capping the consolidated materials results in an excellent barrier to all pathways of migration but requires that the integrity of the cap be continuously maintained. The contaminants are not detoxified or reduced in quantity, but are sealed in place. Without a driving force, the contaminants will tend to remain bound in the soil matrix. Because the soils are highly impermeable and infiltration will be minimized by the RCRA cap, downward migration is not likely.

Because all of the contaminated material remains on site with Alternative 22, operation and maintenance include the monitoring of surface water and public drinking water supply to ensure that contaminant migration has not occurred. In addition, maintenance of land use restriction appurtenances is required. Fence maintenance is slightly more extensive in that a separate fence around the consolidation cell is included. Cap maintenance is also included although the area of cap, about 1 acre, is less than that for Alternatives 3 and 4.

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SECTION IV

001435

4.0 DETAILED EVALUATION OF REMEDIAL ALTERNATIVES

This section presents a detailed evaluation of each of the alternatives which passed the screening process. Detailed descriptions, emphasizing key features such as the technologies employed, associated components, implementation, special engineering factors, on site configuration, safety, and environmental considerations, were provided for each of these alternatives in Section 3.0. The detailed evaluations discussed in this section assess the cost effectiveness of each alternative in terms of the requirements of Section 300.68(h) of the NCP, which specifies that a detailed analysis of each alternative should include:

- Refinement and specification of alternatives in detail, with emphasis on use of established technology;

- Evaluation in terms of engineering implementation, reliability, and constructibility;

- An assessment of the extent to which the alternative is expected to effectively prevent, mitigate, or minimize threats to, and provide adequate protection of, public health and welfare and the environment;

- An analysis of any adverse environmental impacts, methods for mitigating these impacts, and costs of mitigation; and

- Detailed cost estimation, including operation and maintenance costs, and distribution of costs over time.

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The major categories of criteria for which each selected alternative is evaluated are as follows:

- Technical Feasibility,

- Institutional Requirements,

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- Public Health Requirements,
- Environmental Impacts, and
- Cost Analysis.

This section allows a comparison of each alternative based on each of these major categories of criteria.

4.1 EVALUATION PROCESS

Table 4-1 presents the criteria used for this detailed evaluation of alternatives. Specific components of each alternative are discussed in the text, and the evaluation is summarized in the associated tables. The technical evaluation addresses the performance, reliability, implementability and safety of the technologies and associated components which make up each alternative. The evaluation of institutional requirements discusses compliance with applicable and relevant federal and state standards and other criteria, guidance, and advisories at Superfund remedial sites, and community concerns. Each alternative is evaluated on how well it limits contaminant migration, and how well it limits the threat to public health as established in the Public Health Evaluation presented in Section 1.4. Environmental impacts of each alternative are evaluated by comparing beneficial and adverse effects. The cost of implementing each alternative includes both the capital costs and the operation and maintenance costs spanning a thirty year period. The present worth values are calculated for each alternative for comparative purposes.

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The results of the detailed evaluation for each alternative with respect to each of the criteria listed in Table 4-1 are expressed in a rating system utilizing the terms high, moderate, and low.

- A high rating indicates that the alternative meets the intent of the criteria and/or meets or exceeds the remedial objectives.

- A moderate rating indicates that the alternative only partially meets the intent of the criteria, however, the alternative does remedy the problem to an appreciable extent even though it does not meet all the remedial objectives.

- A low rating indicates that the alternative does not meet the criterion and/or does not meet the remedial objectives.

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TABLE 4-1

DETAILED EVALUATION CRITERIA

TECHNICAL FEASIBILITY

Performance
- o Effectiveness
- o Useful Life

Reliability
- o Operation and Maintenance Requirements
- o Possible Failure Modes

Implementability
- o Constructibility
- o Time

Safety
- o Worker
- o Neighborhood

INSTITUTIONAL REQUIREMENTS

Conformance to ARAR
Permitting Requirements
Community Concerns

PUBLIC HEALTH REQUIREMENTS

Minimization of Chemical Releases
Exposures During Remedial Action
Exposures After Remedial Action

ENVIRONMENTAL IMPACTS

Beneficial Effects
- o Final Environmental Conditions
- o Improvements in Biological Community
- o Improvements in Human Use Resources

Adverse Effects
- o Construction and Operation
- o Mitigative Measures

COST

Capital Cost
Operation and Maintenance Costs
Present Worth Cost

-.2 TECHNICAL FEASIBILITY

This subsection presents the technical evaluation of each alternative relative to its performance, reliability, implementability, and safety.

Performance is the ability to effectively perform the intended function. Performance of a remedial alternative is evaluated based on two factors: effectiveness and useful life. Effectiveness refers to the degree to which a remedial action will prevent or minimize substantial danger to public health or the environment. An example is the degree to which an alternative prevents further migration of contaminants. Preference is given to those technologies that completely immobilize, destroy, or recycle the hazardous material. The useful life is the length of time this level of effectiveness can be maintained, for example, the operating life of a treatment facility.

Reliability of a remedial action is evaluated in terms of operation and maintenance requirements, and demonstrated performance at similar sites. Evaluation of operation and maintenance includes the frequency and complexity of the operation and maintenance activities, such as replacing spent carbon in a carbon adsorption treatment facility and the availability of labor and materials. Technologies requiring frequent attention, perhaps as often as once per week or month, or complex operation and maintenance activities are considered less reliable. The evaluation of demonstrated performance includes an estimate of the probability of failure for each component of the remedial alternative and performance of the technologies demonstrated at other hazardous waste sites.

Implementability is the ease of installation or constructibility of the remedial alternative and the time required to achieve a given level of response. Constructibility is the ability to actually build or implement the remedial technologies given the existing site conditions and conditions external to the site such as availability of equipment or zoning clearances.

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Safety of neighboring communities and environments as well as that of the workers during implementation is evaluated in terms of short term and long term threats. Short term refers to the construction period, while long term encompasses post closure operation and maintenance activities of the workers and exposure of the community to hazardous substances following closure operations.

4.2.1 Evaluation of Technical Feasibility of Remedial Alternatives

Alternative 1 - No Action

In the no action alternative there will be no additional remedial action. The site will be fenced to restrict access, using a 6 foot chain link fence and three strands of barbed wire on top of the fence. Warning signs will be posted to discourage casual entry onto the property. Monitoring will be maintained in order to detect contaminant migration.

- Performance

  The no action alternative is expected to provide no additional control of the migration of contaminants from the site. Contamination on site is expected to migrate by erosion and will likely move beyond the site boundaries in the future.

  The performance rating for this alternative is low.

- Reliability

  The no action alternative requires periodic monitoring due to the fact that continued migration of contaminants is expected.

  The reliability rating for this alternative is low.

- o Implementability

The ability to do nothing is easily accomplished. Implementability for the no action alternative is high.

- o Safety

Fencing the site and providing warning signs is a common feature of all the alternatives. The purpose of fencing is to prevent casual, unrestricted contact with potential site hazards. Short term safety considerations are for fencing construction activities. Because the fence will be installed around the perimeter of the property in relatively uncontaminated areas, safety is rated moderate. Long term safety considerations are for maintenance and monitoring activities and for future potential exposure to contaminants migrating away from the site. Because contaminants are expected to migrate, long term safety is rated low.

- o Overall

The no action alternative is deficient in its performance, reliability, and safety. Site hazards are not mitigated, therefore, migration of contaminants is expected.

The overall rating for technical feasibility is low.

Alternative 2 - Containment Without Treatment - Capping

Capping of contaminated areas is a relatively common approach to the problem of surficial contamination. At the CCA site contaminants are present at the ground surface over an area of approximately 7 acres. Construction of a cap can be accomplished with standard construction techniques. Restrictions must be imposed on post closure activities which may disturb or destroy the cap. Construction and excavation activities in capped areas must therefore be prohibited.

- Performance

  Cap performance is directly related to operation and maintenance. The cap is subject to periodic repair, spot replacement, and erosion. Assuming that operation and maintenance is adequate for the selected material of construction, the cap should function well as a barrier to minimize migration and protect against the hazards at the site. It is unlikely that the cap would fail completely and require total replacement, given adequate yearly maintenance. The cap, in conjunction with site specific geological considerations (the on site clays are highly impermeable), hydrogeological considerations (no shallow groundwater), and chemical contaminants (the chemicals have a high affinity for and adherence to soil particles), will prevent migration of contaminants.

  The performance rating for capping is high.

- Reliability

  Capping is reliable only if properly maintained. The ongoing cap maintenance period is assumed to be 30 years. After this period, if maintenance is suspended, protection will be reduced.

Reliability for capping is moderate due to uncertainty of adequate long-term maintenance.

o Implementability

The cap can be readily applied by conventional construction methods to the areas of the site where necessary. Access is open and the topography is fairly flat. Implementation would require approximately 3 months. Only during wet weather periods would construction activities be hampered.

Implementability is high.

o Safety

For the construction of the cap, no excavation of contaminated soil is required. Construction workers and the surrounding populace and environment will not be exposed to freshly excavated, contaminated soil. Workers can be protected from site hazards with minimal protection (gloves, boots, coveralls) and without requiring respiratory protection or other safety equipment which would likely be needed if excavation took place. This level of safety equipment gives workers a better field of vision, less heat stress, and clear communications while working. Long term protection against site hazards is very good in the areas capped. Access to the capped area is restricted by construction of a secure fence, as described in Alternative 1. Minimal exposure is expected during cap repair and maintenance activities, should the cap become damaged.

The safety rating is high due to the low potential of both short and long term exposure.

o Overall

Implementation, performance and safety features of the capping alternative are very favorable. Long term reliability is uncertain, due to the reliance on continued maintenance, which cannot be assured. The likelihood of total failure is low, and spot repair/replacement can be readily accomplished within the scope of annual maintenance.

The overall rating is moderate to high.

Alternative 3 - Containment Without Treatment - Landfill

Alternative 3 is a combination of on site removal and on site landfilling. Standard construction methods are employed for soil excavation, transportation, building cleanup, and demolition. Precautions will be taken to prevent worker exposure to contaminants. This will consist of dust control measures and protective clothing including respiratory protection.

The landfill will be double lined and provided with liquid collection systems to remove leachate and to detect leakage. Contaminated materials will be placed directly into the prepared landfill without treatment, and the landfill will be capped. Residual contaminated liquids would be removed to an off site commercial deep well disposal facility. A liner compatibility study (Appendix E) has shown that the materials to be disposed would not cause deterioration of the lining material.

Post closure care will be required for the landfill, including monitoring of surface water and public drinking water, and periodic maintenance.

o Performance

Contaminated materials will be removed by conventional earthmoving equipment such as bulldozers, pan scrapers, excavators, dump trucks, etc. After removal, soil samples will be collected to determine whether or not clean up levels are met. If contamination still exists in excess of clean up limits, additional material will be removed. Removal is expected to have a high level of performance. The landfill design includes a double lining, with leachate collection and leak detection systems. The cap will adequately prevent percolation of rainfall and therefore minimize the generation of leachate. The soils are composed of highly impermeable clays which should be readily compacted in the landfill, further enhancing landfill overall performance. Even in the event of failure of the landfill liner, the contaminants are tightly bound in the soil matrix and unlikely to migrate. There are no shallow aquifers so that even if downward contaminant migration occurred, no groundwater resource would be immediately affected.

Landfill performance is rated high.

- Reliability

Removal reliability is excellent, since on site sample testing can be used to determine whether the contaminants have been removed to attain clean up limits. Additional removal can be accomplished immediately, if necessary. Landfill design has progressed in recent years to include rugged, durable and chemical resistant liners, combined with leak detection monitoring between double layers of synthetic lining materials. Synthetic materials may experience deterioration over time, however, as demonstrated by the liner compatibility tests in Appendix E. The liner material is compatible with site wastes. Based on the test results, liner materials should remain intact for a minimum of 30 years and would likely last for 100 years or more. Maintenance is required for the landfill cap including revegetation, erosion repair, landscape maintenance, and spot replacement as needed. The leak detection and leachate collection systems require periodic inspection with corrective actions as necessary including liquid removal and disposal, pump maintenance and replacement. The lack of shallow groundwater enhances reliability.

Reliability is rated low to moderate due to the need for significant operation and maintenance of cap, leak detection, and leachate collection systems, and the possibility of future failure.

- Implementability

Construction methods for on site removal and landfill construction are generally practiced throughout the waste disposal industry. Time to implement this alternative is approximately 4 months. Consideration for weather-related construction impacts (collection of contaminated rainfall runoff, muddy areas during wet weather, etc.) will be required, but no unproven technology will be employed.

Implementability is rated high.

o Safety

Construction accidents and contamination exposures during implementation are safety concerns for short term activities. Proper planning and training of site workers should adequately address construction safety and worker exposure issues. Site conditions will require engineering controls such as water spraying during excavation to minimize fugitive dust.

After completion of construction, the long term threat of migration of contaminants would be minimal. The site will be fenced and site access after construction will continue to be limited to approximately 15 days per year. Maintenance workers would potentially be exposed to contaminated liquids which may accumulate in leachate collection systems and leak detection systems. There is the possibility of future release in the event of liner failure.

The landfill safety rating is moderate to high.

o Overall

The use of an on site landfill for direct disposal is attractive from an engineering feasibility viewpoint. The construction methods employed are standard. Materials used are durable and highly effective. The disposed materials are very appropriate and compatible with synthetic lining materials. Continuous care is needed because the materials are not reduced in toxicity, mobility or volume.

The overall rating is moderate.

Alternative 4 - Total Immobilization with Landfill

Alternative 4 is a combination of on site immobilization of contaminants and on site landfilling. Construction methods are similar to Alternative 3 for contaminant removal and landfill construction. The technical feasibility of this alternative is evaluated based in part on the success of immobilization technologies at other waste sites with similar wastes. A final design of the specific immobilization procedures including optimum cement, water and fixating additive ratios, curing time and final compressive strength, can only be achieved and subsequently tested in laboratory/pilot scale studies.

However, a preliminary technical evaluation of feasibility is possible, subject to confirmation, assuming that the immobilized and solidified waste at the site will meet the requirements of the TCLP test for those compounds listed in 40 CFR 261. This is a reasonable assumption because of the flexibility available in over-designing the immobilization process by using excess cement and fixating additive.

- Performance

The performance of immobilization technology for this site is anticipated to be very good when combined with RCRA landfilling. If properly applied, the useful life is indefinite and risk of failure is very low. However, due to a lack of bench scale data on the leachability of contaminants from the immobilized material, the true level of protection can only be assumed to be higher than either landfilling or immobilization alone.

The performance rating for this alternative is high.

- Reliability

Immobilization technology can result in an inert solid that minimizes leachable contaminants. These solids are bound up in a permanent matrix from which driving forces of migration are not significant. When combined with secure landfilling the result is anticipated to increase the reliability of the landfill containment. The fixated materials would not contribute significant contaminants to the leachate generated (if any). The landfill will require closure and post closure monitoring, as well as periodic maintenance and inspection. Leak detection and leachate collection systems will require inspection and corrective actions as necessary. Likelihood of liner failure is similar to Alternative 3. With adequate operation and maintenance the combined technologies of immobilization and landfilling form a fairly reliable system. Although not quantified, leaching of contaminants would be minimal should the landfill liner fail.

The reliability rating for this alternative is moderate.

o Implementability

Construction methods for on site removal and landfill construction are generally practiced throughout the waste disposal industry. Consideration for weather-related construction impacts (collection of contaminated rainfall runoff, muddy areas during wet weather, etc.) will be required, but no unproven technology will be employed.

Implementation of the immobilization technology requires laboratory studies to determine optimal feed rates of stabilization chemicals. Testing of immobilized materials will be used to determine the volume of total landfilled materials. The time required to complete site activities is relatively short, on the order of 3 to 5 months with immediate site closure at the end of activities. No special equipment or technology is required.

The implementability rating for this alternative is moderate to high due to the period of performance and staged handling of materials in the immobilization process prior to landfilling.

o Safety

Construction accidents and contamination exposures during implementation are safety concerns. Proper planning and training of site workers should adequately address construction safety and worker exposure issues.

Site conditions will require engineering controls such as water spraying during excavation to minimize fugitive dust. After completion of construction, the threat of migration of contaminants would be minimal. The site will be fenced and site access after construction will continue to be limited to approximately 15 days per year. In the event of liner failure, contaminant migration would be minimized by the immobilization-treated wastes; however, the liner failure condition is similar to Alternative 3.

The safety rating is moderate to high.

o Overall

Redundancy of systems to prevent migration of contaminants is present in this alternative. The site geology, soil characteristics, engineering features of the landfill, and the immobilization of the contaminants prior to landfill placement are compatible with long term management of these wastes.

Overall technical feasibility of immobilization, combined with on site landfilling is rated moderate to high.

Alternative 11 - Total Incineration

The technical feasibility of this technology has been demonstrated for various organic materials including pesticides. Laboratory and pilot tests must be conducted to determine the actual operating conditions and specifications of various components of the incineration system, particularly the pyrolizing chamber and after burner. The supporting technologies required to implement this alternative, such as off-gas scrubbing, ash washing and dewatering, clarifiers and carbon adsorption units, are standard unit operations with well defined performance data and design criteria. Therefore, this analysis focuses on the incinerator unit in presenting the evaluation within the five major criteria categories. This is a reasonable approach considering that the operation specifications of the incinerator determine the design and performance requrements of the downstream operations, and essentially control overall system performance.

o Performance

Nearly complete destruction of the hazardous organic contaminants in the soil can be expected using this alternative. Destruction efficiencies of 99.99 percent can be obtained. Residual organic material in the stack gas is captured in the downstream scrubbing operations. Arsenic is volatilized in the incinerator to a limited extent. It is expected that arsenic would undergo changes in oxidation state and potentially form other arsenic compounds with different toxicity characteristics. The ash washing operation will be effective in removing the arsenic compounds which will be disposed of off site. Arsenic compounds not removed in the ash washing are likely to be fused and immobilized in the ash to such a degree as to be environmentally inert. This alternative exhibits a high degree of performance because nearly complete destruction of the organics is achieved in the treated soils, and nearly all hazardous arsenic compounds are extracted and removed from the soils processed.

The performance rating is high based on the destruction of toxic organics and selective removal of arsenic from the soil.

- Reliability

Soil removal reliability is the same as Alternative 3. Various components of the overall incineration process, as well as the incinerator unit, were considered in evaluating the reliability of this alternative. The dominant factor in evaluation of this criteria is current reliability data obtained from other incineration operations in the United States. Another factor considered is the historical reliability of equipment of any nature operated under on site conditions.

The incinerator is operated at extremely high temperatures, handles large quantities of dry/moist solids, and is mechanical in design. For these reasons, it requires a great deal of maintenance. This includes repair and replacement of material handling conveyors, grates, rakes, etc., as well as proper lubrication and inspection of moving parts. The afterburner, air preheater and waste heat boiler are also operated at extremely high temperatures, heating and cooling flue gas which is corrosive. These systems also require considerable repair and replacement maintenance. In addition, the afterburner and the incinerator have little flexibility for accommodating large changes in operating conditions, such as feed rate, soil chemistry, energy input, etc. Therefore, operational control of feed conditions and response to changes is a critical feature. Another critical component is the off-gas scrubbing. The scrubber is operated at high temperatures, quenching the flue gas and absorbing corrosive contaminants from the flue gas, and will require a great deal of maintenance. The incineration remedy results in complete removal of contaminants in excess of cleanup limits.

The reliability rating is moderate due to the complexity of operation and maintenance of the component systems.

- Implementability

There are no forseeable site conditions which would prevent construction of the treatment system. However, summer heat, rainy seasons, and dry, dusty weather could slow down operations, particularly excavation.

To treat all of the contaminated materials and implement all the various aspects of this alternative will take approximately 18 months, depending upon weather conditions and availability of contractors and equipment. Implementation would involve work plan development and approval, preparation of specifications and bid packages, test burns, assembly of treatment units, mobilization, construction, startup, treatment, demobilization, and site restoration. A test burn is required to more accurately determine the incinerator design and operation parameters. In addition, field treatability studies would probably be required to determine the ash wash system, clarifier and thickener design and operation parameters. Carbon adsorption and ash dewatering field treatability studies may not be required, as these systems have been used extensively in similar applications and can be designed and assembled using off-the-shelf equipment.

As systems are not currently available combining incineration, ash washing, waste water treating, ash dewatering and material loading/shredding, a custom designed system will be required. The level of effort and time needed to coordinate the design of these technologies into one fully integrated, properly functioning design will be above normal.

The implementability rating is moderate.

- Safety

Construction accidents and contamination exposures during implementation are safety concerns. Proper planning and training of site workers should adequately address construction safety and worker exposure issues.

During construction of the treatment systems site personnel who work directly with contaminated wastes will be required to wear protective clothing as necessary to reduce their possible exposure to contaminants.

During treatment of the contaminated materials, there are several areas for exposure. In excavating the soil, excavating the drums and demolishing the buildings, dust control must be used to reduce contaminated dust emissions. Without such dust control, the surrounding communities could be exposed to some minor level of potentially contaminated airborne particulate. In addition, the excavation personnel will have to wear protective clothing and respirators to reduce their exposure to the on site contaminants, as required by appropriate health and safety procedures. The operations and maintenance personnel will be exposed to contaminated materials within the treatment facility. Construction related hazards can be minimized by following established health and safety procedures.

After treatment is completed the site will pose a much reduced threat to the surrounding community. All contaminants above cleanup limits will be treated or removed from the site. The site will be fenced and site access after construction will continue to be limited to approximately 15 days per year.

The safety rating is moderate.

o Overall

Based on the evaluations presented above, the overall technical feasibility rating for Alternative 11 is moderate.

Alternative 17 - Total Offsite

In this alternative, all excavated soil, removed drums and demolished buildings are disposed of at an off site RCRA landfill. All contaminated liquids are disposed of at an off site injection well. The site will be fenced and access limited to 15 days per year or less.

- Performance

The removal of material from the areas of contamination in excess of the cleanup limits reduces the exposure hazard. Fencing and limiting site access should aid in minimizing human exposure to those areas with residual contamination (below cleanup limits). Materials removed will present the same hazards in the landfill/ injection well facility where they are disposed, except that containment or isolation from contact with the environment would be improved.

The performance rating is moderate.

- Reliability

Excavation and removal of site contaminants are the same as Alternative 3. Removal of the waste is a very effective remedy for the site and its surrounding environment. Only those residuals below cleanup limits will remain at the site. Long term reliability involves the ultimate fate of removed materials which have been disposed in off site facilities. To the extent that off site facilities could experience future failures, this remedy should reflect that potential occurrence.

The reliability rating is moderate to high due to uncertain security of off site facilities.

- Implementability

There are no known site conditions which would prevent excavation and disposal of the contaminated materials. The removal of soils and other contaminated materials will be by conventional construction methods. Construction would be subject to normal delays due to weather related circumstances.

This alternative will take approximately 4 months. Implementation would involve work plan development and approval, preparation of specifications and bid packages, mobilization, construction, demobilization, and site restoration.

The implementability rating is moderate.

- Safety

Construction accidents and contamination exposures during implementation are short term safety concerns. Proper planning and training of site workers should adequately address construction safety and worker exposure issues. During removal of the contaminated materials, dust control, such as water spraying, must be used to reduce contaminated dust emissions. Without such controls, the surrounding communities could be exposed to some minor level of potentially contaminated airborne particulate. In addition, the excavation personnel will have to wear protective clothing to reduce their exposure to the on site contaminants.

Environmental exposures are expected if a transport truck carrying contaminated material to the off site landfill is involved in an accident and material is spilled. The contaminated material can be readily collected and the contaminants are strongly bound to the soils, therefore the adverse impact on the environment should be minimal.

After removal is completed the site will pose a much reduced long term threat to the surrounding community. The site will be fenced and site access after construction will continue to be limited to approximately 15 days per year.The off site disposal facilities will experience a long term possibility of exposure, depending on the site specific nature of the facility used.

The safety rating is moderate due to long term exposure potential at off site disposal facilities.

- Overall

Based on the evaluations presented above, the overall technical feasibility rating for Alternative 17 is moderate.

Alternative 21 - Soil Flushing

Alternative 21 is a combination of on site removal and on site soil flushing. Standard construction methods are employed for soil excavation, transportation, building cleanup, and demolition. Precautions wil be taken to prevent worker exposure to contaminants. This will consist of dust control measures and protective clothing including respiratory protection. The feasibility of soil flushing technology has been demonstrated for various organic materials, including chlorinated hydrocarbons, and for lead. Laboratory and pilot tests must be conducted to determine actual solvents to be used, dose rates, and optimum extraction conditions. The supporting technology (chemical precipitation) includes standard unit operations with well defined performance data and design criteria. Therefore, this analysis focuses on the flushing process units in presenting the evaluation within the five major criteria categories. This is a reasonable approach considering that the operation specifications of the flushing units determine the design and performance requirements of the downstream operations, and essentially control overall system performance.

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o Performance

Contaminated materials will be removed by conventional earthmoving equipment such as bulldozers, pan scrapers, excavators, dump trucks, etc. After removal, soil samples will be collected to determine whether or not clean up levels are met. If contamination still exists in excess of clean up limits, additional material will be removed. Removal is expected to have a high level of performance. Extraction of organic compounds can be expected to exceed 99% of the material in the soil using this alternative. Removal rates for arsenic compounds via flushing are not established, and can only be determined from laboratory and pilot studies. Residual arsenic that can not be extracted in this process can be assumed to be immobile and environmentally inert. This alternative is thus expected to have a performance level at least as high as the immobilization alternative.

The performance rating for Alternative 21 is high.

- Reliability

Various components of the overall soil flushing process, as well as the flushing units, were considered in evaluating the reliability of this alternative. Because of the lack of similar installations, and the probable amount of testing which will be required, some breakdowns due to development can be expected. Material handling equipment (pumps, conveyors, augers), and moving parts of process equipment (blenders, mixers, contactors) are most subject to breakdown. In start up of a new technology there may be no redundancy of spare parts to quickly repair or replace equipment breakdowns.

On the other hand, the process does not involve difficult environmental conditions. It operates at ambient temperatures and reasonable pressures. For these reasons, the equipment itself can be expected to be reliable.

Overall, the reliability rating is moderate to high.

- Implementability

There are no foreseeable site conditions which would prevent construction of the treatment system. During construction and excavation, weather related delays and problems with muddy or hot, dusty conditions are unavoidable, but manageable.

To treat all of the contaminated materials and implement all the various aspects of this alternative will take approximately 24 months, depending upon testing results, weather conditions and availability of contractors and equipment. Implementation would involve work plan development and approval, preparation of specifications and bid packages, test runs, assembly of treatment units, mobilization, construction, startup, treatment, demobilization, and site restoration.

Testing is required to determine particular solvents and extraction efficiency. Field treatability studies are required to determine chemical dose rates and treatment design parameters.

As systems combining two-stage soil flushing with chemical precipitation are not currently available, a custom designed system will be required. The level of effort and time needed to coordinate the design of these technologies into one fully integrated, properly functioning design will be above normal.

The implementability rating is moderate.

- Safety

During construction of the treatment systems, for this alternative, the surrounding community would not be exposed to increased levels of hazardous materials. On the other hand, the site personnel will need to wear protective clothing to reduce their exposure to the on site contaminants.

During treatment of the contaminated materials, there are several areas for exposure. In excavating the soil, excavating the drums and demolishing the buildings, controls must be used to reduce contaminated dust emissions. The surrounding communities could be exposed to minor levels of potentially contaminated airborne particulate. In addition, the excavation personnel will wear protective clothing to reduce their exposure to the onside contaminants. The operations and maintenance personnel will be exposed to contaminated materials within the treatment facility. The O&M workers will have to wear protective clothing to reduce their exposure to the on site contaminants.

After removal is completed the site will pose a much reduced threat to the surrounding community. The site will be fenced and site access after construction will continue to be limited to approximately 15 days per year.

The safety rating is moderate to high.

- Overall

  Based on the evaluations presented above, the overall technical feasibility rating for Alternative 21 is moderate to high.

Alternative 22 - Containment Without Treatment - Consolidation/Capping

Consolidation of contaminated areas followed by capping will reduce the area to be capped. At the CCA site contaminants are present at the ground sur' ce over an area of approximately 7 acres. Consolidtion will reduce this area to approximately 1 acre. Construction of a cap can be accomplished with standard construction techniques. Restrictions must be imposed on post closure activities which may disturb or destroy the cap. Construction and excavation activities in capped areas must therefore be prohibited. Standard construction methods are employed for soil excavation, transportation, building cleanup, and demolition. Precautions will be taken to prevent worker exposure to contaminants. This will consist of dust control measures and protective clothing including respiratory protection.

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o Performance

Cap performance is directly related to operation and maintenance. The cap is subject to periodic repair, spot replacement, and erosion. Assuming that operation and maintenance is adequate for the selected material of construction, the cap should function well as a barrier to minimize migration and protect against the hazards at the site. It is unlikely that the cap would fail completely and require total replacement, given adequate yearly maintenance. The cap, in conjunction with site specific geological considerations (the on site clays are highly impermeable), hydrogeological considerations (no shallow groundwater), and chemical contaminants (the chemicals have a high affinity for and adherence to soil particles), will prevent migration of contaminants.

The performance rating for consolidation/capping is high.

o Reliability

Removal reliability is excellent, since on site sample testing can be used to determine whether the contaminants have been removed to attain clean up limits. Additional removal can be accomplished immediately, if necessary.

The cap is reliable only if properly maintained. The ongoing cap maintenance period is assumed to be 30 years. After this period, if maintenance is suspended, protection will be reduced.

Because the cap is reduced in area, reliability for consolidation/ capping is moderate to high.

o Implementability

Construction methods for on site removal are generally practiced throughout the waste disposal industry. Time to implement this alternative is approximately 4 months. Consideration for weather-related construction impacts (collection of contaminated rainfall runoff, muddy areas during wet weather, etc.) will be required, but no unproven technology will be employed.

The cap can be readily applied by conventional construction methods to the areas of the site where necessary. Access is open and the topography is fairly flat.

Implementability is high.

o Safety

Construction accidents and contamination exposures during implementation are safety concerns for short term activities. Proper planning and training of site workers should adequately address construction safety and worker exposure issues. Site conditions will require engineering controls such as water spraying during excavation to minimize fugitive dust. Long term protection against site hazards is very good in the areas capped. Access to the capped area is

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restricted by construction of a secure fence, as described in Alternative 1. Minimal exposure is expected during cap repair and maintenance activities, should the cap become damaged.

The safety rating is high due to the low potential of both short and long term exposure.

- Overall

Implementation, performance and safety features of the consolidation/capping alternative are very favorable. Long term reliability is good due to the reduced cap area. The likelihood of total failure is low, and spot repair/replacement can be readily accomplished within the scope of annual maintenance.

The overall rating is high.

4.2.2 Summary of Technical Feasibility

The evaluations of the technical feasibility of the candidate remedial alternatives are summarized in Table 4-2.

TABLE 4-2

SUMMARY OF TECHNICAL FEASIBILITY EVALUATION

Remedial Alternative	Performance	Reliability	Implementability	Safety	Overall
1. No Action	Low	Low	High	Low	Low
2. Containment - Capping	High	Moderate	High	High	Moderate to High
3. Containment - Landfill	High	Low to Moderate	High	Moderate to High	Moderate
4. Total Immobilization	High	Moderate	Moderate to High	Moderate to High	Moderate to High
11. Total Incineration	High	Moderate	Moderate	Moderate	Moderate
17. Total Offsite	Moderate to High	Moderate to High	Moderate	Moderate	Moderate
21. Soil Flushing	High	Moderate to High	Moderate	Moderate to High	Moderate to High
22. Consolidation/ Capping	High	Moderate to High	High	High	High

4.3 INSTITUTIONAL REQUIREMENTS

This section of the Feasibility Study presents a discussion and evaluation of the institutional concerns regarding the Crystal City Airport site and remedial action alternatives as described in Section 3.0. These concerns are divided into three categories as presented in Table 4-1: conformance to Applicable or Relevant and Appropriate Requirements (ARARs), permitting requirements, and community concerns. An overview of these three categories, starting with a detailed description of the ARARs, is presented first, followed by evaluations of the remedial action alternatives with respect to these institutional concerns.

4.3.1 Conformance with Applicable or Relevant and Appropriate Requirements (ARARs) and Other Regulations

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In the 1985 revision of the National Contingency Plan (NCP) which implements CERCLA, and in the 1986 amendments to CERCLA (SARA), emphasis was placed on ensuring that remedial actions taken under the CERCLA law consider other Federal and State laws. In many cases such remediation is not required to conform to other laws, because CERCLA has pre-empted their application. Congress included this provision in the original CERCLA law (PL 96-510, December 11, 1980) in order that conformance with various permitting requirements would not delay essential cleanup operations. Concern about the way EPA may use this power led in part to a law suit (Environmental Defense Fund v. EPA, No. 82-2234, D.C. Cir., Feb. 1, 1984). One result of this suit was that EPA pledged to clarify its policy regarding other regulatory requirements. This policy was developed and presented in the 1985 revision to the NCP. It states that all CERCLA remedies must comply with applicable, or relevant and appropriate regulatory requirements (ARAR) of other Federal, State or local governments. CERCLA, as amended by SARA, also requires, to the extent possible, that action taken use treatment to permanently and significantly reduce the mobility, toxicity, or volume of hazardous material (Section 121(b)(1)). The extent to which remedial action alternatives attain these goals will be discussed.

Applicable requirements are those that would apply if CERCLA had not pre-empted them. Standards associated with the applicable regulations may be required to be met in a Superfund remedy. This policy is intended to insure that the public health and the environment are protected when remedial activities are contracted by the government, as they are when such actions are undertaken by private industry. The principal difference in compliance is that for Superfund sites, actual permit approvals are not required. For example, a permit is not necessary for an outfall which discharges Superfund treated rain water into the Espantosa Slough. The National Pollution Discharge Elimination System (NPDES), though "applicable" to the outfall, has been preempted by the CERCLA law. Nevertheless, the intent of the regulation must be met so that levels of contaminant releases to the river are consistent with NPDES policy.

Relevant requirements are those which were intended to apply to problems similar to those encountered at the site, even if they are not applicable without CERCLA preemption. Only relevant requirements which are also appropriate for site-specific conditions are to be considered. The use of relevant requirements may be necessary to remedy a very hazardous condition which otherwise would not be regulated. The Federal Resource Conservation and Recovery Act (RCRA) is an example of a law that is relevant and appropriate to the Crystal City Airport. This law is not applicable because the site was neither given interim status nor was there a permit issued to dispose of hazardous materials. The RCRA law is relevant to the proposed remedies which include landfilling and capping.

The CCA Site gets the full benefit of the CERCLA preemption. As a result, the applicable requirements, as well as the relevant and appropriate ones, are necessarily Federal. Requirements which are to be considered include both Federal as well as all State laws and regulations. A list of potentially applicable or relevant and appropriate requirements taken from the NCP is presented in Appendix C. These and other laws, particularly those of the State of Texas, were reviewed during the development of alternatives and a selection was made of those most likely to be pertinent to the CCA Site.

Federal Laws and Regulations:

- o Resource Conservation and Recovery Act (RCRA) (42 USC 6901), Subtitle C: This law was enacted to regulate the management of hazardous waste, including its generation, transportation, treatment, storage, and disposal.

- Landfills (40 CFR 264, Subpart N)

- Incinerators (40 CFR 264, Subpart O)

- Closure and Post-Closure (40 CFR 264, Subpart G)

- o Safe Drinking Water Act (SDWA) (42 USC 300): This law was enacted to protect the public health by limiting the concentrations of contaminants that may be present in public drinking water supplies.

  - Drinking Water Standards (40 CFR 141), including maximum contaminant levels (MCLs) and recommended maximum contaminant level goals (MCLGs).

  - Underground Injection Control (UIC) Standards (40 CFR 146) These regulations govern the use of injection wells.

- o Clean Water Act (CWA) (33 USC 1251): This law was enacted to restore the chemical, physical, and biological integrity of the Nation's waters.

  - National Pollution Discharge Elimination System (NPDES) (40 CFR 122) These regulations govern point source releases to surface water, such as outfalls to a river or creek.

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- o Clean Air Act (CAA) (42 USC 7401):

  This law was enacted to protect and enhance the quality of the Nation's air resources by the prevention and control of air pollution.

  - National Emission Standards for Hazardous Air Pollutants (NESHAPs, 40 CFR 61). These govern the atmospheric release of hazardous pollutants.

These laws and regulations will impact the various alternatives differently according to the characteristics of the alternatives. Below are some of the significant features of regulatory concern:

- o Discharges to surface waters, which should protect the water quality of the receiving stream (NPDES permits and Water Quality Standards).

- o On site landfill construction (RCRA).

The standards and regulations involved in the remediation at any site are subject to the discretion of the lead agencies. The remedial alternatives are evaluated with respect to pertinent federal, state, and local regulations. Ratings of "low", "moderate", or "high" are then given on the basis of how well the alternative conforms to the standards of the ARARs and other regulations.

4.3.2 Permitting Requirements

Superfund remediation efforts do not require permits for compliance with Federal or State environmental regulations, primarily to prevent delays in implementing cleanup actions, but the principles of compliance must still be followed. A brief description of the permit requirements and application procedures which could be appropriate for the various alternatives is provided as follows:

- o National Pollution Discharge Elimination System (NPDES) Permit for discharges to surface waters,

- Underground Injection Control (UIC) permit for "injection" wells,
- Air Emissions Permit for any facility which may emit air pollutants,
- Building permits, as may be needed by city or county codes, and
- Review and approval by the State of Texas of construction reports, plans, and specifications, for any treatment facility.

A rating of "high", "moderate", or "low" is given to an alternative on the basis of how easy it would be to conform with the permitting procedures and standards as though all pertinent permits were required.

4.3.3 Community Concerns

The last aspect of institutional concerns involves the public and how acceptable the chosen alternatives might be to them. Public input to the selection process and general agreement on the chosen alternative is very important to the remediation effort. Below are the main issues that have been voiced concerning the CCA site:

- Concern for possible hazards to nearby residents and public schools.
- Concern that the public water supply may have been adversely affected.
- Concern for future use of the airport property.

These concerns are discussed in more detail for specific alternatives in the subsequent evaluations. A rating of "high", "moderate", or "low" is given based on the degree to which the alternative is likely to receive public acceptance. These ratings may be modified by public input before selection of a final alternative.

4.3.4 Evaluation of Institutional Concerns

Alternative 1 - No Action

In the no action alternative, no attempt is made to comply with regulatory standards, permitting issues, or community concerns. The site presents the hazards identified in Section 1.4 of this report. With no additional control measures the site could not be used for any purpose due to the existing public health risk of exposure. Without remedy, the site could result in off site contamination in excess of regulatory limits in the rainfall runoff, and public health exposure limits in the soils and sediments washed off site.

- Conformance with ARAR's and Other Regulation

    CERCLA, as amended by SARA

    The no action alternative does not conform to Section 121 (b) (1) in that it does not permanently and significantly reduce the mobility, toxicity, or volume of hazardous substances, pollutants, and contaminants.

    Clean Water Act, Water Quality Criteria

    The no action alternative does not control migration of site contaminants. Samples collected in the Remedial Investigation indicate that on one occasion site runoff was contaminated in excess of water quality criteria. There is no affirmative assurance that water quality limits can be attained in either a short term or a long term sense.

    Clean Air Act

    No excavation will take place. Air emissions will be minimal.

    Conformance with regulations is low due to lack of conformance to 121(b)(1) of CERCLA and The Clean Water Act.

o Permitting

No action means no permitting requirements, except for construction of the fence, which may require a local building permit.

The rating is high.

o Community Concerns

With no action taken, the community concerns are not addressed. The site presents a hazard, principally to the environment and to rare site visitors.

The rating is low.

The overall institutional rating is low to moderate.

<u>Alternative 2 - Containment Without Treatment - Capping</u>

o Conformance to ARAR's and Other Regulations

CERCLA, as amended by SARA

Alternative 2, because it does not permanently and significantly reduce by treatment the volume, toxicity or mobility of the contaminants, does not conform to Section 121(b)(1).

RCRA, Landfill

The cap is for surface sealing of wastes in place and does not protect against downward migration. There is no double-lined landfill or RCRA type cap; therefore Alternative 2 does not comply with 40 CFR, Section 264.

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Clean Water Act, Water Quality Criteria

By protecting against erosion and migration of site contaminants, the properly maintained cap provides adequate assurance that the site will not cause water quality limits to be exceeded.

Clean Air Act

No excavation will take place. Air emissions will be minimal during construction and controlled by the cap for the long term.

The conformance with ARAR's is rated moderate.

o Permitting Requirements

Activities on site would not require permits other than for site closure. No treatment or discharge to surface waters is expected. No air emission sources are created or used in the alternative.

Permitting is rated high.

o Community Concerns

As a result of capping the site can be re-opened for limited use (10-15 days per year). The cap functions adequately to protect against contact with and migration of contaminants to neighboring areas.

Conformance with community concerns is rated moderate.

Overall conformance to institutional requirements is moderate to high.

1001474

Alternative 3 - Containment Without Treatment - Landfill

o Conformance to ARAR's and Other Regulations

CERCLA, as amended by SARA

Conformance with Section 121(b)(1) is not achieved because there is no treatment to permanently and significantly reduce the volume, toxicity or mobility of the contaminants.

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site and placing them in a secure landfill, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of off site surface water migration of contaminants. Source removal will help to protect the quality of local streams.

Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a reduced potential source of off site airborne contaminants.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

RCRA, Landfill

By designing the landfill according to RCRA (40 CFR 264.301 Design and Operating Requirements, Landfills), the intent of RCRA will be satisfied.

Alternative 3 provides conformance with the air, water and RCRA regulations while minimizing the long term contamination of the air and water, but does not conform to CERCLA, as amended by SARA.

Conformance of alternative 3 to pertinent regulations is rated moderate to high.

- Permitting Requirements

The landfill design is to be in conformance with RCRA guidelines and rules. The intent of the applicable permits will be fairly easy to meet.

Liquid waste disposal is to an off site commercial injection well which will already be permitted.

The ease of permitting is rated high.

- Community Concerns

This alternative removes highly contaminated material for disposal in an on site landfill. It protects the clean air and clean water. Access to the site is still limited to 10-15 days per year.

Alternative 3 receives a moderate community concerns rating.

Based on the evaluations presented above, the overall institutional requirements rating for alternative 3 is moderate to high.

Alternative 4 - Total Immobilization with Landfill

o Conformance to ARAR's and Other Regulations

CERCLA, as amended by SARA

Alternative 4 reduces the mobility of the hazardous material, presumably on a permanent basis. Thus, although it also increases the volume of contminated material, it does conform to Section 121(b)(1).

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site, immobilizing them and placing them in a secure landfill, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of off site surface water migration of contaminants. Source removal will help to protect the quality of local streams.

Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a much reduced source of off site airborn contaminants.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

RCRA, Landfill

By designing the landfill according to RCRA, the intent of RCRA will be satisfied. The wastes will be immobilized before landfilling by mixing with water and solidification/fixation additives. Proper dosages will be determined by laboratory testing for leachate toxicity.

Immobilization provides complete conformance with the air, water and RCRA regulations while minimizing the long term contamination of the air and water.

Conformance of alternative 4 to pertinent regulations is rated high.

- Permitting Requirements

The landfill design is to be in conformance with RCRA guidelines and rules. The intent of the applicable permits will be fairly easy to meet. Construction related permits for the immobilization process are not expected to pose unusual local problems.

The ease of permitting is rated high.

- Community Concerns

This alternative removes highly contaminated material for immobilization and disposal in an onsite landfill. It protects the clean air and clean water. Access to the site is still limited to 10-15 days per year.

Alternative 4 receives a moderate community concerns rating.

Based on the evaluations presented above, the overall institutional requirements rating for alternative 4 is moderate to high.

Alternative 11 - Total Incineration

o Conformance to ARAR's and Other Regulations

CERCLA, as amended by SARA

Because this alternative reduces both the toxicity and the volume of the waste, permanently and significantly, it conforms to Section 121(b)(1).

RCRA, Incinerator

The performance of this alternative relative to the criteria specified in 40 CFR 264.343 can only be evaluated after a test burn of the contaminated soil. However, normal destruction efficiencies for the organic contaminants should exceed the regulatory requirements for this alternative because it will be operated as required by 40 CFR 264.435. Emission limits are expected to include carbon monoxide levels as well as indicator chemicals as described in Section 1.4.3.

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site, incinerating them and returning the treated soil to the land, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of off site surface water migration of contaminants. Source removal will help to protect the quality of local streams. Although arsenic wil not be destroyed during incineration, it is expected that virtually all arsenical materials will be concentrated in either the scrubber liquid or the ash washing liquid. Treatment of these liquids by chemical precipitation before their discharge to a nearby stream will protect the surface water quality.

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Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a reduced potential source of off site airborne contaminants. Air emissions from the incinerator will be controlled by means of stack gas scrubbing. Emission control design is expected to be in compliance with all regulatory limits.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

Texas Air Pollution Control Regulations, Section 101.4

The use of water spraying is intended to supress fugitive dust emissions from the site. However, it may prove nearly impossible to entirely eliminate the release of potentially contaminated dust from the site during the remedial action. The air concentrations and human exposure levels are expected to be minimal for the duration of the remedial action.

Incineration provides generally complete conformance with the air, water and RCRA regulations by treating the contaminated materials while preventing the contamination of the air and water.

Conformance of alternative 11 to pertinent regulations is rated high.

o Permitting Requirements

The incinerator design is to be in conformance with RCRA guidelines and Clean Air Act limits. The intent of the applicable permits will be fairly easy to meet. Construction related permits for installing the incineration process are not expected to pose unusual local problems. In order to dispose of treated soils by land spreading, the treated wastes must be tested according to the TCLP test, which determines leachability of the materials and the ability to delist them.

Meeting the intent of the applicable permits will be fairly time consuming, so the ease of permitting is rated moderate.

o Community Concerns

This alternative removes highly contaminated material for incineration and land spreading. It protects the clean air and clean water. Access to the site is still limited to 10-15 days per year. The presence of a highly visible hazardous waste incineration facility is anticipated to create additional community concern. The local residents may not want such a facility in their community.

Alternative 11 receives a low to moderate community concerns rating.

Based on the evaluations presented above, the overall institutional requirements rating for alternative 11 is moderate.

Alternative 17 - Total Offsite

o Conformance to ARAR and Other Regulations

CERCLA, as amended by SARA

This alternative incorporates removal and disposal of all contaminated material. Under Section 121(b)(1), such an alternative is to be treated as the least favored alternative remedial action. Thus Alternative 17 does not conform to CERCLA, as amended by SARA.

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site and placing them in a secure landfill, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of offsite surface water migration of contaminants. Source removal will help to protect the quality of local streams.

Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a much reduced source of off site airborn contaminants.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

RCRA, Landfill

Wastes will only be transported to an off site landfill in demonstrated compliance with RCRA, the intent of RCRA will be satisfied. The wastes will not be reduced in toxicity, mobility or volume before landfilling.

DOT Rules

By following the transportation rules, all communities along the route to the off site disposal facilities will be assured maximum possible safety in transporting the contaminated waste.

Texas Solid Waste Disposal Act (TSWDA)

The above discussion of RCRA applies to meeting this Texas rule.

Alternative 17 provides complete conformance with the air, water and RCRA regulations while minimizing the long term contamination of the air and water. It does not conform to CERCLA, as amended by SARA.

Conformance to pertinent regulations is rated moderate.

- Permitting Requirements

Waste transportation permits will be required of the transportation company, along with EPA identification numbers. Generator identification numbers will likely be provided by the TWC or EPA. Manifest information will also be required for each shipment off site. These are not unusual or difficult requirements.

The ease of permitting is rated high.

- Community Concerns

This alternative removes highly contaminated material for disposal in an off site landfill. This material will be transported through the community, a fact which can be expected to raise concern about the potential for accidental spill. It protects the clean air and clean water. Access to the site is still limited to 10-15 days per year.

Alternative 17 receives a low to moderate community concerns rating.

Based on the evaluations presented above, the overall institutional requirements rating for off site disposal is moderate .

Alternative 21 - Soil Flushing

o Conformance to ARAR's and Other Regulations

CERCLA, as amended by SARA

The soil flushing alternative involves the permanent and significant reduction in volume, and off site reduction in toxicity, of contaminated materials. Thus it conforms to CERCLA, as amended by SARA.

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site, processing them in soil flushing treatment units and returning the treated soil to the land, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of off site surface water migration of contaminants. Source removal will help to protect the quality of local streams.

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Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a reduced potential source of off site airborne contaminants.

RCRA, Landfill

The performance of this alternative relative to the criteria specified in 40 CFR, Section 264 can only be evaluated after a test run of the contaminated soil. However, expected removal efficiencies for the organic contaminants should exceed the regulatory requirements for this alternative.

DOT, 49 CFR Section 179

The waste material removed from the site will be in full compliance with the regulations governing the transportation of hazardous waste on public thoroughfares.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

Conformance of alternative 11 to pertinent regulations is rated high.

o Permitting Requirements

Significant environmental and human health impacts are mitigated by separating the contamination from the waste materials. The treatment facilities would ordinarily require the application for several permits, including National Pollution Discharge Elemination System (NPDES), RCRA part B, and a Texas Water Commission discharge permit.

Meeting the intent of the applicable permits will be fairly time consuming, so the ease of permitting is rated moderate.

o Community Concerns

This alternative reduces the toxicity of the contaminated material on site by removing the contaminants and protects the air and water. However, it would not completely satisfy the community concerns in that access to the site is still restricted to 10 - 15 days/year.

For this reason, this alternative received a moderate community concerns rating.

Based on the evaluations presented above, the overall institutional requirements rating for alternative 21 is moderate to high.

Alternative 22 - Consolidation/Capping

Conformance to ARAR's and Other Regulations

Consolidation/capping does not reduce the volume, toxicity or mobility of contaminated material. Therefore, it does not conform to Section 121(b)(1) of CERCLA, as amended by SARA.

Clean Water Act, Water Quality Criteria

By removing the high concentrations of contaminants from the site and placing them in a consolidation cell, local streams will be protected and water quality criteria will be adhered to. The major impact is the reduced possibility of off site surface water migration of contaminants. Source removal will help to protect the quality of local streams.

Clean Air Act

Fugitive dust will be controlled during excavation. The possibility exists that dust, containing contaminants, may be carried off site under highly dry and windy conditions. The impact of site excavation operations in these conditions is not known. After completion, however, the site will be a reduced potential source of off site airborne contaminants.

OSHA

Site workers will be properly trained to abide by work safety rules to attain the maximum possible safety during cleanup.

RCRA, Landfill

The cap will be designed to RCRA requirements. The consolidation cell will not meet other RCRA landfill requirements The intent of RCRA will be partially satisfied because the natural soil properties and the lack of a near-surface groundwater will serve to isolate the material. The wastes will not be reduced in toxicity, mobility or volume before consolidation and capping.

Alternative 22 provides partly complete conformance with the air, water and RCRA regulations while minimizing the long term contamination of the air and water.

Conformance of alternative 3 to pertinent regulations is rated low.

- Permitting Requirements

The consolidation cell design is not in conformance with RCRA guidelines and rules. The intent of the applicable permits will not be met, as there will be no leachate collection or detection systems.

The ease of permitting is rated low.

- Community Concerns

This alternative removes hightly contaminated material for disposal in an on site consolidation cell. It protects the clean air and clean water. Access to the site is still limited to 10-15 days per year.

Alternative 22 receives a moderate community concerns rating.

Based on the evluations presented above, the overall institutional requirements rating for alternative 3 is low to moderate.

4.3.5 Summary of Institutional Evaluations

The individual and overall institutional ratings are presented in Table 4-3 for each alternative.

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TABLE 4-3

SUMMARY OF INSTITUTIONAL REQUIREMENTS EVALUATION

Remedial Alternative	Conformance to ARAR's and Other Regulations	Permitting Requirements	Community Concerns	Overall
1. No Action	Low	High	Low	Low to Moderate
2. Containment - Capping	Moderate	High	Moderate	Moderate to High
3. Containment - Landfill	Moderate	High	Moderate	Moderate to High
4. Total Immo -bilization	High	High	Moderate	Moderate to High
11. Total Incin -eration	High	Moderate	Moderate	Moderate to High
17. Total Offsite	Moderate	High	Low	Moderate
21. Soil Flush	High	Moderate	Moderate	Moderate to High
22. Containment Consolidation/ Capping	Low	Low	Moderate	Low to Moderate

4.4 ENVIRONMENTAL IMPACTS

Each remedial alternative was evaluated for beneficial and deleterious environmental effects, with consideration to feasible mitigation measures. The Remedial Investigation did not include quantitative or qualitative sampling of environmental species, therefore the assessment of environmental impacts is based on subjective evaluation. The relative degree to which each alternative would alleviate the adverse site impacts will be compared, as well as additional stresses that might result from the cleanup measures themselves.

Aspects which were considered for beneficial effects were the final environmental conditions of the site and the improvements in human use resources. The analysis of potential adverse conditions concentrated on effects occurring during implementation of the remedial action and the possible mitigative measures which could be incorporated into the design. Impacts during construction are anticipated to be minor, by incorporating dust control and storm water runoff control into the design.

For each alternative the beneficial effects are assigned, as a group, a single rating of "low," "moderate," or "high," indicative of how well the alternative promotes environmental concerns. Such beneficial effects would be the removal or destruction of site contamination, restoration of site use, and reduction of contaminant migration. Adverse effects of each alternative are treated in like fashion, i.e. if adverse impacts are present and not mitigated, the alternative would get a lowered rating. Adverse effects include temporary or permanent removal of vegetated areas, potential migration of contaminants during construction, and construction relted dust and noise impacts. A rating of "High" is always on the favorable side for each criterion so that the ratings can easily be combined. Finally, each alternative is assigned an "Overall Environmental Rating" indicative of its relative favorability.

-.4.1 Evaluation of Environmental Impacts of Remedial Alternatives

Alternative 1 - No Action

c Beneficial Effects

Only through site access control (fencing), which affects the human population primarily, is there any beneficial effect. Local wildlife wil continue to be exposed to pesticides. Therefore the rating for beneficial effects are low.

c Adverse Effects

Site conditions will get no worse over time, but in the short term, adverse effects will be the same. No field surveys of indigenous wildlife populations were conducted, nor were any specimens collected for laboratory analysis. However, casual observations made during the Remedial Investigation by field sampling crews indicated that the animals on site appeared to be unaffected by the contaminated soils on site. A local hunter observed that the jackrabbits had unusual bumps on their bodies, but this was not substantiated by any definitive studies. A more definitive assessment of adverse environmental effects would require a significant study effort. With the no action alternative there will be continued exposure to site contamination and migration of contaminants into areas not currently affected. Therefore the environmental improvement of adverse effects is low.

The overall rating for the no action alternative is low.

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- **Beneficial Effects**

Immediate beneficial effects will be obtained by implementation of the capping alternative. Site hazards will be isolated, exposure to contamination will be reduced, and migration of contamination will be controlled. Capping construction activities require little excavation, so it will have a smaller role in generating [illegible] dust than other alternatives in which excavation is required. [illegible] is rated high in beneficial effects.

- **Adverse Effects**

It is in the long term that capping must be evaluated in terms of adverse effects. Maintenance plays a key role in determining whether the site may have future adverse effects. Properly maintained, the cap should provide good protection, however in the event of cap failure, site contaminants have not been reduced in toxicity or volume and will continue to have adverse impacts (as indicated in Alternative 1) if they migrate.

The rating for adverse effects is moderate for capping due to uncertainty of long-term maintenance.

The overall rating is moderate to high.

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Alternative 3 - Containment Without Treatment - Landfill

o Beneficial Effects

Immediate benefits will result from removal of site contaminants and disposal in an on site landfill. Site hazards will be isolated, exposure to contamination will be reduced, and migration of contamination will be controlled. This cleanup alternative provides for stable, long term containment of contaminants. Access to the site is improved, though limited to 10-15 days per year. Storm water runoff quality would be improved because the source contaminated materials have been removed and placed in permanent isolation.

The landfill is designed to be a permanent secure facility, and, with proper maintenance, migration should not occur.

Beneficial effects are rated high.

o Adverse Effects

During construction, short term adverse impacts could occur related to construction activities. These include increased levels of contaminants in storm runoff, removal of vegetated areas, dust generation and construction traffic noise impacts. These can be somewhat controlled by providing for noise, dust, and stormwater control. Residual contaminants below the cleanup limit could pose a lower level long term threat. There is also the possibility of contaminant release if the landfill liner should fail. Because the materials landfilled have not been treated to reduce toxicity, mobility or volume, their migration impacts have not been reduced.

The rating for control of adverse effects is low.

The overall environmental rating is moderate.

Alternative 4 - Total Immobilization with Landfill

o Beneficial Effects

In Alternative 4 the landfill technology is combined with immobilization of the contaminants. The level of protection and risk of failure obtained by combining landfilling and immobilization are favorable, compared to the technologies by themselves. Site hazards will be isolated, exposure to contamination will be reduced, and migration of contamination wil be controlled. With the immobilization treatment applied to landfilled material, an additional level of environmental protection is provided in the reduced mobility of the contaminants. The risk of future leakage and migration from the landfill is very low. Therefore, the beneficial aspects of this alternative are rated high.

o Adverse Effects

Residual contaminants will remain on site below the cleanup limits. These residuals could pose a lower level long term threat. The wastes remain on site in an immobilized state encapsulated in a secure lined landfill, which has a future possibility of failure. If failure should occur the risk of contaminant migration is minimized by the reduced mobility of the contaminants imparted by the immobilization treatment process. Therefore, the adverse effects are rated moderate.

This alternative is rated moderate to high in environmental effectiveness.

Alternative 11 - Total Incineration

o Beneficial Effects

Alternative 11 includes removal and on site incineration of the contaminated materials. Site hazards will be minimized, exposure to contamination wil be reduced, and migration of on site contamination will be minimized. These actions will reduce the long term hazards of the site and minimize the further migration of contaminated materials from the site. The beneficial effects of this alternative are rated high.

o Adverse Effects

The trucking of the arsenic sludge could, on rare occasions, be subject to accidental spillage. Introduction of this arsenic sludge could cause short term degradation and trauma to the environment and exposed organisms. The volume of this sludge is expected to be low, therefore the possible adverse effects of a trucking accident are minor. Incineration is rated low to moderate in control of adverse environmental effects.

Alternative 11 has been rated moderate in the overall consideration of its environmental effects.

Alternative 17 - Total Offsite

- Beneficial Effects

Alternative 17 includes removal and off site disposal of all contaminated materials. Site contamination will be minimized, exposure to contamination will be reduced, and migration of contamination will be minimized. Off site exposure to these contaminants will be controlled by the secure disposal site, which will be a commercial RCRA approved landfill or deep well injection facility. Given the above effects the environmental benefits of Alternative 17 are rated high.

- Adverse Effects

The trucking of the contaminated material could, on rare occasions, be subject to accidental spillage. With the volume of trucking involved in this alternative (over 700 truck loads), the risk of a transportation related accident, possibly resulting in an environmental release, is a significant concern. Also the possible failure of off site disposal facilities is a future adverse incident with an unknown environmental impact, depending on the site selected for disposal. The adverse effects are not considered major, but they are of unknown impact, therefore the rating is low.

Alternative 17 has been rated moderate in its total effect on the environment.

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Alternative 21 - Soil Flushing

Beneficial Effects

Alternative 21 includes removal, on-site treatment, and off site disposal of the contaminated residual materials. Site hazards will be removed and minimized, exposure to contamination will be reduced, and migration of contamination will be minimized. The implementation of soil flushing will extract chemical contaminants from the soils so that treated soils can be re-applied to the excavated areas. The environmental benefits for Alternative 21 are rated high.

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Adverse Effects

The trucking of the arsenic sludge and organic material could, on rare occasions, be subject to accidental spillage. Either of these could present a difficult cleanup. Possible adverse effects are trauma and toxicity to environmental receptors in the vicinity of such a spill. Since the sludges to be removed from the soil flushing process will be highly concentrated and more mobile than in the soil matrix, their toxic effect on receptors will be significant. The total volume to be removed will be relatively small so that the likelihood of a transportation accident resulting in a spill is also minor. Thus Alternative 21 is rated low to moderate in controlling adverse environmental effects.

Alternative 21 has been rated moderate in its overall effects on the environment.

: Beneficial Effects

In Alternative 22 immediate environmental benefits will result from removal of on site contamination above cleanup limits. These contaminated materials will be consolidated in a common unlined cell, where placement of a RCRA cap will complete the encapsulation of the wastes. There is no impact on groundwater, and soil permeability will prevent downward migration of the contaminants. The consolidation/capping cell will be securely fenced to prevent disturbance of the cap. Annual maintenance will be required to ensure that the cap retains its integrity to prevent environmental exposure to the wastes.

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Beneficial effects are rated high.

c Adverse Effects

In the short term the construction related environmental effects include increased levels of contaminants in local storm runoff and airborne dust. These effects can be controlled by providing for dust and stormwater controls. Construction activities will be minimized for this alternative due to the reduced size of excavation needed for the consolidation cell compared to a RCRA landfill. There would be no adverse off site transportation effects.

Control of adverse effects is rated moderate.

Overall environmental effect of implementing Alternative 22 is moderate to high.

4.4.2 Summary of Environmental Effects Evaluation

The environmental evaluation and ratings are summarized in Table 4-4.

TABLE 4-4

SUMMARY OF ENVIRONMENTAL IMPACTS EVALUATION

Remedial Alternative	Beneficial Effects	Adverse Effects	Overall
1. No Action	Low	Low	Low
2. Containment - Capping	High	Moderate	Moderate to High
3. Containment - Landfill	High	Low to Moderate	Moderate
4. Total Immo -bilization	High	Moderate	Moderate to High
11. Total Incin -eration	High	Low to Moderate	Moderate
17. Total Offsite	High	Low	Moderate
21. Soil Flushing	High	Low to Moderate	Moderate
22. Consolidation/ Capping	High	Moderate	Moderate to High

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4.5 PUBLIC HEALTH EVALUATION OF REMEDIAL ALTERNATIVES

The following discussion describes the qualitative evaluation and comparison of public health impacts and protection for each remedial alternative. The evaluation of each alternative is based upon assessing the level of hazard posed by implementing each alternative. Each alternative is addressed according to the detailed criteria presented in Table 4-1:

- Minimization or Prevention of Chemical Releases: how well the alternative prevents the release of additional contaminants from the site or prevents further migration of the contaminants.

- Exposures During Remedial Action: the level of contamination to which workers or nearby residents are exposed during the course of the remedial effort.

- Exposures After Remedial Action: the continuing, residual contamination which will remain in the vicinity of the site for chronic exposure after the remediation is over.

Other criteria which were recommended for consideration by EPA guidance documents (USEPA 1985a) were omitted because they were already considered under other sections of the evaluation, were duplicative of other detailed criteria of this section, or were inapplicable to the site. These included:

- the capacity of the alternatives to minimize or prevent exposures -- covered under the exposures during, and after, remediation,

- the chemical releases not minimized or prevented -- included in the criteria for chemical releases minimized,

- relevant and applicable standards are, or are not, met -- described in the ARAR sections of the institutional evaluation (Section 4.3),

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- adjustments which had to be made to standards, criteria, advisories, or guidance -- also described under the ARARs (Section 4.3).

- exposures during implementation - in all cases except no action, the only public health hazards are construction hazards, primarily to workers; contaminant exposures are minimal and short-term.

By the general rule (Section 4.1) that the higher the evaluation, the more the alternative promotes the intent of the criterion in achieving the remedial objectives, the terms "high", "moderate", and "low" signify that public health is well protected, moderately protected, or only minimally protected, respectively, by the alternative.

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4.5.1 Evaluation of Public Health for Remedial Alternatives

Alternative 1 - No Action

- Minimization or Prevention of Chemical Release

  As indicated previously, the no action alternative does not prevent or minimize chemical releases. Therefore its rating is low.

- Exposure During Remedial Action

  The only exposure during Remedial Action would be that of a fencing contractor. No other work is being done, no excavation work in contaminated areas is expected. Exposure is expected to be minimal. The rating for controlling exposure is low, since no control action in contaminated areas are taken.

- Exposures After Remedial Action

Site conditions remain the same, therefore, the rating is low.

The overall rating for the no action alternative is low.

Alternative 2 - Containment Without Treatment - Capping

o Minimization or Prevention of Chemical Release

While this alternative does not eliminate all migration of contaminated material from the site, it reduces it significantly. The rating for the alternative is moderate.

o Exposures During Remedial Action

During mobilization, construction, demobilization, and site restoration (which is approximately a 3 month duration), little exposure to the residents is expected via inhalation. Construction workers, however, could be exposed to minor exposure from inhalation or direct contact, therefore, protective clothing will be needed. The rating for this alternative is moderate to high.

o Exposures After Remedial Action

After cleanup, little exposure is expected via inhalation or direct contact. The rating for this alternative is moderate to high.

The overall public health protection afforded by Alternative 2 is moderate to high.

Alternative 3 - Containment Without Treatment - Landfill

o Minimization or Prevention of Chemical Release

While this alternative does not eliminate all migration of contaminated material from site, it reduces the source significantly. The rating for the alternative is moderate.

- Exposures During Remedial Action

  During mobilization, construction, demobilization, and site restoration (which is approximately a 4 month duration), little exposure to the residents is expected via inhalation. Construction workers and excavation workers in particular, however, could be exposed to significant exposure from inhalation or direct contact, therefore, protective clothing and respirators will be needed. The rating for this alternative is moderate.

- Exposures After Remedial Action

  After cleanup, little exposure is expected via inhalation (due to reduced dusting) or direct contact (due to land use restriction). The rating for this alternative is moderate to high.

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The overall public health protection afforded by Alternative 3 is moderate to high.

Alternative 4 - Total Immobilization

- Minimization or Prevention of Chemical Release

  While this alternative does not eliminate all migration of contaminated material from the site, it reduces the source significantly. The rating for the alternative on this account is moderate.

- Exposures During Remedial Action

  During mobilization, construction, treatment, demobilization, and site restoration (which is approximately a 6 month duration), little exposure to the residents is expected via inhalation. Construction workers, excavation workers, and treatment operators could be exposed to significant exposure from inhalation or direct contact, therefore, protective clothing and respirators will be needed. The rating for this alternative is moderate.

- Exposures After Remedial Action

  After cleanup, little exposure is expected via inhalation (due to reduced dusting) or direct contact (due to land use restriction). The rating for this alternative is moderate to high.

The overall public health protection afforded by Alternative 4 is moderate to high.

Alternative 11 - Total Incineration

- Minimization or Prevention of Chemical Release

  While this alternative does not eliminate all migration of contaminated material from the site, it significantly reduces the toxicity and volume of the waste. Because the toxicity is reduced, the rating for the alternative is high.

- Exposures During Remedial Action

  During mobilization, construction, treatment, demobilization, and site restoration (which is approximately an 18 month duration), little exposure to the residents is expected via inhalation. Construction workers, however, could be exposed to significant exposure from inhalation or direct contact, therefore, protective clothing and respirators will be needed. The rating for this alternative is moderate.

- Exposures After Remedial Action

  After cleanup, the organic hydrocarbon toxicity is greatly reduced. The toxicity of arsenic can not be reduced; therefore the arsenic sludge remaining from the treatment process will be contained in a secure landfill off site. Although the same potential exists for failure as Alternatives 3 and 4, this alternative only contains arsenic, a relatively immobile waste. Therefore, the exposure rating is high.

The overall public health protection afforded by Alternative 11 is moderate to high.

Alternative 17 - Total Offsite

- Minimization or Prevention of Chemical Release

  The evaluation of the release of chemicals for this alternative is the same as Alternative 11. The rating is moderate.

- Exposures During Remedial Action

  The evaluation of the exposure during remedial action for this alternative is the same as Alternative 3. The rating for this alternative is moderate.

  This alternative involves the off site transportation (estimated at about 320 miles) of all the contaminated material (estimated at about 730 truck loads). Thus, it has the highest risk of accidental spillage of contaminated material during transport.

- Exposures After Remedial Action

  The evaluation of the exposure after remedial action for this alternative is the same as Alternative 11. It is assumed that the increased risk to the population surrounding the off site landfill, due to the disposal of CCA wastes, is minimal because it will be a licensed commercial facility. The rating is moderate to high.

The overall public health protection afforded by alternative 17 is moderate to high.

Alternative 21 - Soil Flushing

o Minimization or Prevention of Chemical Release

While this alternative does not eliminate all migration of contaminated material from site, it reduces it significantly. The rating for the alternative is moderate.

o Exposures During Remedial Action

During mobilization, construction, treatment, demobilization, and site restoration (which is approximately an 18 month duration), little exposure to the residents is expected via inhalation. Construction workers, however, could be exposed to significant exposure from inhalation or direct contact, therefore, protective clothing and respirators will be needed. The rating for this alternative is moderate.

o Exposures After Remedial Action

After cleanup, little exposure is expected via inhalation (due to reduced dusting) or direct contact (due to land use restriction). The rating for this alternative is high.

The overall public health protection afforded by Alternative 21 is moderate to high.

Alternative 22 - Containment Without Treatment - Consolidation/Capping

o Minimization or Prevention of Chemical Release

While this alternative does not eliminate all migration of contaminated material from site, it reduces the source significantly. The rating for the alternative is moderate.

- Exposures During Remedial Action

During mobilization, construction, demobilization, and site restoration (which is approximately a 4 month duration), little exposure to the residents is expected via inhalation. Construction workers and excavation workers in particular, however, could be exposed to significant exposure from inhalation or direct contact, therefore, protective clothing and respirators will be needed. The rating for this alternative is moderate.

- Exposures After Remedial Action

After cleanup, little exposure is expected via inhalation (due to reduced dusting) or direct contact (due to land use restriction). The rating for this alternative is moderate to high.

The overall public health protection afforded by Alternative 22 is moderate to high.

4.3.2 Summary of Public Health Impacts Analysis

Table 4-5 is included here as a synopsis of each of the aspects affecting the various criteria, the ratings for the criteria, and the overall ratings for public health impacts.

TABLE 4-5

SUMMARY OF PUBLIC HEALTH EVALUATION

Remedial Alternative	Minimization of Chemical Releases	Exposures during Remedial Action	Exposures after Remedial Action	Overall
1. No Action	Low	Low	Low	Low
2. Containment - Capping	Moderate	Moderate to High	Moderate to High	Moderate to High
3. Containment - Landfill	Moderate	Moderate	Moderate to High	Moderate to High
4. Total Immo-bilization	Moderate	Moderate	Moderate to High	Moderate to High
11. Total Incin-eration	High	Moderate	Moderate to High	High
17. Total Offsite	Moderate	Moderate	Moderate to High	Moderate to High
21. Soil Flushing	Moderate	Moderate	High	Moderate to High
22. Containment-Consolidation Capping	Moderate	Moderate	Moderate to High	Moderate to High

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4.6 COST ANALYSIS

The detailed cost analysis consists of the three steps as specified in the EPA Guidance on Feasibility Studies under CERCLA (EPA 1985a): estimation of costs, present worth analysis, and sensitivity analysis. The development of conceptual level cost estimates is based on the conceptual engineering performed for each remedial alternative as presented in Section 3.0. The cost estimates presented in this section are expressed in 1987 dollars and include capital costs and annual operation and maintenance costs. The cost estimates are accurate to within -30 percent and +50 percent of the final project cost as per the Guidance Document.

With respect to the future cost of remedy should failure occur, Alternatives 11 (Total Incineration), 17 (Total Off Site) and 21 (Soil Flushing) involve off site disposal of all contaminants. It is assumed that the operators of those off site facilities would bear the cost of any failure. Alternatives 2 (Capping) and 22 (Consolidation/Capping) both involve on site disposal by containment without treatment. The most likely failure for these alternatives would be cap failure, for which an estimated repair cost has been included under Operation and Maintenance. Alternatives 3 (Landfill) and 4 (Total Immobilization), both use a capped landfill. Its most likely failure mode is liner failure, because cap repair cost has been included under Operation and Maintenance. Liners are expected to last for approximately 100 years, according to manufacturers of lining materials. There is no significant experience on liner failure for the particular wastes involved at the CCA site. The Liner Compatibility test results in Appendix E are difficult to interpret, in that some parameters appear to decrease in strength, while others increase in strength, compared to control specimens. Present value cost of total remedy replacement for either Alternative 3 or 4 is approximately $100,000.00 or less, assuming 4% interest rate over a 100 year period. Finally, Alternative 1 (No Action) is likely to fail since it includes no remedial action. Cost of its failure is assumed to be at least the cost of the next cheapest alternative (22), or about $1.6 million present worth.

4.6.1 Capital Costs

All important facilities/equipment and construction features identified in the conceptual design were quantified and used in estimating the capital costs. The total capital costs were developed under two major categories: direct costs and indirect costs. The major direct capital costs include such items as site preparation, construction, equipment, buildings, and services costs. Materials, equipment, and installation costs for each remedial alternative were derived from literature sources, vendor quotes, and previous studies. Table 4-6, which is placed at the end of this section, includes a summary of the capital cost estimates including both direct and indirect capital costs. An itemized breakdown of the capital cost estimates for the remedial alternatives is presented in Appendix D by major cost components.

The indirect capital costs include engineering, design, administration and inspection expenses, contingency allowances, preparation of permit-equivalent information, and in some cases, shakedown. Shakedown costs take into consideration any additional costs created in getting from completion of construction to functional operation. The assumptions used for indirect capital costs estimates are as follows:

- Contingency allowances: 5 - 20% of Total Direct Construction Cost, depending on how well the technologies involved are established and the uncertainties involved in implementation.

- Engineering and design expenses: 5 - 12% of Total Direct Construction Cost, depending on the complexity of the technology and ancillary equipment needs.

- Administration and inspection expenses: 4 - 5% of Total Direct Construction Cost.

- Permit-Related Costs: 0.5 - 2% of Total Direct Construction Cost.

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- o Shakedown Costs: 1 - 2% of Total Direct Construction Cost, added if the process requires preliminary adjustments in operation.

4.6.2 Annual Operation and Maintenance Costs

The annual operation costs for each cost component were developed based on estimated power demand, material and chemical quantities, and sampling and analysis requirements. Unit cost rates provided by vendors were used to estimate some of these operation costs. The annual maintenance costs were developed based on equipment replacement schedules and servicing requirements, and general maintenance activities.

An itemized breakdown of the annual operation and maintenance cost estimates for the remedial alternatives is presented in Appendix D. The total estimated annual operation and maintenance costs incurred are also summarized in Table 4-6.

4.6.3 Present Worth

Present worth analysis is used to evaluate the capital and operation and maintenance costs that occur over different time periods of the remedial alternatives by discounting all future costs to a common monetary basis, the present worth. This allows the costs of the various alternatives to be compared on the basis of a single total cost figure representing the amount of money, that, if invested in the base year and expended as needed, would be sufficient to cover all costs associated with the remedial action over its planned life. The present worth of an alternative is computed according to the following formula:

$$PW = (PWF_{\substack{i = 4\% \\ n = 30\ Yrs}})\ (O + M) + TCC$$

Where:

PW = present worth

PWF = present worth factor for an interest rate of 4 percent and a period of thirty years

O = annual operation cost

M = annual maintenance cost

TCC = total capital cost

The PWF is a function of the interest rate and the time period. An interest rate of 4 percent and a time period of 30 years was used to develop the present worth according to the EPA Guidance Document (EPA 1985c). It should be noted that no inflation factor has been considered in the operation and maintenance cost. Although maintenance of arsenical wastes is expected to be required in perpetuity, the Guidance Document limits the time period of analysis (planned life) to a maximum of 30 years. Table 4-6 presents a summary of the present worth of each of the remedial alternatives including its capital cost and the present worth of its operation and maintenance cost.

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4.6.4 Sensitivity Analysis

A sensitivity analysis may be conducted to assess the effect that assumptions associated with the design, implementation, operation, interest rate, and planned life can have on the estimated costs of the alternatives. These assumptions depend on the accuracy of the data developed during the remedial investigation and on prediction of the future behavior of the remedial technology and are subject to varying degrees of uncertainty. The sensitivity of the costs to these uncertainties can be evaluated by varying these assumptions and noting the effect on estimated costs.

Sensitivity of the present worth of the operation and maintenance costs to interest rates 4%, 7%, and 10% was analyzed and is also summarized in Appendix D. As shown, the present worth of each alternative increases as the interest rate decreases since the higher the interest rate, the less money is needed initially to finance the annual operation and maintenance costs over the 30 years. The use of lower interest rates may also be interpreted as an inclusion of inflation rates. For example, a 7 percent interest rate may be interpreted as a 10 percent time value of money with a 3 percent inflation rate. The present worth of remedial alternatives with high annual operation and maintenance costs compared to capital cost are more sensitive to interest rates than those with low operation and maintenance costs relative to capital costs. This fact indicates that if inflation is considered significant, alternatives with high operation and maintenance costs become less attractive economically.

4.6.5 Summary of Cost Estimates

Table 4-6 presents a summary of the cost estimates for the final candidate Remedial Alternatives. The costs of the major components of each alternative are listed. Capital costs, operation and maintenance costs and present worth values for an interest rate of 4 percent are presented. Details of the costs may be found in Appendix D.

SUMMARY OF COST ESTIMATES

Remedial Alternative	Capital Cost	Operation and Maintenance	Present Worth of O & M (4%)	Total
1. No Action	$ 154,016	$ 26,000	$ 449,593	$ 603,609
2. Containment - Capping	1,382,432	36,848	637,876	2,020,308
3. Containment - Landfill	1,511,254	27,331	472,608	1,983,862
4. Total Immobilization	3,264,872	27,551	476,405	3,741,277
11. Total Incineration	11,105,206	16,000	276,673	11,381,879
17. Total Offsite	6,717,816	16,000	276,673	6,994,489
21. Soil Flushing	15,804,358	16,000	276,673	16,081,031
22. Containment-Consolidation/Capping	1,132,318	27,247	471,148	1,603,466

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SECTION V

5.0 SUMMARY OF ALTERNATIVES

This section presents a summary of the detailed evaluation of the remedial alternatives in terms of costs (capital costs and present worth of total costs), and various evaluation criteria including public health, environmental, technical, institutional and community concerns. The advantages and disadvantages of each remedial alternative are discussed and the alternatives ranked.

A summary of the alternatives is presented in Table 5-1. The advantages and disadvantages of these alternatives are highlighted below.

In all of the action alternatives, soil removal or treatment is to be accomplished only on the soils identified to be above the cleanup level of 100 ppm for the indicator parameters (DDT, toxaphene and arsenic). Based on this level of potential residual contamination, site access will need to be limited to 10 to 15 days per year.

Alternative 1: No Action

The best feature of Alternative 1 is that it has the lowest cost (Table 5-1), which is the capital cost of fence construction plus the present value of annual fence maintenance and monitoring. If the no action alternative were selected, the airport could not be used, even to a limited extent. Health effects which are evaluated in Section 1.4 identified unacceptable risk of contaminant exposure as the site exists without remediation. Regulatory limits on water quality have been exceeded and would tend to get worse rather than better as time goes by. Contaminant migration would extend the limits of areas contaminated beyond the property boundary.

TABLE 5-1

SUMMARY OF DETAILED EVALUATION

Remedial Alternative	Technical Feasibility Rating	Institutional Requirements Rating	Public Health Requirements Rating	Environmental Impacts Rating	Cost Analysis ($ 1000)
1. No Action	Low	Low to Moderate	Low	Low	$ 603
2. Containment - Capping	Moderate to High	Moderate to High	Moderate to High	Moderate to High	2,020
3. Containment - Landfill	Moderate	Moderate to High	Moderate to High	Moderate	1,983
4. Total Immobilization	Moderate to High	Moderate to High	Moderate to High	Moderate to High	3,741
11. Total Incineration	Moderate	Moderate to High	High	Moderate	11,381
17. Total Off Site	Moderate	Moderate	Moderate to High	Moderate	6,994
21. Soil Flushing	Moderate to High	Moderate to High	Moderate to High	Moderate	16,081
22. Consolidation/ Capping	High	Low to Moderate	Moderate to High	Moderate to High	1,603

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Alternative 2: Containment without Treatment - Capping

The option of capping or sealing off the surface of contaminated areas of the site is an attractive alternative. It is simple to understand, easy to implement, and one of the least costly alternatives which is protective of human health and the environment. At the CCA Site, capping would be highly effective, both as a source containment technology and as an isolation shield to protect against physical contact with the wastes.

Site features which favor capping are 1) the impermeable nature of the soils, 2) the lack of near surface groundwater resources, and 3) the potential future use of the airport.

There are several disadvantages to capping. The contamination remains unchanged in place. Although the forces of migration are isolated from the wastes, the contaminants are not reduced in mobility, toxicity, or volume. The cap would require periodic maintenance. Any construction at the airport would need to consider the possibility of exposure to the wastes if the cap was disturbed.

Regulatory compliance is not achieved by the capping alternative alone; the chemical parameters are not reduced in volume, toxicity or mobility.

Alternative 3: Containment without Treatment - Landfill

This alternative is even more attractive than capping, due to the fact that contaminants are removed and placed in an on site landfill. Because the landfill is to be designed in accordance with RCRA, the remedy offers more protection to the environment than capping alone, and achieves a greater degree of regulatory compliance.

There are disadvantages to direct landfilling. Even though technology has improved, a man-made containment structure such as a secure RCRA

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landfill has the possibility of failure. Wastes are not modified in this alternative to reduce toxicity, mobility or volume prior to landfilling. Therefore, if the landfill fails, the wastes are subject to the same forces of migration as they were without the landfill. There is a requirement to perform periodic inspections, monitoring, operation of collection systems, and corrective action as needed.

Alternative 4: Total Immobilization with Landfilling

The major advantage of this alternative is the level of risk reduction, or environment protection redundancy, provided by disposing of the immobilized waste soil in a secure landfill. The landfill prevents the forces of migration from contacting the wastes. The immobilization of the wastes reduces their mobility on a long term basis. The ARARs are complied with and the institutional requirements are rated high.

The disadvantages are increased cost for the lower long term risk provided by the immobilization procedure. In addition, the construction of the RCRA landfill must be completed before starting the immobilization process.

Alternative 11: Incineration

The major advantage of this alternative is the detoxification of the organic hydrocarbons present in the soil treated, thus, reducing the level of risk. In addition, the removal and disposal (at an off site landfill) of arsenic compounds from the soil treated will also help to reduce the level of risk.

The disadvantages of this alternative include cost, implementability, reliability, and community concern.

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Alternative 17: Off Site

The major advantage to this alternative is the on site level of risk reduction by disposing of the contaminated materials in an off site secure landfill.

The disadvantages to this alternative include institutional requirements, cost, reliability and community concern. This alternative does not reduce the mobility, toxicity, or volume of the contaminants.

Alternative 21: Soil Flushing

The major advantage of this alternative is removal of virtually all of the organic hydrocarbons and arsenic from the soil that is treated, and their off site disposal. Thus, it would reduce the level of risk.

The disadvantages of this alternative include the lack of proven feasibility, implementability, reliability, and potential community concern.

Alternative 22: Consolidation/Capping

The option of capping or sealing off the consolidated contaminants is an attractive alternative. At the CCA Site, capping would be highly effective, both as a source containment technology and as an isolation shield to protect against physical contact with the wastes. Site features which favor capping are 1) the impermeable nature of the soils, 2) the lack of near surface groundwater resources, and 3) the potential future use of the airport.

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Consolidation of the wastes in an on site cell, followed by capping with a RCRA designed cap will be a relatively easy construction project to implement. Excavation methods are relatively routine. Less excavation is required for the consolidation cell, compared to an on site RCRA landfill. Operation and maintenance is reduced because leak detection and leachate collection systems are not required. If technologies for more cost effective, on site treatment of these wastes are developed in the future, the wastes could be readily removed from, or treated in place in the consolidation cell. Other than the No Action alternative, this remedy is the least costly one which removes wastes from its present location.

One disadvantage of alternative 22 is that the remedy relies on natural soil containment, rather than synthetic lining. Since no near surface groundwater is present, the contaminants are tightly bound to soil particles, and the cap will isolate the wastes from contact with erosion forces, the possibility of migration is not significant. Another disadvantage is that the contaminants are not reduced in mobility toxicity, or volume.

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APPENDIX A

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APPENDIX A

USEPA REGION VI

LETTER TO TWC

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VI
ALLIED BANK TOWER AT FOUNTAIN PLACE
1445 ROSS AVENUE
DALLAS, TEXAS 75202

April 10, 1987

Mr. Greg Tipple
Texas Water Commission
P.O. Box 13087, Capitol Station
Austin, Texas 78711

Dear Mr. Tipple:

The purpose of this letter is to summarize the April 1, 1987, conference call regarding the Crystal City Airport risk assessment. As discussed, the risk assessment should be developed assuming casual exposure for the ingestion and direct contact pathways and for both casual and residential exposure for the inhalation pathway. The fraction of the year for which a person would be casually exposed to the site should be revised from 60 days/year to between 10-15 days/year. In addition to revising the duration of exposure, the soil intake of .42 grams should be reduced to .1 gram for determining an advisory soil concentration for the ingestion pathway. The assessment for inhalation should be based on an air concentration of inhalable particles which represents the actual percentage a contaminant is present, rather than assuming the entire inhalable particles are completely contaminated. Finally, as discussed, the previously proposed action level of 100 ppm toxaphene (October 16, 1986) should be used by EBASCO in developing alternatives in the feasibility study.

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The intent of performing a site specific risk assessment was to develop acceptable concentration levels based on the anticipated usage of the site. Assuming that the airport is opened following remediation, the exposure to site contamination would be, at most, limited. Based on conversations with local officials previous usage of the airport has been minimal; therefore, it is highly unlikely there would be day to day exposure to site contaminants in the future. Maintenance on the airport is now and would continue to be minimal. Based on this information, it is appropriate to assume site exposure would range from 10 to 15 days/year.

The assumption of an adult ingesting .42 grams of soil per day seems excessive for the Crystal City Airport. This number was developed for calculating the potential cancer risk an adult would be subjected through ingestion under normal circumstances. From a review of the Journal of Toxicological and Environmental Health (vol 14:4739, 1984), it appears an intake level of .1 gram would be appropriate for ingestion of contaminated soils. Ingestion of site soils would be on a limited basis; therefore, the assessment should be performed assuming occasional exposure (10-15 days/year).

EBASCO's risk assessment for the inhalation pathway should be based on the air concentration of inhalable particles which reflect actual site conditions. The recently completed risk assessment assumes all of the inhalable particles are completely contaminated by each constituent present at the site. A more realistic assumption would be that the inhalable particles are contaminated by the same percentage of contaminants present in the on-site contaminated soil. The assessment for inhalation of these contaminated particles should be performed for both the casual and residential settings.

Through a literature search performed in October 1986, a guidance titled Health Assessment Document for Acrylonitrile (October 1983) was used to obtain a proposed action level of 100 ppm toxaphene. The advisory soil concentration appears to coincide with the proposed action level if the above noted site specific assumptions are used during the calculations. Since the proposed action level is approximately equal to the revised site specific soil advisory concentration, EBASCO is directed to use 100 ppm toxaphene during the development of alternatives within the feasibility study.

Should you have any questions, please contact Jim McGuire at (214) 655-6715.

Sincerely,

Stanley G. Hitt, Chief
Texas Remedial Section

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APPENDIX B

APPENDIX B

REMEDIAL TECHNOLOGIES POTENTIALLY
APPLICABLE TO HAZARDOUS WASTE SITES

REMEDIAL TECHNOLOGIES POTENTIALLY APPLICABLE TO HAZARDOUS WASTE SITES

1. NO ACTION

   A. Monitoring

      1. Public Drinking Water
      2. Surface Streams

2. CONTAINMENT

   A. Capping

      1. Native Material
      2. Clay
      3. Chemical Sealants/Stabilizers
      4. Asphalt
      5. Concrete
      6. Synthetic Membranes
      7. Multimedia

   B. Containment Barriers

      1. Gas/Vapors

         a. Soil Bentonite Slurry Wall
         b. Cement Bentonite Slurry Wall
         c. Grout Curtains
         d. Steel Sheet Piling

      2. Particulates

         a. Native Material
         b. Clay
         c. Chemical Sealants/Stabilizers
         d. Asphalt
         e. Concrete
         f. Synthetic Membranes
         g. Multimedia
         h. Windscreens

      3. Sediments

         a. Curtains
         b. Cofferdams
         c. Pneumatic Barriers

3. COLLECTION/DIVERSION

A. <u>Gas/Vapors</u>

1. Pipe Vents (Passive)
2. Trench Vents (Passive)
3. Active Gas Collection

B. <u>Surface Water</u>

1. Dikes and Berms
2. Ditches and Trenches
3. Terraces and Benches
4. Chutes and Downpipes
5. Seepage Basins
6. Sedimentation Basins
7. Levees
8. Addition of Freeboard
9. Floodwalls

4. REMOVAL

A. <u>Liquid Wastes</u>

1. Mechanical Pumps
2. Siphons
3. Tanker Truck

B. <u>Solid Wastes/Soil</u>

1. Backhoe
2. Dragline
3. Cranes and Attachments
4. Front End Loaders
5. Scrapers
6. Pumps
7. Industrial Vacuums
8. Drum Grapplers
9. Forklifts and Attachments

C. <u>Sediments</u>

1. Mechanical Dredging

a) Clamshell
b) Dragline
c) Backhoe

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2. Hydraulic Dredging

   a) Plain Suction
   b) Cutterhead
   c) Dust Pan

3. Pneumatic Dredging

   a) Airlift
   b) Pneuma
   c) Oozer

5. LAND SURFACE MODIFICATION

A. Grading

1. Spreading
2. Scarification
3. Tracking
4. Contour Furrowing

B. Revegetation

1. Grasses
2. Legumes
3. Shrubs
4. Trees (Conifers, Hardwoods)

6. ON- OR OFF- SITE DISPOSAL

A. Contaminated Liquids

1. Discharge to Municipal or Industrial Treatment Facility
2. Discharge to Water Body
3. Reuse/Recycle
4. Deep Well Injection
5. Temporary Storage (Tank, Surface Impoundment)
6. Thermal Destruction (see IV.B.4)

B. Contaminated Solids

1. Land Application
2. Landfill
3. Thermal Destruction (see IV.B.4)
4. Temporary Storage (Waste Pile)

C. Treated Liquids

1. Discharge to Municipal Or Industrial Treatment Facility
2. Discharge to Water Body
3. Injection (see II.B.4)
4. Reuse/Recycle (Water Supply, Irrigation)
5. Temporary Storage (Tank, Surface Impoundment)

D. <u>Treated Solids</u>

1. Land Application or Backfill
2. Landfill
3. Reuse/Recyle (Construction Material)
4. Temporary Storage

7. ON- OR OFF-SITE TREATMENT[1]

A. <u>Biological</u>

1. Aerobic

a) Activated Sludge (W,L)
b) Trickling Filter (W,L)
c) Rotating Biological Contactor (W,L)
d) Oxidation Ditch (W,L)
e) Aerated Lagoon (W,L)
f) Sequencing Batch Reactor (W,L)
g) Fluidized Bed (W,L)
h) Composting (S,D)
i) Land Farming (S,D)
j) Nitrification/Denitrification (W,L)

2. Anaerobic (Digestion)

a) Single Stage (W,L,S)
b) Two Stage (W,L,S)
c) Two Phase (W,L,S)
d) Fixed Bed (W,L)
e) Fluidized Bed (W,L,S)
f) Solids Contact (W,L,S)
g) Lagoon (W,L,S)

B. <u>Chemical</u>

1. Neutralization (W,L,S,D)
2. Precipitation (W,L,S,D)
3. Activated Alumina Adsorption (G,W,L)
4. Ion Exchange (W,L)
5. Coagulation/Flocculation (W,L,S)
6. Chemical Oxidation (W,L,S,D)

a) Hydrogen Peroxide
b) Ozonation
c) Permanganate
d) Chlorination

7. Reduction (W,L,S,D)
8. Hydrolysis (W,L,S,D)
9. Chemical Dechlorination (W,L,S,D)

10. Ultraviolet Radiation (W,L)
11. Formaldehyde (S)
12. Catalytic Hydrogenation (W,L)
13. Photolysis (G,P,W,L,S)
14. Electrodialysis (W,L)

C. <u>Physical</u>

1. Flow Equalization (W,L)
2. Sedimentation (W,L,S)
3. Activated Carbon Adsorption (G,W,L)
4. Reverse Osmosis/Membrane Separation/Dialysis (G,W,L)
5. Liquid-Liquid Extraction (W,L)
6. Gravity Flotation (W,L)
7. Steam Distillation (W,L,S)
8. Air Stripping (W,L)
9. Steam Stripping (W,L)
10. Filtration (W,L)

    a) Granular Bed
    b) Fabric
    c) Porous Membrane

11. Ultrafiltration (W,L)
12. Dissolved Air Flotation (W,L,S)
13. Evaporation (W,L,S)
14. Soil Washing/Solvent Extraction (W,L,S)
15. Dewatering

    a) Screens, Hydraulic Classifiers, Scalpers (W,L,S,D)
    b) Centrifuges (W,L,S)
    c) Gravity Thickening (W,L,S)
    d) Belt Presses (S,D)
    e) Plate/Frame or Recessed Plate Filter Presses (S,D)
    f) Drying Beds (S,D)
    g) Vacuum Filtration (S,D)

16. High Gradient Magnetic Separation (S)
17. Mechanical Aeration

D. <u>Solidification/Stabilization/Fixation</u> (P,W,L,S,D)

1. Cement-Based (W,L,S,D)
2. Lime-Based (W,L,S,D)
3. Thermoplastics (S,D)
4. Organic Polymer (S,D)
5. Self-Cementation (S)
6. Surface Encapsulation (S,D)
7. Fly Ash, Sawdust, or Polymer Soil Amendment (S,D)
8. Water, Polymers, or Calcium Chloride Wetting Agents (P,S)

E. Thermal

1. Rotary/Cement Kiln (G,S,D)
2. Fluidized/Circulating Bed (G,W,L,S,D)
3. Multiple Hearth (S,D)
4. Liquid Injection (W,L)
5. Molten Salt (S)
6. Molten Glass (S)
7. High Temperature Fluid Wall (G,W,L,S,D)
8. Plasma Arc Pyrolysis (S)
9. Pyrolysis/Starved Combustion (S)
10. Wet Air Oxidation (W,L,S)
11. Infrared Combustion (S)
12. Industrial Boiler or Furnace (S)
13. Vitrification (S)

F. Land Treatment

1. Land Farming

B. IN-SITU TREATMENT[1]

A. Biological

1. Aerobic

a) Nutrient Supplementation (W,L,S,D)
b) Microbial Seeding (W,L,S,D)
c) Nitrification/Denitrification (W,L,S)
d) Oxygenation (W,L,S,D)

2. Anaerobic

a) Nutrient Supplementation (W,L,S,D)
b) Microbial Seeding (W,L,S,D)

B. Chemical

1. Neutralization (W,L,S,D)
2. Sulfide Precipitation (W,L,S,D)
3. Hydroxide Precipitation (W,L,S,D)
4. Oxidation (W,L,S,D)
5. Reduction(W,L,S,D)
6. Hydrolysis (W,L,S,D)
7. Chemical Dechlorination (W,L,S,D)
8. Polymerization (W,L)

C. Physical

1. Soil Aeration (L,S)
2. Solvent Flushing (L,S,D)
3. Mining with Surfactant (L,S)
4. Permeable Bed Treatment (G,S,L)

   a) Limestone
   b) Activated Carbon

5. Solidification (W,L,S,D)

   a) Cement - Based
   b) Lime - Based
   c) Thermoplastics
   d) Organic Polymers
   e) Self-Cementation

6. Soil Amendment (S)

7. Vaporization (G,W,L,S)

D. Thermal

1. Vitrification (S)

2. RF Heating

E. Immobilization

9. INSTITUTIONAL CONTROLS

A. Land Use Restrictions

B. Water Use Restrictions

1/ Treatment technologies are keyed to types of materials that can potentially be handled as follows: G - Gas/Vapor; P - Particulates; W - Surface Waters; L - Leachate/Groundwater; S - Solid Wastes/Soils; and D - Sediments

APPENDIX C

APPENDIX C

NCP APPLICABLE, RELEVANT AND APPROPRIATE REQUIREMENTS

APPENDIX C

Potentially applicable or relevant and appropriate requirements.

1. EPA's Office of Solid Waste administers, inter alia, the Resource Conservation and Recovery Act of 1976, as amended (Pub. L. 94-580, 90 Stat 95, 42 U.S.C. 6901 et seq.). Potentially applicable are relevant requirements pursuant to that Act are:

    a. Open Dump Criteria - Pursuant to RCRA Subtitle D criteria for classification of solid waste disposal facilities (40 CFR Part 257). Note: Only relevant to nonhazardous wastes.

    b. In most situations Superfund wastes will be handled in accordance with RCRA Subtitle C requirements governing standards for owners and operators of hazardous waste treatment, storage, and disposal facilities: 40 CFR Part 264, for permitted facilities, and 40 CFR Part 265, for interim status facilities.

        - Ground Water Protection (40 CFR 264.90-264.109)
        - Ground Water Monitoring (40 CFR 265.90-265.94)
        - Closure and Post Closure (40 CFR 264.110-264.120, 265.110-265.112)
        - Containers (40 CFR 264.170-264.178, 265.170-265.177)
        - Tanks (40 CFR 264.190-264.200, 265.190-265.199)
        - Surface Impoundments (40 CFR 264.220-264.249, 265.220-265-230)

- Waste Piles (40 CFR 264.250-264.269, 265.250-265.258)

- Land Treatment (40 CFR 264.270-264.299, 265.270-265.282)

- Landfills (40 CFR 264.300-264.339, 265.330-265.316)

- Incinerators (40 CFR 264.340-264.999, 265.340-265.369)

2. EPA's Office of Water administers several potentially applicable or relevant and appropriate statutes and regulations issued thereunder:

   a. Section 14.2 of the Public Health Service Act as amended by the Safe Drinking Water Act as amended (Pub. L.93-523, 88 Stat. 1660, 42 U.S.C. 300f et. seq.).

      - Maximum Contaminant Levels (for all sources of drinking water exposure). (40 CFR 141.11-141.16)

      - Underground Injection Control Regulations. (40 CFR Parts 144, 145, 146, and 147)

   b. Clean Water Act as amended (Pub. L. 92-500, 86 Stat. 816, 33 U.S.C. 1251 et. seq.).

      - Requirements established pursuant to sections 301, 302, 303 (including State water quality standards), 306, 307, (including Federal pretreatment requirements for discharge into a publicly owned treatment works), and 403 of the Clean Water Act. (40 CFR Parts 131.400-469)

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c. Marine Protection, Research, and Sanctuaries Act (33 U.S.C. 1401).

- Incineration at sea requirements. (40 CFR Parts 220-225, 227, 228. See also 40 CFR 125.120-125.124,

3. EPA's Office of Pesticides and Toxic Substances.

a. Toxic Substances Control Act (15 U.S.C. 2601).

- PCB Requirements Generally: 40 CFR Part 761; Manufacturing Processing, Distribution in Commerce, and Use of PCBs and PCB Items (40 CFR 761.20-761.30); Markings of PCBs and PCB Items (40 CFR 761.40-761.45); Storage and Disposal (40 CFR 761.60-761.79). Records and Reports (40 CFR 761.180-761.185). See also 40 CFR 129.105, 750.

- Disposal of Waste Material Containing TCDD. (40 CFR Parts 775.180-775.197)

4. EPA's Office of External Affairs

Section 404 (b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR Part 230).

Procedures for Denial or Restriction of Disposal Sites for Dredged Material (Section 404(c) Procedures, 40 CFR Part 231).

5. EPA's Office of Air and Radiation administers several potentially applicable or relevant and appropriate statutes and regulations issued thereunder.

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c. Clean Air Act (42 U.S.C. 7401).

- National Ambient Air Quality Standards for total suspended particulates (40 CFR Parts 50.6-50.7)

- National Ambient Air Quality Standards for ozone (40 CFR 50.9)

- Standards for Protection Against Radiation - High and low level radioactive waste rule, (10 CFR Part 20). See also 10 CFR Parts 10, 40, 60, 61, 72, 960, 961

- National Emission Standards for Hazardous Air Pollutants for Asbestos, (40 CFR 61.140-61.156). See also 40 CFR 427.110-427.116, 763

- National Emission Standard for Hazardous Air Pollutants for Radionuclides (40 CFR Part 61, 10 CFR 20.101-20.108)

6. Other Federal Requirements

a. OSHA requirements for workers engaged in response activities are codified under the Occupational Safety and Health Act of 1970 (29 U.S.C. 651). The relevant regulatory requirements are included under:

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- Occupational Safety and Health Standards (General Industry Standards) (29 CFR Part 1910)

- The Safety and Health Standards for Federal Service Contracts (29 CFR Part 1926)

- Recordkeeping, reporting, and related regulations (29 CFR Part 1904)

b. Historic Sites, Buildings, and Antiquities Act (16 U.S.C. 461).

c. National Historic Preservation Act, 16 U.S.C. 470. Compliance with NEPA required pursuant to 7 CFR Part 650. Protection of Archaeological Resources: Uniform Regulation -Department of Defense (32 CFR Part 229, 229.4). Department of the Interior (43 CFR Part 7, 7.4).

d. DOT Rules for the Transportation of Hazardous Materials, 49 CFR Parts 107, 171.1-171.500. Regulation of activities in or affecting waters of the United States pursuant to 33 CFR Parts 320-329. The following requirements are also triggered by Fund-financed actions:

  - Endangered Species Act of 1973, 16 U.S.C. 1531. (Generally, 50 CFR Parts 81, 225, 402). Wild and Scenic Rivers Act, 16 U.S.C. 1271

  - Fish and Wildlife Coordination Act, 16 U.S.C 661 note

- Fish and Wildlife Improvement Act of 1978, and Fish and Wildlife Act of 1956, 16 U.S.C. 742a note

- Fish and Wildlife Conservation Act of 1980, 16 U.S.C. 2901. (Generally, 50 CFR Part 83)

- Coastal Zone Management Act of 1972, 16 U.S.C. 1451. (Generally, 15 CFR Part 930 and 15 CFR 923.45 for Air and Water Pollution Control Requirements)

Other Federal Criteria, Advisories, Guidance, and State Standards to be Considered

1. Federal Criteria, Advisories, and Procedures

Health Effects Assessments (HEAs).

Recommended Maximum Concentration Limits (RMCLs).

Federal Water Quality Criteria (1976, 1980, 1984). Note: Federal Water Quality Criteria are not legally enforceable. State water quality standards are legally enforceable, and are developed using appropriate aspects of Federal Water Quality Criteria. In many cases, state water quality standards do not include specific numerical limitations on a large number of priority pollutants. When neither state standards nor MCLs exist for a given pollutant, Federal Water Quality Criteria are pertinent and therefore are to be considered.

Pesticides registrations.

Pesticides and food additive tolerances and action levels. Note: Germane portions of tolerances and action levels may be pertinent and therefore are to be considered in certain situations.

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Waste load allocation procedures, EPA Office of Waste.

Federal sole source aquifer requirements.

Public health basis for the decision to list pollutants as hazardous under section 112 of the Clean Air Act.

EPA's Groundwater Protection Strategy

New Source Performance Standards for Storage Vessels for Petroleum Liquids.

TSCA health data.

Pesticide registration data.

TSCA chemical advisories (2 or 3 issued to date).

Advisories issued by FWS and NMFS under the Fish and Wildlife Coordination Act.

Executive Orders related to Floodplains (11988) and Wetlands (11990) as implemented by EPA's August 6, 1985, Policy on Floodplains and Wetlands Assessments for CERCLA Actions.

TSCA Compliance Program Policy.

OSHA health and safety standards that may be used to protect public health (nonworkplace).

Health Advisories, EPA Office of Water.

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2. St tandards.

State Approval of Water Supply System Additions or Developments.

State Ground Water Withdrawal Approvals.

Requirements of authorized (Subtitle C of RCRA) state hazardous waste programs.

State Implementation Plans and Delegated Programs Under Clean Air Act.

All other State requirements, not delegated through EPA authority.

Approved State NPDES programs under the Clean Water Act.

Approved State UIC programs under the Safe Drinking Water Act. Note: Many other state and local requirements could be pertinent. Forthcoming guidance will include a more comprehensive list.

3. USEPA RCRA Guidance Documents

Draft Alternate Concentration Limits (ACL) Guidance

a. EPA's RCRA Design Guidelines:

- o Surface Impoundments, Liners Systems, Final Cover and Freeboard Control
- o Waste Pile Design - Liner Systems
- o Land Treatment Units
- o Landfill Design - Liner Systems and Final Cover

b. Permitting Guidance Manuals:

- Permit Applicant's Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities
- Permit Writer's Guidance Manual for Hazardous Waste Land Treatment, Storage, and Disposal Facilities
- Permit Writer's Guidance Manual for Subpart F
- Permit Applicant's Guidance Manual for the General Facility Standards
- Waste Analysis Plan Guidance Manual
- Permit Writer's Guidance Manual for Hazardous Waste Tanks
- Model Permit Application for Existing Incinerators
- Guidance Manual for Evaluating Permit Applications for the Operation of Hazardous Waste Incinerator Units
- A guide for Preparing RCRA Permit Applications for Existing Storage Facilities
- Guidance Manual on Closure and Postclosure Interim Status Standards

c. Technical Resource Documents (TRDs):

- Evaluating Cover Systems for Solid and Hazardous Waste

- Hydrologic Simulation of Solid Waste Disposal Sites
- Landfill and Surface Impoundment Performance Evaluation
- Lining of Water Impoundment and Disposal Facilities
- Management of Hazardous Waste Leachate
- Guide to the Disposal of Chemically Stabilized and Solidified Waste
- Closure of Hazardous Waste Surface Impoundments
- Hazardous Waste Land Treatment
- Soil Properties, Classification, and Hydraulic Conductivity Testing

d. Test Methods for Evaluating Solid Waste:

- Solid Waste Leaching Procedure Manual
- Methods for the Prediction of Leachate Plume Migration and Mixing
- Hydrologic Evaluation of Landfill Performance (HELP) Model Hydrologic Simulation on Solid Waste Disposal Sites
- Procedures for Modeling Flow Through Clay Liners to Determine Required Liner Thickness
- Test Methods for Evaluating Solid Wastes

- A Method for Determining the Compatibility of Hazardous Wastes

- Guidance Manual on Hazardous Waste Compatibility

4. USEPA Office of Water Guidance Documents

   a. Pretreatment Guidance Documents:

      - 304(g) Guidance Document Revised Pretreatment Guidelines (3 Volumes)

   b. Water Quality Guidance Documents

      - Ecological Evaluation of Proposed Discharge of Dredged Material into Ocean Waters (1977)

      - Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses (1983)

      - Water-Related Environmental Fate of 129 Priority Pollutants (1979)

      - Water Quality Standards Handbook (1983)

      - Technical Support Document for Water Quality-Based Toxics Control

   c. NPDES Guidance Documents:

      - NPDES Best Management Practices Guidance Manual (June 1981)

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- o Case studies on toxicity reduction evaluation (May 1983)

d. Ground Water/UIC Guidance Document:

- o Designation of a USDW
- o Elements of Aquifer Identification
- o Interim guidance for public participation
- o Definition of major facilities
- o Corrective action requirements
- o Requirements applicable to wells injecting into, through, or above an aquifer which has been exempted pursuant to Section 146.104(b)(4)
- o Guidance for UIC implementation on Indian lands

5. USEPA Manuals for the Office of Research and Development

a. EW 846 methods-laboratory analytic methods.

b. Lab protocols developed pursuant to Clean Water Act Section 304(h).

APPENDIX D

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APPENDIX D

DETAILED COST
EVALUATION DATA

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GENERAL FACTORS

FACTORS

Inputted

Distance to -offsite	- landfill, mi			[illegible]
	- burner, mi			[illegible]
	- well inject, mi			[illegible]
Density	-soil, tons/yd			1.35
	-drum(steel), tons/yd			[illegible]
	-bldg matl, tons/yd			[illegible]
Capacity	-truck	-dump	-tons	25.00
			-yds	20.00
		-scraper	-tons	20.25
			-yds	15.00
		-tank, gal		[illegible]
		-freight, # drums		50.00
Landfill	-RCRA	-depth, ft		[illegible]
		-liner thickness, ft		3.00
	-non-RCRA-depth, ft			15.00
Drums	-quantity buried, #			[illegible]
	-weight each, tons			[illegible]
	-depth buried, ft			2.5
Soil	- (excl drums)	-vol, yds		[illegible]
		-area, sq yds		[illegible]
Bldg matl	-quantity, tons			150.00
Discount rate, %				4.00
Avg tran-onsite-soil-dump trk-min				[illegible]
			-to uncover drums	[illegible]
		-scraper-min		[illegible]
	-drum freight, min			[illegible]
	-bldg matl-dump trk, min			[illegible]
	-offsite, min			[illegible]
Duration	-post closure period, yrs			30.00
	-workday, hrs			[illegible]
	-work month, days			30.00
Rainfall	-average, inches/ month			[illegible]

FACTORS

calculated

Drums	soil to excav to uncover drums, yds/drum	[illegible]
	area to cap to cover drums, sq ft	[illegible]

ALTERNATIVE NO. 1 – NO ACTION

INPUT QUANTITIES			CALCULATED QUANTITIES	
Liquids -collect -drum, gal		1000.00	Transport-liquids, [illegible] truck loads	[illegible]
-rainfall area, sq ft		0.00	Liquids -collect -rainfall, total gal	0.00
-recycle/reuse, gal		0.00	-to disposal, gal	1000.00
Fencing -repair, LF		1000.00	Duration -construction, mo	2.75
-new, LF		10000.00		

INPUT FACTORS		CALCULATED FACTORS
Duration -mobilization, mo	0.05	
-closure, mo	0.50	
Mobilization, % direct cost	2.50	
Site Preparation, % direct cost	0.00	
Site restoration, % direct cost	0.00	
Demobilization, % direct cost	1.00	
Contingency, % direct cost	10.00	
State sales tax, % direct cost	[illegible]	
Engineering/design, % direct cost	10.00	
Administration/inspection, % direct cost	4.00	
Permitting, % direct cost	0.00	
Fencing -install, LF/wk	[illegible]	

INPUT UNIT COSTS		CALCULATED COSTS
Liquids -collect, local $	[illegible]	

ALTERNATIVE NO. 1 - [illegible]

ACTIVITY COSTS - CAPITAL

Direct	COST BASIS	UNIT COST	TOTAL COST
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	[illegible] gal [illegible]	[illegible] /gal	[illegible]
[illegible]	1 truck hauling a load as required or [illegible] per day per truck	[illegible] /load	[illegible]
[illegible]	[illegible] gal for [illegible]	[illegible] gal	[illegible]
[illegible]	[illegible] LF new fencing	[illegible] /LF	[illegible]
[illegible]	[illegible] LF existing fencing to be removed	[illegible] /LF	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
Total direct costs			[illegible]

Indirect			
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
Total indirect costs			[illegible]
TOTAL CAPITAL COSTS			[illegible]

1001562

[illegible]

[illegible] - [illegible] O & M

[illegible]			[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]
TOTAL			[illegible]

[illegible] - TOTAL - [illegible]

Capital	[illegible]
O & M	[illegible]
[illegible] TOTAL	[illegible]

)001563

ALTERNATIVE NO 2 - CONTAINMENT - CAPPING

INPUT QUANTITIES

Liquids	-collect	-decon	-reuse/evap, gal	[illegible]
			-dispose, gal	[illegible]
		-rainfall area, sq ft		[illegible]
Fencing	-repair, LF			[illegible]
	-new	-total site, LF		[illegible]

CALCULATED QUANTITIES

Excavate soil	-for landfill for bldg matl, yds		[illegible]
Transport soil	-for landfill, # trk loads		17.63
	-bldg matl, # trk loads		[illegible]
	-liquids, # trk loads		2.71
Cap in-place	-soil, SF		[illegible]
	-drums, SF		[illegible]
Landfill	-usable volume, yds		296.77
	-area	at base, SF	[illegible]
		-at surface, SF	[illegible]
	-perimeter, LF		227.92
	-liner, SF		[illegible]
Liquids	-collect	-rainfall-reuse/evap, gal	[illegible]
		-dispose, gal	6233.33
	-to disposal, gal		16233.33
	-to recycle/reuse & evap, gal		32066.67
Fencing	-cap area-soil, LF		[illegible]
	-drums, LF		143.50

INPUT FACTORS

Duration	-mobilization, mo	1.00
	-construction, mo	[illegible]
	-closure, mo	1.00
Mobilization, % direct cost		2.50
Site Preparation, % direct cost		2.50
Site restoration, % direct cost		1.00
Demobilization, % direct cost		1.00
Contingency, % direct cost		[illegible]
State sales tax, % direct cost		[illegible]
Engineering/design, % direct cost		[illegible]
Administration/inspection, % direct cost		4.00
Permitting, % direct cost		0.50
Transport	-cap material, # loads/day	[illegible]
Load soil	-to make landfill, # loads/day	[illegible]

CALCULATED FACTORS

INPUT UNIT COSTS

Liquids	-collect, total $	[illegible]
	-recycle/reuse, total $	[illegible]

CALCULATED COSTS

Transport soil	-to make landfill, $/yd		[illegible]
	bldg matl $/ton		[illegible]
Load	-soil	-to make landfill, $/yd	$5.00
	bldg matl $/ton		[illegible]

1001564

ALTERNATIVE NO 2 - CONTAINMENT - CAPPING

ACTIVITY COSTS - CAPITAL

Direct	COST BASIS	UNIT COST	TOTAL COST
Mobilization	% of direct cost	2.50 %	$21,000.62
Site Preparation	% of direct cost	2.50 %	$21,000.62
Excavate -soil -to make landfill	326.45 yds soil to be excavated by front end loader	$5.00 /yd	$1,632.26
Demolish/load -bldg mtl	150.90 tons building material to demolish and load	$686.64 /ton	$102,995.76
Liquids -collect	68700.00 gal collected	1750.42 /1000 gal	$40,000.00
-recycle/reuse	32466.67 gal reused	3.21 /gal	$20,000.00
Transport -onsite -soil -to make landfill	326.45 yds soil to be transported by 1 dump truck	$1.44 /yd	$470.09
-bldg mtl	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$31.66 /ton	$4,700.36
-offsite -liquids	1 truck hauling 3 loads as required at $1,110 per load	$1,110 /load	$3,330.00
Land Applic -soil -to make landfill	36000.00 sq yd to be regraded using 1 grader	$1.25 /sq yd	$43,000.00
Landfill -bldg -onsite -liner,drains, etc	0.00 sq ft of liner	$5.00 /sq ft	$0.00
-cap	3571.46 sq ft of paving	$1.75 /sq ft	$519.35
Cap -soil (in place)	340560.00 sq ft of paving	$1.75 /sq ft	$595,980.00
-drums (in place)	880.00 sq ft of paving	$1.75 /sq ft	$1,540.00
Well inject -offsite -disposal fee	16233.33 gal for disposal	$0.25 /gal	$4,058.33
Fencing -new	12960.90 LF new fencing	$11.00 /LF	$142,569.90
-existing-repair	1000.00 LF existing fencing to be repaired	$3.50 /LF	$3,500.00
Lab Testing -field	2.00 mo duration	$20,000 /mo	$40,000.00
Site Restoration	% of direct cost	1.00 %	$10 [illegible]
Demobilization	% of direct cost	[illegible]	[illegible]
Total, direct costs			$1,[illegible]

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ALTERNATIVE NO 2 - CONTAINMENT - CAPPING

ACTIVITY COSTS - CAPITAL

Indirect			
Contingency	% of direct cost	10.00 %	$108,002.47
State sales tax	% of direct cost	0.00 %	$0.00
Engineering/design	% of direct cost	10.00 %	$108,002.47
Administration/inspection	% of direct cost	4.00 %	$43,200.99
Permitting	% of direct cost	0.5 %	$43,200.99
Total, indirect costs			$302,406.93
TOTAL, CAPITAL COSTS			$1,382,431.66

ACTIVITY COSTS - ANNUAL O & M

Monitoring			$10,000.00
Maintenance -fencing	13960.00 LF fencing	$1.00 /LF	$13,960.00
-cap	7.92 acres of paving	$1,000 /ac	$7,920.37
Site Management			$5,000.00
TOTAL			$36,880.65

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	$1,382,431.66
O & M	$431,876.39
GRAND TOTAL	$1,814,308.05

001566

ALTERNATIVE NO 3 - CONTAINMENT -RCRA LANDFILL

INPUT QUANTITIES

Liquids	-collect -drum	-to evap, gal	[illegible]
		-to dispose, gal	[illegible]
	-rainfall area, sq ft		5000 00
Fencing	-repair, LF		[illegible]
	-new	-total site, LF	[illegible]

INPUT FACTORS

Duration	-mobilization, mo	1 00
	-construction, mo	4 00
	-closure, mo	1 00
Mobilization, % direct cost		2 50
Site Preparation, % direct cost		2 50
Site restoration, % direct costs		1 00
Demobilization, % direct cost		1 00
Contingency, % direct cost		10 00
State sales tax, % direct cost		6 00
Engineering/design, % direct cost		[illegible]
Administration/inspection, % direct cost		4 50
Reporting, % direct cost		0 50
Shutdown, % direct cost		0 00
Cap thickness, ft		[illegible]
Cap material % from storage		[illegible]
Haul-soil -to make landfill $ [illegible]		[illegible]
Lab test -duration, mo		1 00

INPUT UNIT COSTS

Liquids	-collect, total $	[illegible]
	-recycle/reuse total $	[illegible]

CALCULATED QUANTITIES

Excavate -soil	-contaminated-to landfill, yds	13000 00
	-to uncover drums -to landfill, yds	[illegible]
	-to make landfill -to stor, yds	17905 64
	-cap material, yds	6464 61
Transport-soil	-contam, # scraper loads	466 67
	-to uncover drums, # trk loads	4 00
	-to make landfill -to stor, # trk	966.90
	-cap mtl -from cap mtl area, # scrap	91 76
	-from stor, # scrapers	365 05
	-to land app-from stor, # scrapers	429 66
	-drums, # trk loads	4 00
	-bldg mtl, # trk loads	14 00
	-liquids, # trk loads	2 71
Unload	-stored soil-to land app, yds	12029 95
	-to use as cap mtl, yds	5075 69
Landfill	-useable volume, yds	13025 31
	area -at base, SF	23021 69
	-at surface, SF	[illegible]
	-perimeter, LF	919 77
	-liner, SF	[illegible]
Liquids	-collect -rainfall-runoff, gal	[illegible]
	-dispose gal	6233 33
	-recycle/reuse, gal	[illegible]
	-to disposal, gal	[illegible]
Fencing	-landfill LF	[illegible]

CALCULATED FACTORS

CALCULATED COSTS

Transport soil	-to uncover drums $/yd	[illegible]
	-to make landfill $/yd	[illegible]
	bldg mtl $/trip	[illegible]
	drums $/trip	[illegible]
Load	drums $/trip	[illegible]
	bldg mtl $/trip	[illegible]
	soil -to make landfill $/yd	[illegible]

001567

ALTERNATIVE NO. 3 - CONTAINMENT AND LANDFILL

ACTIVITY COSTS - CONT'D

Direct			Cost Basis	Unit Cost	Total Cost
Mobilization			% of direct cost	2.50 %	[illegible]
Site Preparation			% of direct cost	2.50 %	[illegible]
Excavate	- soil	- contaminated to landfill	[illegible] yds contaminated soil to be excavated and transported by scraper	[illegible] /yd	[illegible]
		- to storage area to landfill	[illegible] yds soil to excavate to storage area	[illegible] /yd	[illegible]
		- to onsite landfill as clay	[illegible] yds soil to be excavated by front end loader	[illegible] /yd	[illegible]
Remove/haul - drums			[illegible] drums to remove and haul	[illegible] /drum	[illegible]
Demolish/haul	- bldg mtl		[illegible] tons building material to demolish and haul	[illegible] /ton	[illegible]
Onsite Transport	- soil	- to storage area to storage	1 truck hauling 3 truckloads per day at [illegible] per day per truck	[illegible] /yd	[illegible]
		- to onsite landfill as clay	trucks hauling 10 truckloads per day at [illegible] per day per truck	[illegible] /yd	[illegible]
	- bldg mtl		1 truck hauling 3 truckloads per day at [illegible] per day per truck	[illegible] /ton	[illegible]
	- drums		1 truck hauling 3 truckloads per day at [illegible] per day per truck	[illegible] /drum	[illegible]
Offsite Transport	- liquids		1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$3,330.00
Reload	- stored soil - to land app		[illegible] yds stored soil to be reloaded and transported by scraper	$11.00 /yd	[illegible]
		- to use as cap mtl	[illegible] yds stored soil to be reloaded and transported by scraper	$11.00 /yd	[illegible]
Land Applic	- stored soil from storage		[illegible] sq yd to be regraded using 1 grader	$1.75 /sq yd	[illegible]
Landfill	- liner drainage etc		[illegible] sq ft of liner	[illegible] /sq ft	[illegible]
	- cap	- clay	[illegible] sq ft of cap	$1.75 /sq ft	[illegible]

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[illegible] [illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
Total direct costs			[illegible]

[illegible]

[illegible]	% of direct cost	[illegible]	[illegible]
State sales tax	% of direct cost	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
[illegible]	% of direct cost	[illegible]	[illegible]
Total indirect costs			[illegible]
[illegible]			[illegible]

00156

ALTERNATIVE [illegible]) - CONTAINMENT AND LANDFILL

ACTIVITY COSTS - ANNUAL O & M

Monitoring			[illegible]
Revenue - [illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Site Management			[illegible]
TOTAL			[illegible]

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	[illegible]
O & M	[illegible]
GRAND TOTAL	[illegible]

001570

ALTERNATIVE [illegible] 4 - [illegible] - [illegible]

INPUT QUANTITIES

Liquids	-collect -drum	-to [illegible], gal	[illegible]
		-to dispose, gal	[illegible]
	-rainfall area, sq ft		[illegible]
Fencing	-supply, LF		[illegible]
	-new	-total site, LF	[illegible]

CALCULATED QUANTITIES

Excavate -soil	contaminated to landfill, yds	[illegible]
	to uncover drums to landfill, yds	[illegible]
	-to onsite landfill -to stor., yds	[illegible]
	-cap material, yds	[illegible]
Transport -soil	contam. [illegible]	[illegible]
	to uncover drums, [illegible]	[illegible]
	-to onsite landfill -to stor., [illegible]	[illegible]
	-cap soil -from cap soil area, [illegible]	[illegible]
	-from stor., [illegible]	[illegible]
	-to land [illegible] stor., [illegible]	[illegible]
-drums, [illegible]		[illegible]
bldg soil, [illegible]		[illegible]
-liquids, [illegible]		17.25
[illegible]	-stored soil-to land [illegible], yds	[illegible]
	-to use as cap soil, yds	[illegible]
Landfill -usable volume, yds		[illegible]
-area	-at base, SF	[illegible]
	-at surface, SF	[illegible]
-perimeter, LF		[illegible]
-liner, SF		[illegible]
Liquids -collect	-rainfall [illegible], gal	[illegible]
	-dispose, gal	[illegible]
-[illegible], gal		[illegible]
-to disposal, gal		[illegible]
Duration -construction, mo		[illegible]
Fencing -landfill, LF		[illegible]

INPUT FACTORS

Duration	-[illegible], mo	1.[illegible]
	-closure, mo	[illegible]
[illegible], % direct cost		[illegible]
Site Preparation, % direct cost		[illegible]
Site restoration, % direct costs		[illegible]
[illegible], % direct cost		[illegible]
Contingency, % direct cost		[illegible]
State sales tax, % direct cost		[illegible]
Engineering/design, % direct cost		[illegible]
[illegible], % direct cost		[illegible]
[illegible], % direct cost		[illegible]
[illegible], % direct cost		[illegible]
Cap thickness, ft		[illegible]
Cap material % from storage		[illegible]
Load soil	-to onsite landfill, [illegible]	[illegible]
[illegible]	-[illegible], tons/[illegible]	[illegible]
	-capacity factor, %	[illegible]
	-[illegible] product/[illegible]	[illegible]
Lab testing -duration, mo		1.[illegible]
[illegible] product, tons/[illegible]		1.25

CALCULATED FACTORS

INPUT UNIT COSTS

Liquids	collect, total $	[illegible]
	-[illegible], total $	[illegible]
[illegible]	-[illegible], $/yd	[illegible]
	-gravel, $/yd	[illegible]
	-[illegible], $/yd	[illegible]
	-[illegible], $/yd	[illegible]
	-[illegible], $/yd	[illegible]
	-[illegible], $/yd	[illegible]
	-transport to landfill, $/yd	[illegible]

CALCULATED COSTS

Transport -soil	-to uncover drums, $/yd	[illegible]
	-to onsite landfill, $/yd	[illegible]
bldg soil, $/[illegible]		[illegible]
drums, $/[illegible]		[illegible]
Load -drums, $/[illegible]		[illegible]
bldg soil, $/[illegible]		[illegible]
-[illegible] landfill, $/yd		[illegible]

0 0 1 5 7 1

ALTERNATIVE [illegible] 4 - SOLIDIFICATION - TOTAL

ACTIVITY COSTS - CAPITAL

Direct			COST BASIS	UNIT COST	TOTAL COST
Mobilization			% of direct cost	2.50 %	$63,767.82
Site Preparation			% of direct cost	2.50 %	$63,767.82
Excavate	-soil	-contaminated-to stock	[illegible] yds contaminated soil to be excavated and transported by scraper	$11.00 /yd	$143,000.00
		-to uncover drums-to stock	[illegible] yds soil to excavate to uncover drums	$29.00 /yd	$1,401.40
		-to onsite landfill -to stor	[illegible] yds soil to be excavated by front end loader	$5.00 /yd	$115,377.20
Remove/load -drums			[illegible] drums to remove and load	[illegible] /drum	$10,533.33
Overpack/load	-bldg mtl		[illegible] tons building material to demolish and load	$[illegible] /ton	$102,995.76
Onsite Transport	-soil	-to uncover drums to storage	1 truck hauling [illegible] truckloads per day at $[illegible] per day per truck	$[illegible] /yd	$1,[illegible]
		-to onsite landfill-to stor	trucks hauling [illegible] truckloads per day at $[illegible] per day per truck	$1.[illegible] /yd	$33,[illegible]
	-bldg mtl		1 truck hauling [illegible] truckloads per day at $[illegible] per day per truck	$[illegible] /ton	$[illegible]
	-drums		1 truck hauling [illegible] truckloads per day at $[illegible] per day per truck	$6.00 /drum	$1,700.00
Offsite Transport	-liquids		1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$19,[illegible]
Upload	-stored soil-to land app		[illegible] yds stored soil to be reloaded and transported by scraper	$11.00 /yd	$170,475.76
		-to use as cap mtl	[illegible] yds stored soil to be reloaded and transported by scraper	$11.00 /yd	$75,[illegible]
Land Applic	-stored soil-from storage		[illegible] sq yd to be [illegible]	$[illegible] /sq yd	$[illegible]
Landfill	-liner drainage etc		[illegible] sq ft of liner	$5.00 /sq ft	$[illegible]
	-cap	-clay	[illegible] sq ft of cap	$[illegible] /sq ft	$[illegible]

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ALTERNATIVE NO 6 - SOLIDIFICATION - TOTAL

ACTIVITY COSTS - CAPITAL

Soils/Sludge	-haul	13625.31 yds waste feed	$10.00 /yd	$136,253.11
	-grind	13625.31 yds waste feed	$10.00 /yd	$136,253.11
	-fixate	13625.31 yds waste feed	$35.00 /yd	$476,885.90
	-transport to curing area	13625.31 yds waste feed	$5.00 /yd	$68,126.56
	-compact	13625.31 yds waste feed	$5.00 /yd	$68,126.56
	-reload cured product	13625.31 yds waste feed	10 /yd	$136,253.11
	-transport cured product to landfill	13625.31 yds waste feed	5 /yd	$68,126.56
Liquids	-collect	206474.00 gal collected	$193.73 /1000 gal	$40,000.00
	-recycled/reused	132974.00 gal recycled/reused	$0.15 / gal	$20,000.00
Well inject	-offsite -disposal fee	107500.00 gal for disposal	$0.25 /gal	$26,875.00
Fencing	-new	11109.12 LF new fencing	$11.00 /LF	$122,200.35
	-existing-repair	1000.00 LF existing fencing to be repaired	$3.50 /LF	$3,500.00
Lab Testing -field		1.21 mo duration	$20,000 /mo	$24,165.56
Site Restoration		% of direct cost	2.50 %	$63,767.02
Health/Safety		% of direct cost	1.00 %	$25,506.81
Total, direct costs				$2,550,680.89
Indirect				
Contingency		% of direct cost	10.00 %	$255,068.09
State sales tax		% of direct cost	0.00 %	$0.00
Engineering/Design		% of direct cost	10.00 %	$255,068.09
Administration/Inspection		% of direct cost	4.00 %	$102,027.23
Permitting		% of direct cost	4.00 %	$102,027.23
Studies		% of direct cost	0.00 %	$0.00
Total, indirect costs				$714,190.64
TOTAL, CAPITAL COSTS				$3,264,871.53

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ALTERNATIVE NO. [illegible] - [illegible] - TOTAL

ACTIVITY COSTS - ANNUAL O & M

Monitoring			[illegible]
Operation - Pumping		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]			[illegible]
TOTAL			[illegible]

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	[illegible]
O & M	[illegible]
GRAND TOTAL	[illegible]

)001574

001575

ALTERNATIVE NO 21 - SOIL FLUSH

ACTIVITY COSTS - CAPITAL

Direct	COST BASIS	UNIT COST	TOTAL COST
Administration	% of direct cost	2.50 %	$395,103.44
Site Preparation	% of direct cost	2.50 %	$395,103.44
Excavate -soil -contaminated	13000 yds contaminated soil to be excavated and transported by scraper	$11.00 /yd	$143,000.00
-to uncover drums	36.87 yds soil to excavate to uncover drums	$30.00 /yd	$1,061.60
Remove/load -drums	200 drums to remove and load	$52.67 /drum	$10,533.33
Demolish/load -bldg mtl	150.00 tons building material to demolish and load	$686.64 /ton	$102,995.76
Transport -onsite -soil -flushed soil	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$17.63 /yd	$229,220.49
-to uncover drums	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$17.20 /yd	$1,200.00
-bldg mtl	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$31.66 /ton	$4,748.36
-drums	1 truck hauling 3 truckloads per day at $900.00 per day per truck	$6.00 /drum	$1,200.00
-offsite -sludge	6000.00 gal per truck	$1,110 /trk	$25,530.00
-liquids -extract	1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$3,330.00
-water	1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$8,880.00
Well inject -offsite -disposal fee	47400.00 gal for disposal	$0.25 /gal	$11,850.00
Soil flush -load	1 loader loading 70 tons per day at $1,111.11 per day per loader	$10.51 /yd	$247,025.93
-grind	20624.37 tons feed	$10.00 /ton	$206,243.71
-1st stage flush	20624.37 tons feed	$220.00 /ton	$4,537,361.67
-2nd stage flush/load	20624.37 tons feed	$250.00 /ton	$5,156,092.01
Incinerat -offsite -waste pesticides	51.56 tons for disposal	$1,000 /ton	$51,560.93

001576

ALTERNATIVE NO. 11 - INCINERATION - TOTAL

INPUT QUANTITIES

Liquids -collect -decon	-reuse/evap, gal	500000.00
	-to dispose, gal	10000.00
	-rainfall area, sq ft	15000.00
-treat	-scrubber-circulat, gpm	50.00
	-tss, ppm	2000.00
	-blowdown, gpm	10.00
	-clarif bldn, %	5.00
	-ash wash-circulat, gpm	50.00
	-tss, ppm	2000.00
	-blowdown, gpm	10.00
	-clarif bldn, %	5.00
	-blowdown-clarif bldn, %	5.00
-waste	-thickenr-blowdown, %	20.00
	-carbon filter, lb/ton	0.50
Fencing	-repair, LF	1000.00
	-new, LF	10000.00

INPUT FACTORS

Incineration-rate, tons/day		100.00
	-capacity factor, %	70.00
	-tons ash/tons feed	0.9
Duration	-construction, mo	6.00
	-closure, mo	2.00
Mobilization, % direct cost		2.50
Site Preparation, % direct cost		2.50
Site preparation, % direct cost		1.00
Demobilization, % direct cost		1.00
Contingency, % direct cost		10.00
State sales tax, % direct cost		0.00
Engineering/design, % direct cost		10.00
Administration/inspection, % direct cost		4.00
Permitting, % direct cost		0.50
Shakedown, % direct cost		1.50
Density	-ash, tons/yd	1.35
	-sludge, lb/gal	11.00

INPUT UNIT COSTS

Incineration-onsite	-grind, $/ton	$10.00
	-incin/scrub, $/ton	$150.00
	-ash wash/dewatr/load, $/tn	$120.00
	-chem precip, $/ton	$50.00
Carbon adsorption	-mob/demob, $	$30,000.00
	-equip rental, $/mo	$7,500.00
	- O & M, $/yr	$5,000.00
	-carbon replacement, $/lb	$10.00
Liquids	-collect, total $	$40,000.00
	-recycle/reuse, total $	$10,000.00
	-treat -clarifier-capital, $/gpm	$3,000.00
	-O&M, $/gpm/yr	$750.00
	-thickenr-capital, $/gpm	$3,000.00
	-O&M, $/gpm/yr	$750.00

CALCULATED QUANTITIES

Excavate -soil	- yds	13000.00
	-to uncover drums, yds	74.07
	-total, yds	13074.07
	-total, tons	17650.00
Transport-soil	- # trk loads	706.00
	-ash, # trk loads	640.05
	-drums, # trk loads	4.00
	-bldg mtl, # trk loads	14.84
	-spent carbon, #truck loads	
	-thickener sludge, # trk loads	
	-liquids, # trk loads	1.90
Incinerat-feed, total tons		20629.73
	-ash, total tons	16001.33
Liquids	-collect -rainfall-reuse/evap, gal	183702.81
	-dispose, gal	37400.00
	-recycle/reuse, gal	683702.81
	-treat -blowdown, gal	5941361.54
	-waste -thickenr-gal	270277.94
	-gpm	6.00
	-carbon filters, lbs	10314.86
	-to dispose, gal	47400.00
Duration -treatment, mo		9.82

CALCULATED FACTORS

CALCULATED COSTS

Transport-soil	-to uncover drums -$/yd	$17.20
	-ash -$/yd	$20.57
	-bldg mtl-$/ton	$31.66
	-drums -$/drum	$6.00
Load	-ash -$/yd	$10.51
	-drums -$/drum	$2.67
	-bldg mtl-$/ton	$36.64

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ALTERNATIVE NO. 11 - INCINERATION - TOTAL

ACTIVITY COSTS - CAPITAL

Direct			COST BASIS	UNIT COST	TOTAL COST
Mobilization			% of direct cost	2.50 %	$214,306.22
Site Preparation			% of direct cost	2.50 %	$214,306.22
Excavate	-soil	-contaminated	13000 yds contaminated soil to be excavated and transported by scraper	$11.00 /yd	$143,000.00
		-to uncover drums	74.07 yds soil to excavate to uncover drums	$20.00 /yd	$1,481.48
Remove/load -drums			200 drums to remove and load	$52.67 /drum	$10,533.33
Demolish/load		-bldg mtl	150.00 tons building material to demolish and load	$686.64 /ton	$102,995.76
Transport	-onsite	ash	1 truck hauling 4 truckloads per day at $960.00 per day per truck	$20.57 /yd	$267,428.57
		-soil -to uncover drums	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$17.28 /yd	$1,280.00
		-bldg mtl	1 truck hauling 3 truckloads per day at $960.00 per day per truck	$31.66 /ton	$4,748.34
		-drums	1 truck hauling 3 truckloads per day at $900.00 per day per truck	$6.00 /drum	$1,200.00
	-offsite	-sludge	6000.00 gal per truck	$1,110 /trk	$51,060.00
		-carbon	2000 lb per truck	$1,110 /trk	$0.00
		-liquids	1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$8,880.00
Well inject	-offsite	-disposal fee	47000.00 gal for disposal	$0.25 /gal	$11,050.00
Incinerate	-load		1 loader loading 70 tons per day at $1,111.11 per day per loader	$10.51 /yd	$247,025.93
	-grind		20629.73 tons feed	$10.00 /ton	$206,297.28
	-incin/scrub		20629.73 tons feed	[illegible] /ton	[illegible]
	-ash wash/dewater/load		20629.73 tons feed	$120.00 /ton	$2,475,567.31

1001578

ALTERNATIVE NO. 11 - INCINERATION - TOTAL

ACTIVITY COSTS - CAPITAL

Liquids	-collect	731102.01 gal collected		$50.50 /1000 gal	$40,000.00
	-recycled/reused	601702.01 gal recycled/reused		$29.75 /1000 gal	$20,900.00
	-treat -scrubber	50.00 gpm for	9.02 months	$3,614 /gpm	$180,699.00
	-ash wash	50.00 gpm for	9.02 months	$3,614 /gpm	$180,699.00
	-blowdown-clarific	20.00 gpm for	9.02 months	$3,614 /gpm	$72,279.60
	-filter	5961361.54 gal over	9.02 months	$0.03 /gal	$180,919.44
	-sludge -thicken	6.03 gpm for	9.02 months	$12,047 /gpm	$21,683.00
Landfill	-offsite -disposal fee	270277.94 gal sludge &	0 lb carbon	$200.00 /ton	$297,305.73
Land Applic	-cover -ash	36000.00 sq yd to be recreated using 1 grader		$1.75 /sq yd	$63,000.00
Fencing	-new	10000.00 LF new fencing		$11.00 /LF	$110,000.00
	-existing-repair	1000.00 LF existing fencing to be repaired		$3.50 /LF	$3,500.00
Lab Testing	-field	9.82 mo duration		$20,000 /mo	$196,473.60
Site Restoration		% of direct cost		1.00 %	$85,754.49
Bonds/Insurance		% of direct cost		1.00 %	$85,754.49
Total, direct costs					$8,575,448.88

Indirect

Contingency	% of direct cost	10.00 %	$857,544.88
State sales tax	% of direct cost	0.00 %	$0.00
Engineering/Design	% of direct cost	10.00 %	$857,544.88
Administration/Inspection	% of direct cost	4.00 %	$343,017.95
Permitting	% of direct cost	0.50 %	$343,017.95
Shutdown	% of direct cost	1.50 %	$128,631.73
Total, indirect costs			$2,529,757.40
TOTAL, CAPITAL COSTS			$11,105,206.19

0001-5-7-9

ALTERNATIVE NO. [illegible] [illegible] - [illegible] - TOTAL

ACTIVITY COSTS - ANNUAL O & M

Monitoring		[illegible]
Operation - [illegible]	[illegible]	[illegible]
Site Management		[illegible]
TOTAL		[illegible]

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	[illegible]
O & M	[illegible]
GRAND TOTAL	[illegible]

001580

[illegible]

INPUT QUANTITIES

[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]

CALCULATED QUANTITIES

[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

INPUT FACTORS

[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible], $ direct cost		[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

CALCULATED FACTORS

INPUT UNIT COSTS

[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]

CALCULATED COSTS

[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]
	[illegible]	[illegible]

1001581

ALTERNATIVE NO. [illegible] - TOTAL - OFFSITE - E

ACTIVITY COSTS - CAPITAL

Direct			Cost Basis	Unit Cost	Total Cost
Mobilization			% of direct cost	2.50 %	[illegible]
Site Preparation			% of direct cost	2.50 %	[illegible]
Excavate	-soil	-contaminated	[illegible] yds contaminated soil to be excavated by front end loader	[illegible] /yd	[illegible]
		-to uncover drums	[illegible] yds soil to excavate to uncover drums	[illegible] /yd	[illegible]
Remove/load -drums			[illegible] drums to remove and load	[illegible] /drum	[illegible]
Demolish/load	-bldg mat'l		[illegible] tons building material to demolish and load	[illegible] /ton	[illegible]
Liquids	-collect		[illegible] gal collected	[illegible] /1000 gal	[illegible]
	-recycle/reuse		[illegible] gal reused	[illegible] /gal	[illegible]
Transport	-offsite -soil	-[illegible]	15 trucks each hauling 1 load per day at [illegible] per day per truck	[illegible] /load	[illegible]
		-to uncover drums	[illegible] trucks each hauling 1 load per day at [illegible] per day per truck	[illegible] /load	[illegible]
	-bldg mat'l		15 trucks each hauling 1 load per day at [illegible] per day per truck	[illegible] /load	[illegible]
	-drums		1 truck hauling 1 load per day at [illegible] per day	[illegible] /load	[illegible]
	-liquids		1 truck hauling loads as required at [illegible] per day per truck	[illegible] /load	[illegible]
Landfill	-offsite -disposal fee	-soil	[illegible] tons soil	[illegible] /ton	[illegible]
		-drums	[illegible] tons drums	[illegible] /ton	[illegible]
		-bldg mat'l	[illegible] tons bldg material	[illegible] /ton	[illegible]
[illegible] liquids -offsite -disposal fee			[illegible] gal for disposal	[illegible] /gal	[illegible]
Fencing	-new		[illegible] LF new fencing	[illegible] /LF	[illegible]
	-existing-remove		[illegible] LF existing fencing to be removed	[illegible] /LF	[illegible]
Lab testing -field			[illegible]	[illegible]	[illegible]
Site [illegible]			% of direct cost	[illegible]	[illegible]
[illegible]			% of direct cost	[illegible]	[illegible]
Total direct costs					[illegible]

0015 82

ALTERNATIVE NO. 13 - TOTAL - OFFSITE - E

ACTIVITY COSTS - CAPITAL

Indirect

Contingency	% of direct cost	10.00 %	$524,829.40
State sales tax	% of direct cost	0.00 %	$0.00
Engineering/design	% of direct cost	10.00 %	$524,829.40
Administration/Inspection	% of direct cost	4.00 %	$[illegible],931.76
Permitting	% of direct cost	0.5 %	$209,931.76
Shutdown	% of direct cost	0.00 %	$0.00
Total, indirect costs			$1,4[illegible],522.33
TOTAL, CAPITAL COSTS			$6,717,816.36

ACTIVITY COSTS - ANNUAL O & M

Operating		$0.00
[illegible] - [illegible]	$1.00 /AF	$11,000.00
Site Management		$5,000.00
TOTAL		$16,000.00

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	$6,717,816.36
O & M	$278,137.51
GRAND TOTAL	$6,[illegible]

0001583

ALTERNATIVE NO   22 - CONTAINMENT - CONSOLIDATION/CAPPING

INPUT QUANTITIES

Liquids -collect -decon -to evap, gal		[illegible]
-to dispose, gal		[illegible]
-rainfall area, sq ft		5000.00
Fencing -repair, LF		1000.00
-new -site, LF		[illegible]
Excav-soil -to uncover drums -to landfill, yds		0.00
Transport -drums, # trk loads		0.00

CALCULATED QUANTITIES

Excavate -soil -contaminated-to landfill, yds	13000.00
-to make landfill -to stor, yds	15979.92
-cap material, yds	5753.23
Transport-soil -contam, # scraper loads	966.67
-to uncover drums, # trk loads	0.00
-to make landfill -to land, # trk	862.92
-cap mtl -from cap mtl area, # scrap	76.71
-from stor, # scrapers	306.84
-to land app-from stor, # scrapers	758.49
-bldg mtl, # trk loads	14.00
-liquids, # trk loads	2.71
Reload -stored soil-to land app, yds	11377.30
-to use as cap mtl, yds	4602.58
Landfill -useable volume, yds	13351.24
-area -at base, SF	16659.92
-at surface, SF	35301.90
-perimeter, LF	751.57
-liner, SF	35677.92
Liquids -collect -rainfall-reuse/evap, gal	20933.33
-dispose, gal	6733.33
-recycle/reuse, gal	44933.33
-to disposal gal	16733.33

INPUT FACTORS

Duration -mobilization, mo	1.00
-construction, mo	4.00
-closure, mo	1.00
Mobilization, % direct cost	2.50
Site Preparation, % direct cost	2.50
Site restoration, % direct costs	1.00
Demobilization, % direct cost	1.00
Contingency, % direct cost	10.00
State sales tax, % direct cost	0.00
Engineering/design, % direct cost	10.00
Administration/inspection, % direct cost	4.00
Permitting, % direct cost	0.50
Shutdown, % direct cost	0.00
Cap thickness-ft of clay	4.00
-total, ft	5.00
Cap material-% from storage	[illegible]
Load-soil -to make landfill, # loads/day	12.00
Lab time -duration, mo	1.00

CALCULATED FACTORS

INPUT UNIT COSTS

Liquids -collect, total $	[illegible]
-recycle/reuse, total $	[illegible]

CALCULATED COSTS

Transport-soil -to uncover drums -$/yd	[illegible]
-to make landfill, $/yd	$1.00
-bldg mtl $/ton	$31.66
-drums $/drum	$6.00
Load drums $/drum	[illegible]
bldg mtl $/ton	[illegible]
soil to make landfill, $/yd	$5.00

001584

ALTERNATIVE NO. 22 - CONTAINMENT - CONSOLIDATION/CAPPING

ACTIVITY COSTS - CAPITAL

Direct			COST BASIS	UNIT COST	TOTAL COST
Mobilization			% of direct cost	2.50 %	$22,115.50
Site Preparation			% of direct cost	2.50 %	$22,115.50
Excavate	-soil	-contaminated to landfill	13000 yds contaminated soil to be excavated and transported by scraper	$11.00 /yd	$143,000.00
		-to uncover drums-to landfill	0.00 yds soil to excavate to uncover drums	$20.00 /yd	$0.00
		-to make landfill -to stor	15979.92 yds soil to be excavated by front end loader	$5.00 /yd	$79,899.59
Remove/load -drums			0.00 drums to remove and load	$52.67 /drum	$0.00
Demolish/load		-bldg mat'l	150.00 tons building material to demolish and load	$686.64 /ton	$102,995.76
Onsite Transport	-soil	-to uncover drums-to storage	1 truck hauling 0 truckloads per day at $960.00 per day per truck	$0.00 /yd	$0.00
		-to make landfill-to stor	trucks hauling 12 truckloads per day at $960.00 per day per truck	$1.44 /yd	$23,011.00
	-bldg mat'l		1 truck hauling 3 truckloads per day at $960.00 per day per truck	$31.56 /ton	$4,740.34
	-drums		1 truck hauling 3 truckloads per day at $900.00 per day per truck	$6.00 /drum	$7,200.00
Offsite Transport	-liquids		1 truck hauling loads as required at $1,110 per day per truck	$1,110 /load	$3,330.00
Reload	-stored soil-to land app		11377.34 yds stored soil to be reloaded and transported by scraper	$11.00 /yd	$125,150.78
		-to use as cap mat'l	4602.50 yds stored soil to be reloaded and transported by scraper	$11.00 /yd	$50,629.60
Land Applic	-spread soil-from storage		36000.00 sq yd to be regraded using 1 grader	$1.75 /sq yd	$63,000.00
Landfill	-soil & bldg mat'l	-liner drainage sy	0.00 sq ft of liner	$5.00 /sq ft	$0.00
		-cap	30036.75 sq ft of clay cap	$1.75 /sq ft	$73,364.62
Cap	-drums (in place)		[illegible] sq ft of clay cap	$1.75 /sq ft	$[illegible]

0015 85

ALTERNATIVE NO. [illegible] [illegible] - [illegible]

ACTIVITY COSTS - CAPITAL

[illegible]	[illegible]	[illegible] /1000 gal	[illegible]
[illegible]	[illegible] gal [illegible]	[illegible] / gal	[illegible]
[illegible]	[illegible] gal for disposal	[illegible] /gal	[illegible]
[illegible]	[illegible]	[illegible] /LF	[illegible]
[illegible]	[illegible]	[illegible] /LF	[illegible]
[illegible]	[illegible]	[illegible] /LF	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Site Restoration	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
Total direct costs			[illegible]

Indirect

Contingency	% of direct cost	[illegible] %	[illegible]
State sales tax	% of direct cost	[illegible] %	[illegible]
Engineering/Design	% of direct cost	[illegible] %	[illegible]
Administration/Inspection	% of direct cost	[illegible] %	[illegible]
Permitting	% of direct cost	[illegible] %	[illegible]
[illegible]	% of direct cost	[illegible] %	[illegible]
Total indirect costs			[illegible]
TOTAL CAPITAL COSTS			[illegible]

001586

ALTERNATIVE NO [illegible] - [illegible]

ACTIVITY COSTS - ANNUAL O & M

Monitoring			[illegible]
[illegible] [illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
Site Management			[illegible]
TOTAL			[illegible]

ACTIVITY COSTS - TOTAL - PRESENT WORTH

Capital	[illegible]
O & M	[illegible]
GRAND TOTAL	[illegible]

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[illegible]

APPENDIX E

APPENDIX E

LINER COMPATIBILITY STUDY LABORATORY REPORT

Gundle

LABORATORY REPORT #2098B

CHEMICAL IMMERSION OF GUNDLINE HD 80 MIL
IN CHLORINATED PESTICIDE
FROM: ENVIROSPHERE COMPANY

DATE: FEBRUARY 17, 1987

SUBJECT:

Results of chemical compatibility (EPA Method 9090) testing of Gundline HD 80 mil with Chlorinated Pesticide after 120 days immersion.

TEST METHOD:

Die-cut ASTM test specimens were placed in the waste solution and kept at temperatures of 23°C and 50°C. Samples were removed after the 120-day period and subjected to the following tests:

Test	Method
Tensile Properties	ASTM D638
Tear Initiation Resistance	ASTM D1004C
Puncture Resistance	FTMS 101B
Weight Change	--
Thickness Change	--

0001590

TEST RESULTS:

Tensile Strength & Elongation

23°C MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2910	15	5123	850
120 Days	3194	15	5104	820
% Change	+9.8	Ø	-.4	-3.5
23°C TD				
Control	2750	15	4661	835
120 Days	3223	14	5143	850
% Change	+17.2	-6.7	+10.3	+1.8
50°C MD				
Control	2910	15	5123	850
120 Days	3302	15	4966	810
% Change	+13.5	Ø	-3.1	-4.7
50°C TD				
Control	2750	15	4661	835
120 Days	3284	15	5656	893
% Change	+19.4	Ø	+21.3	+6.9

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Weight Change, 1" x 3"

		Control	120 Days	% Change
23°C	MD	3.8933	3.8934	+.003
	TD	2.9845	3.9851	+.02
50°C	MD	3.8958	3.9079	+.3
	TD	3.5994	3.6066	+.2

Thickness Change, 1" x 3"

		Control	120 Days	% Change
23°C	MD	.81"	.79"	-2.5
	TD	.75"	.76"	+1.3
50°C	MD	.82"	.83"	+1.2
	TD	.87"	.86"	-1.1

Tear Resistance (lbs)

		Control	120 Days	% Change
23°C	MD	70	70	0
	TD	76	74	-2.6
50°C	MD	70	68	-2.9
	TD	76	74	-2.6

Puncture (lbs)

	Control	120 Days	% Change
23°C	62	[illegible]	+2[illegible]
50°C	62	8[illegible]	+2[illegible]

CONCLUSION:

After 120 days immersion at both 23°C and 50°C, the Gundline HD experienced no significant drop in physical properties. Only a slight increase in weight was observed, an indication that little or no absorption has taken place. [illegible] HD appears to be compatible with the chlorinated pesticide [illegible]

CERTIFIED BY:

Sengthong Phouangsavanh
Lab Technician

Mark Cadwallader
Director of Research & Technical Development

001591

Gundle

LABORATORY REPORT #2098A

CHEMICAL IMMERSION OF GUNDLINE HD 80 MIL IN CHLORINATED PESTICIDE WASTE

DATE OF TEST: JANUARY 19, 1987

SUBJECT:

Results of chemical compatibility (EPA Method 9090) testing of Gundline HD 80 mil with Chlorinated Pesticide Waste after 90 days immersion.

TEST METHOD:

Die-cut ASTM test specimens were placed in the waste solution and kept at temperatures of 23°C and 50°C. Samples were removed after the 90day period and subjected to the following tests: 1001592

Test	Method
Tensile Properties	ASTM D638
Tear Initiation Resistance	ASTM D1004C
Puncture Resistance	FTMS 101B
Weight Change	--
Thickness Change	--

TEST RESULTS:

Tensile Strength & Elongation

23°C MC	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2910	15	5123	850
90 Days	3032	15	5185	893
% Change	+4.2	0	+1.2	+5.1
23°C TD				
Control	2750	15	4661	835
90 Days	3102	15	5068	870
% Change	+13	0	+8.7	+4.2
50°C MC				
Control	2910	15	5123	850
90 Days	3193	15	5068	840
% Change	+9.7	0	-1.1	-1.2
50°C TD				
Control	2750	15	4661	835
90 Days	3164	15	5366	910
% Change	+15	0	+15	+9

Weight Change, 1" x 3"

		Control	90 Days	% Change
23°C	MD	3.8933	3.8937	+.01
	TD	3.9845	3.9847	+.01
50°C	MD	3.8958	3.9054	+.2
	TD	3.5994	3.6027	+.1

Thickness Change, 1" x 3"

		Control	90 Days	% Change
23°C	MD	.81"	.82"	+1.2
	TD	.75"	.76"	+1.3
50°C	MD	.82"	.83"	+1.2
	TD	.87"	.88"	+1.1

Tear Resistance (lbs)

		Control	90 Days	% Change
23°C	MD	70	70	0
	TD	76	74	-2.6
50°C	MD	70	67	-4.3
	TD	76	70	-7.9

Puncture (lbs)

	Control	90 Days	% Change
23°C	62	73	+18
50°C	62	80	+29

CONCLUSION:

After 90 days immersion at both 23°C and 50°C, the Gundline HD experienced no decrease in physical properties.

CERTIFIED BY:

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Lab Technician

Mark Cadwallader
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1001593

LABORATORY REPORT #2098

CHEMICAL IMMERSION OF GUNDLINE HD 80 MIL
WITH CHLORINATED PESTICIDE

November 21, 1986

SUBJECT

Results of chemical compatibility (EPA Method 9090) testing of Gundline HD 80 mil with Chlorinated Pesticide after 30 days immersion.

TEST METHOD

Die-cut ASTM test specimens were placed in the waste solution and kept at a temperatures of 23°C and 50°C. Samples were removed after the 30 day period and subjected to the following tests:

001594

Test	Method
Tensile Properties	ASTM D638
Tear Initiation Resistance	ASTM D1004C
Puncture Resistance	FTMS 101B
Weight Change	--
Thickness Change	--

TEST RESULTS

Tensile Strength & Elongation

23°C MD	Yield Strength (psi)	Yield Elongation (%)	Break Strength (psi)	Break Elongation (%)
Control	2910	15	5123	850
30 Days	2825	15	5125	863
% Change	-2.9	Ø	+.04	+1.5
23°C TD				
Control	2750	15	4661	835
30 Days	2839	15	4565	848
% Change	+3.2	Ø	-2.1	+1.6
50°C MD				
Control	2910	15	5123	850
30 Days	2901	15	5041	863
% Change	-.3	Ø	-1.6	+1.5
50°C TD				
Control	2750	15	4661	835
30 Days	3059	15	5215	845
% Change	+11.2	Ø	+12	+1.2

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Weight Change, 1" x 3"

		Control	# Days	% Change
23°C	MD	3.8933	3.8946	+.03
	TD	3.9845	3.9857	+.03
50°C	MD	3.8958	3.8978	+.05
	TD	3.5994	3.6020	+.07

Thickness Change, 1" x 3"

23°C	MD	.81"	.82"	+1.2
	TD	.75"	.75"	Ø
50°C	MD	.82"	.83"	+1.2
	TD	.87"	.88"	+1.1

Tear Resistance (lbs)

23°C	MD	70	70	Ø
	TD	76	71	-6.6
50°C	MD	70	69	-1.4
	TD	76	73	-4

Puncture (lbs)

23°C	62	65	+4.8
50°C	62	67	+8.1

CONCLUSION

After 30 days immersion at both 23°C and 50°C there were no significant changes in physical properties of the Gundline HD.

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Lab Technician

Mark Cadwallader, Director of Research & Technical Development

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