112269

CONSULTING ENGINEERS and PLANNERS
55 South Richland Avenue / P.O. Box M-55 / York, Pennsylvania 17405
Telephone (717) 843-5561
Telex No. 820403

ORIGINAL

January 9, 1987

1/15/87

Mr. Harold Snyder/Mr. Scott Parrish
Hazardous Site Control Division
Office of Emergency and Remedial Response (WH-548E)
U.S. Environmental Protection Agency
401 M Street, S. W.
Washington, DC 20460

NPL-03-3-240

Reference: EPA Rulemaking Proposal to Add Keystone Sanitation Co.'s Landfill Site to National Priorities List
BH No. 62209

Dear Mssrs. Snyder and Parrish:

Enclosed for your review are two copies of the following reports:

1. "Review and Evaluation of Keystone Landfill Maryland's Monitoring System Investigation and Report" for the County Commissioners of Carroll County, Maryland by Edmond G. Otton and Associates, Consulting Geologists (December 10, 1986).

2. "Report on Study of Water Supply Contamination Potential from Keystone Landfill Operations for the Borough of Hanover" by Capitol Engineering Corporation (December 2, 1986).

You will note these studies reached virtually the same conclusions as did earlier studies. We felt these studies, which were just released, were of sufficient importance that providing copies to your office for review was definitely merited.

Should you have any questions, please do not hesitate to call our office.

Very truly yours,

BUCHART-HORN, INC.

Timothy E. Saylor, Director
Chemistry and Earth Sciences Division

TES/llb

cc: James Heenahan, Esq. - US EPA-Phila.
Tim Traverse - US EPA-Phila.
Robert Emmett, Esq. - Reed Smith Shaw & McClay
Franklin Kury, Esq. - Reed Smith Shaw & McClay
Michael Steiner - PA DER
Bill Bryant/Kenneth Noel - Keystone Sanitation Co.
James Barnette/U.S. Senator Arlen Spector - Washington, DC
George Bloom, Esq.

AR10208

ORIGINAL
(R...)

CARROLL COUNTY MARYLAND

225 N. Center Street
Westminster, Maryland 21157
WESTMINSTER 301-848-4500
BALTIMORE 301-876-2085

Charles W. Thompson, Jr.
COUNTY ATTORNEY
Paul G. Zimmermann
ASSISTANT COUNTY ATTORNEY
Teresa L. Conaway
ASSISTANT COUNTY ATTORNEY

File No. 1560

December 16, 1986

Mr. Joseph B. O'Brien, Borough Manager
The Borough of Hanover
44 Frederick Street
Hanover, Pennsylvania 17331

Re: Keystone Sanitary Landfill

Dear Mr. O'Brien:

We received our consultant's report this morning. A copy of the report and the "Executive Summary" of the Maryland Department of Health's study are enclosed. Naturally, this report is public information.

Sincerely,

Teresa L. Conaway

Teresa L. Conaway
Assistant County Attorney

TLC/dmb

Encl. (2)

AR101209

EDMOND G. OTTON AND ASSOCIATES
CONSULTING GEOLOGISTS
~~26 W. Pennsylvania Ave.~~
7400 York Road
TOWSON, MARYLAND 21204

Bus. 301-825-1533
Res. 301-823-1892

A.I.P.G. CERTIFIED PROF. GEOLOGIST NO. 2122
REGISTERED PROF. GEOLOGIST NO. 528 (GEORGIA)
FELLOW, GEOLOGICAL SOCIETY OF AMERICA

December 10, 1986

File No. 1560

County Commissioners
of Carroll County, MD
225 N. Center Street
Westminster, MD 21157

Attention: Office of the County Attorney
(Ms. Teresa L. Conaway)

Dear Sirs:

In accordance with our contract with you executed on November 19, 1986, we are enclosing our evaluation of the June 1986 report by the Maryland State Department of Health and Mental Hygiene, Waste Management Administration, titled Keystone Landfill Maryland Monitoring System Investigation and Report.

Our task, as designated in Section 2 of the contract, was to determine the scientific validity and reliability of the above mentioned report, and specifically to judge if the conclusions reached are supported by the data included.

In order to do this we must assume that the data given is reliable, and, particularly, that the chemical analyses of the water samples were made by approved standard methods.

Our report and two attached illustrations are enclosed. We trust our review and evaluation meets the requirements of our contract. We will be available to meet with the Carroll County Commissioners and their staff at a convenient time and place.

Sincerely,

Edmond G. Otton

Edmond G. Otton
C.P.G. No. 2122

EGO:jt

REVIEW AND EVALUATION OF

"KEYSTONE LANDFILL MARYLAND MONITORING SYSTEM INVESTIGATION AND REPORT"

Nature of the Report

This report actually is a compendium of at least eleven reports and letters of comment, plus a large amount of data. The most important report is the first one which includes 18 pages of text, a page of references, 13 figures, 2 tables, and 12 items in an Appendix. Also of importance are two reports by Wallace Koster, consulting geologist of Chambersburg, Pa.; his reports are followed by comments from MDH & MH-WMA concerning some of his conclusions. The final report is by Charles Zeleski of the Carroll County Health Department. It consists of 11 pages, a bibliography and appendices. It is an excellent summary of the situation.

Difficulty of the Problem

An inherent difficulty in many studies of ground-water contamination is the problem of trying to determine its source, especially where there is no substance present in the ground water unique to the presumed source. This is especially true at the Keystone landfill. Nowhere in the report could we find any detailed information on the nature of the material placed in the landfill and/or the dates of emplacement. We do know that the initial filling began along the south end in 1966 and is continuing to this day. We, therefore, have 20 years of filling taking place. If the character of the material emplaced in the landfill is known, this information is not included in the report, and presumably was not available to MDH & MH-WMA.

The basic problem addressed by the study is not to identify contaminated wells, but to identify wells contaminated by leachate from the landfill. As an example, the table in Appendix IX shows that the well at the Eddy residence (MD-R-3) contained trace amounts of chloroform, chloramethane, ethyl benzene, and 1,2-dichloroethane. These are all volatile organic compounds not found in uncontaminated ground water. However, the well location map (p. 73) shows that the Eddy well is approximately 4,700 feet south of the landfill and lies across two drainage divides. This well is one of the most distant residential wells monitored in the program, and yet the water from it contained volatile organic carbons (VOCs). These substances must have come from some source other than the landfill. This is true of other wells where the water contains VOCs.

Major Conclusions Based on the Hydrogeology and the Flow Systems

1) The available data supports the existence of two aquifer systems: a) a shallow aquifer that lies at the base of the water table and extends a few tens of feet below it. Most of the vertical and lateral movement of ground water must take place within this zone, and this is the zone within which the limited migration of leachate also must occur.

b) A deeper ground-water aquifer, if one exists, has not been shown to be present immediately south of the landfill, at least based on the aquifer-test data obtained from tests on the three groups of cluster monitoring wells M 1-3, M 4-6, and M 7-9.

The aquifer test conducted on well MD-W-2 (depth of 85 ft with 20 ft of gravel pack) was analyzed by the Hvorslev formula and the following values of hydraulic conductivity (K) and transmissivity (T) were obtained. Transmissivity is the hydraulic conductivity times the aquifer thickness.

K(cm/sec)[1/]	K(ft/day)	T(ft^2/day)
0.000035	0.10	2.0

The aquifer test on well MD-W-4 (depth 250 ft with 75 ft of gravel pack and screen) showed the following values of hydraulic conductivity and transmissivity:

K(cm/sec)	K(ft/day)	T(ft^2/day)
0.0000015	0.004	0.3

The aquifer test on well MD-W-7 (depth 250 ft with 50 ft of gravel pack and screen) showed the following values of hydraulic conductivity and transmissivity:

K(cm/sec)	K(ft/day)	T(ft^2/day)
0.00000014	0.00028	0.14

All of the above values are extremely low. The range in values of transmissivity (T) is from 0.14 ft/day to 2.0 ft^2/day. Formations having transmissivity values below 10 to 15 ft^2/day approach the lower limit of being considered aquifers. The fact that the wells yield any water at all must be due to the fact that a limited quantity of ground water can be stored in the well bore (about 1.5 gallons/foot in a 6-inch diameter hole). This water slowly seeps into the well during periods of no water demand.

1/ To convert cm/sec to ft/day multiply by 2,854

The zone of very low transmissivity lies at the following depths in the wells tested:

Well Number	Depth of Zone (ft)
MD-W-2	65 - 85
MD-W-4	175 - 250
MD-W-7	200 - 250

Rates of Flow in Deeper Rocks

Two of the most important figures given in the report are Figures 7 and 10B. This report includes our Figure 1 showing the hydrogeology from the landfill to Humbert Schoolhouse Road. Figure 7 is the contour map of the water table in the shallow aquifer during August-October 1985. By means of the data on the hydraulic head distribution shown on Figure 7, we can compute the possible rates of flow of water downgradient, based on the hydraulic conductivity values obtained from the aquifer tests. The formula is:

$$v = \frac{K\left(\frac{h_1 - h_2}{L}\right)}{\theta}$$

where:

v = ground-water velocity, in ft/day

K = hydraulic conductivity, in ft/day

L = distance of travel, in ft

h_1 = elevation of upper point on water table, in ft

h_2 = elevation of lower point on water table, in ft

θ = effective porosity, in percent

To compute the flow velocity from well K3 at the edge of the landfill to well MD-R-7, a distance of about 1,650 feet, the formula and computations are, using a K value of 0.004 ft/day and an estimated porosity of 0.01:

$$v = \frac{0.004 \quad \frac{740-700}{1,650}}{0.01} = \frac{.004(.024)}{.01} = .0096 \text{ ft/day}$$

The above velocity amounts to about 3.5 ft/year. At this rate (applied to the deeper rocks) a particle of water would have moved about 70 feet from the landfill during the 20 years since filling began in 1966.

Based on a hydraulic conductivity of 0.10 ft/day, the rate of movement of ground water between the two wells would be 0.24 ft/day, or about 87.6 ft/year. Thus, during the 20 year period of landfilling, a particle of water would have moved about 1,750 feet down slope. The conclusion from the above crude calculations is that, if leachate has moved any significant distance from the landfill, it must have migrated through earth materials having a higher hydraulic conductivity than the lowermost values used here, or the leachate must move at rates significantly different than the normal ground water.

The second major illustration in the report, Figure 10B (cross section A-A'), is extremely important as it indicates the normal and expected direction of movement of ground water in a Piedmont locale. Figure 10B shows that ground water will move downgradient from the landfill (at well K-W-2) to the unnamed tributary lying between the

State line and the Humbert Schoolhouse Road. This stream functions as a ground-water sump and receives water from both the south and north directions. Any flow of contaminated water from the north will be balanced by an equal flow of uncontaminated water (at least not contaminated by the landfill) from the south, providing hydraulic heads, permeabilities of the rocks, etc., are approximately equivalent. Of course, heavy pumping of ground water by wells south of the stream could lower the water table and result in possible movement of water across the stream and into the south part of the aquifer. However, such pumping is not occurring and the poor permeability of the aquifer precludes the possibility of this happening. Figure 1 of this report graphically shows this situation.

Use of Chloride Ion as a Tracer Substance

Ideally, the best way to identify ground-water contamination from a landfill would be to identify a substance unique to the fill, but this does not seem possible at this time. Furthermore, an ideal tracer substance should be highly mobile and not be adsorbed by the earth materials through which it moves. Of the common ions, the chloride ion comes the closest to fulfilling these criteria. According to the following table, chloride ions in leachate from sanitary landfills would have a representative range of from 300 to 3,000 mg/liter.

Table 1. Representative Ranges for Various Inorganic Constituents in Leachate from Sanitary Landfills [a/]

Parameter	Representative Range (mg/l)
Potassium (K^+)	200 - 1,000
Sodium (Na^+)	200 - 1,200
Calcium (Ca^{++})	100 - 3,000
Magnesium (Mg^{++})	100 - 1,500
Chloride (Cl^-)	300 - 3,000
Sulfate (SO_4^{--})	10 - 1,000
Alkalinity	500 - 10,000
Iron (Fe) (total)	1 - 1,000
Manganese (Mn)	0.01 - 100
Copper (Cu)	< 10
Nickel (Ni)	0.01 - 1
Zinc (Zn)	0.1 - 100
Lead (Pb)	< 5
Mercury (Hg)	< 0.2
Nitrate (NO_3^-)	0.1 - 10
Ammonia (NH_4^+)	10 - 1,000
Phosphorus (P) as phosphate (PO_4)	1 - 1,000
Organic nitrogen	10 - 1,000
Total dissolved organic carbon	200 - 30,000
COD (chemical oxidation demand)	1,000 - 90,000
Total dissolved solids	5,000 - 40,000
pH	4 - 8

Examination of the concentration of chloride ions in several wells for which analyses were made shows that the highest chlorides occurred in Keystone monitoring well No. 3 at the southwestern border of the landfill. Appendix X, Table of Inorganic Analyses, shows that the chloride content of the water from this well ranged from 25 to 1,340 mg/liter, based on 16 samples taken during the period January 7, 1981, through January 7, 1986. The mean chloride content during this interval was 752 mg/liter; this is more than

a/ Griffin, R.A. and others, 1976, Alteration of pollutants in municipal landfill leachate by clay minerals, Part I: Illinois State Geol. Survey Bulletin 78, Urbana, Ill.

twice the lower limit of the chloride ions in leachate, as indicated by the Illinois Geological Survey (Table 1) and establishes the chloride ion as a valid tracer substance.

The mean chloride content of 17 residential wells in the Babylon Phyllite-Marburg Schist unit in northern Carroll County ranges from 1.0 to 34 mg/liter, with the mean value being 8 mg/liter. b/

Thus, the Keystone monitoring well No. 3 has a chloride content 94 times greater than the 17-well average in presumed uncontaminated wells in the aquifer. Based on an assumed southwestward movement of ground water from the landfill, the mean chloride content of the cluster monitoring wells M 1-3 ranged from 8.5 to 16.1 mg/liter and the chloride content of cluster wells M 4-6 ranged from 2.7 to 9.5 mg/liter. Cluster wells M 7-9 had an even lower chloride content, ranging from 2.5 to 9.8 mg/liter. All of these data are shown on our Figure 2, which is attached. Chlorides in the cluster wells are low.

The chloride content of the stream samples is most significant. The mean values from sampling stations S4 through S7 range from 19 to 105 mg/liter, with the two highest values being 37.3 and 105 mg/liter. The highest value (105 mg/liter) is 13 times greater than the value for uncontaminated wells (8 mg/liter). This appears to indicate that the chloride and leachate-contaminated ground water may be by-passing most of the cluster wells (certainly the two easternmost clusters) and appearing in the unnamed tributary of Piney Run. This would give support to the hydrogeologic data and

---

b/ Nine of the 17 wells are from the chemical analyses data of Hilleary and Weigle (1981) for the Littlestown quadrangle. The remaining eight analyses are from residential wells sampled during the Keystone landfill study.

theory which indicates that this should occur, especially if the leachate-contaminated water is moving along a shallow zone near the top of the aquifer. The mean depth of the weathered zone in 18 wells near the landfill is only 15 ft (data from Buchart-Horn, Inc., Consulting Engineers).

Summary of Our Conclusions Regarding Statements in the Report

B. Geology and Hydrogeology (p. ii)

Geology (p. ii)

1. Statements here are correct and factual.

Hydrogeology (p. iii)

Statements 1 and 2 are correct and supported by substantial data.

C. Contamination (p.iii)

1. Statement correct and based on sufficient data.

2. Statement correct and based on sufficient data.

3. Statement essentially correct, but possibly some of the high chloride values at the stream sampling stations S4 through S7 could be due to attenuated leachate-derived chlorides which arrived at the stream by by-passing cluster wells 1 through 3.

D. Conclusion (p. iv)

The monitoring and investigation has basically met the two requisite goals: 1) Evaluate the quality of ground water in the study area as it relates to possible contamination from the landfill; and 2) to determine if the landfill is the source of contamination of Maryland residential wells.

We agree that the investigation has met the goals and objectives as stated above. It must be recognized that a very substantial effort and expense has gone into the Keystone Landfill study by the government agencies involved.

1) Potability (p. iv)

   a. Shallow aquifer - south of the unnamed tributary of Piney Creek. No existing drinking water standard or recommended maximum contaminant level (RMCL) is exceeded in any sample for pollutants attributable to the Keystone landfill. Statements appear to be correct, based on the latest available analyses.

   b. Shallow aquifer - north of the tributary of Piney Creek. Trace volatile organic contamination attributable to the landfill is documented in this region. No drinking water standard is exceeded by this trace contamination. However, one RMCL (tetrachloroethlene) is exceeded in cluster well MD-W-2, but not in any residential well. Statement is correct, but chlorides above background levels (see our Figure 2) suggest some trace amounts of leachate may be present southwest of the landfill.

2) Contamination Source (p. iv) - Trace volatile organic contamination originating at the Keystone Sanitation, Inc. landfill is documented southwest of the landfill and north of the unnamed tributary of Piney Creek in Maryland. Data presented in report and conclusions drawn support this statement, in our opinion.

Problems with the Keystone Landfill Report

1. Our review of the report was hampered somewhat by the fact that a standard system was not uniformly used in referring to the wells and springs. A single map should be used to reference all wells used or discussed, and numbers should be assigned on this map. We realize this problem was due to the several authors involved and that this is not one single report by a single agency.

2. Several maps are in the report but road names are on very few of them. In the text, wells are identified as being near a certain road or owned by a property owner, but it took some searching to identify these wells and the information concerning them. A property location map would have been helpful, but was not included.

3. Figure 4 (Lineament and Fracture Trace Map). Most geologists do not consider an alignment of several hilltops to constitute a linear feature, but several of the heavy lines on the map are based on this definition.

4. All area maps should show the Keystone landfill on them, as this feature is the focus of the entire project. A person reading the report for the first time may find it necessary to refer back to a previous map to locate the landfill site.

5. The large numbers of organic chemicals identified in the water analyses are of great interest, and these are listed on page 13. However, no information is given as to possible sources for these compounds, which could come from random spills or dumping of paints, motor oils, gasoline, fuel oil, or other substances on the ground, including herbicides or pesticides used on farm fields or lawns.

6. Possibly the greatest weakness in the report is the lack of information on the nature of the material placed in the landfill. It must be assumed that this information is not available to the MDH & MH-WMA or to the officials of Carroll County.

7. At this time, we cannot see the necessity for additional ground-water studies in the subject area. However, the monitoring program, especially for water quality, should be continued, at least for a few more years.

Edmond G. Otton

Edmond G. Otton
Certified Professional Geologist
No. 2122

Enclosures: Figures 1 and 2.

EXECUTIVE SUMMARY

INTRODUCTION - In the spring of 1984, citizens of northern Carroll County, Maryland became aware of reports of groundwater contamination in the area of the Keystone Sanitation, Inc. landfill which is located near the state boundary in Union Township, Adams County, Pennsylvania. An investigation by the Waste Management Administration (WMA), DHMH confirmed the reports that the groundwater at the Keystone Sanitation, Inc. landfill had become contaminated with various volatile organic and inorganic compounds. In response to concerns expressed by area residents that this contamination may affect the quality of groundwater in Maryland, the Waste Management Administration, in February of 1985, published the "Keystone Area Ground Water Monitoring System Proposal."

II. MONITORING SYSTEM

1. Description - The monitoring system consists of nine newly-constructed groundwater wells, seven selected residential wells, and six surface water sampling locations. The monitoring points were located between the suspected source of contamination, the Keystone Sanitation, Inc. landfill, and the major concentration of nearby residences along Humbert Schoolhouse Road. The monitoring points were arranged in three zones: (a) the newly-constructed monitoring wells being closest to the landfill, (b) surface sampling locations intermediate between the landfill and Humbert Schoolhouse Road, and (c) the selected residential wells being closest to Humbert Schoolhouse Road.

2. Data Collection - Groundwater data was received from a variety of sources. Foremost was the data obtained from the routine sampling of the monitoring system. This data included parameters generally associated with a municipal landfill and those specific volatile organic compounds known to be contaminating the groundwater at the Keystone Sanitation, Inc. landfill. Samples were collected from the monitoring system monthly for the first quarter and quarterly thereafter. A total of six sampling rounds were completed. Additional monitoring data was received from a variety of sources, including the Keystone Sanitation, Inc. landfill, Pennsylvania Department of Environmental Resources, and the Carroll County Health Department. Geologic data was received from the United States Geological Survey and the University of Maryland.

B. GEOLOGY AND HYDROGEOLOGY

Concurrent with the collection of groundwater data, an investigation of the geology and hydrogeology in the study area was conducted.

Geology

1. The dominant rock type is the Babylon Phyllite member of the Marburg Schist. This is a dense crystalline rock which is essentially impermeable. However, water can flow in a well-developed fracture system within the rock which parallels the fine, continuous cleavage that the rock exhibits.

2. The Babylon Phyllite contains abundant, naturally occurring minerals which have the potential to leach inorganic constituents into the groundwater.

Hydrogeology

1. Surface water and shallow groundwater moves southward and southwestward, respectively, from only the southern portion of the Keystone Sanitation, Inc. landfill to the small tributary of Piney Creek in Maryland. This is the only potential impact area in Maryland for contamination from the landfill.

2. Surface and shallow groundwater moves northward and northeastward, respectively, from the Humbert Schoolhouse Road area to the small tributary of Piney Creek. This region cannot be affected by contamination from the Keystone Sanitation, Inc. landfill.

3. There is no evidence of a deep groundwater aquifer in the study area.

C. CONTAMINATION

1. Trace volatile organic contamination, originating at the Keystone Sanitation, Inc. property is documented southwest of the landfill and north of the tributary of Piney Creek in Maryland.

2. Volatile organic contamination in the residential wells south of the tributary of Piney Creek is caused by isolated or localized phenomenon, not contamination from the Keystone Sanitation, Inc. landfill.

3. Inorganic contamination present in all study area wells is caused by naturally occurring conditions, not contamination from the Keystone Sanitation, Inc. landfill.

ORIGINAL
(Red)

D. CONCLUSION

The groundwater monitoring and investigation program conducted by the Waste Management Administration in the Keystone area had two requisite goals: (1) to evaluate the quality of the groundwater in the study area as it relates to possible contamination from a nearby landfill, and (2) to determine whether the landfill is the source of the contamination.

1. Potability - The foremost concern of area residents is the safeness of the drinking water in their community. The data accumulated during this investigation requires that any response to this concern must be stated in terms of two distinct groundwater regions within the study area.

   a. Shallow aquifer - south of the tributary of Piney Creek - No existing drinking water standard or recommended maximum contaminant level (RMCL) is exceeded in any sample for pollutants attributable to the Keystone Landfill.

   b. Shallow aquifer - north of the tributary of Piney Creek - Trace volatile organic contamination attributable to the Keystone Sanitation, Inc. landfill is documented in this region. No drinking water standard is exceeded by this trace contamination. However, one RMCL (tetrachloroethene) is exceeded in MD-W-2, but not in any residential well.

2. Contamination Source - Trace volatile organic contamination originating at the Keystone Sanitation, Inc. landfill is documented southwest of the landfill and north of the unnamed tributary of Piney Creek in Maryland.

E. COSTS

In order to properly evaluate the possible contamination of Maryland waters, significant expenditures have been made by State, Federal and Local Government Agencies. Estimated expenditures by the Waste Management Administration (WMA) and the Carroll County Health Department (CCHD) are detailed below:

Laboratory Analysis of Samples	$ 88,000
Well Installation Costs	27,300
WMA and CCHD Manpower Expenses	90,000
Equipment and Miscellaneous Expense	17,000
	$222,300

REPORT ON STUDY OF WATER SUPPLY CONTAMINATION POTENTIAL FROM KEYSTONE LANDFILL OPERATIONS FOR THE BOROUGH OF HANOVER

DECEMBER 2, 1986

Capitol Engineering Corporation

CONSULTING CIVIL ENGINEERS

DILLSBURG, PENNSYLVANIA 17019

Capitol Engineering Corporation

CONSULTING CIVIL ENGINEERS

124 W CHURCH ST., P.O. BOX 445

PHONE (717) 432-9628 DILLSBURG, PENNSYLVANIA 17019-0445

EDWARD W BOGGS, P.E.
THOMAS S LADUE, P.E.
CARL L. SPATARO, P.E.
ROBERT E. SMITH, P.E.
ROY W. SMITH, P.E. 1948-1979
ROBERT E. MARTZALL, P.E. 1953-1984

December 2, 1986

Hanover Borough Council
44 Frederick Street
Hanover, PA 17331

8305-C
Evaluation of Contamination
from Keystone Landfill

Attention: Mr. Joseph O'Brien
Borough Manager

Gentlemen:

As per your request, we are pleased to submit herewith 25 copies of our report on the evaluation of the potential of the contamination from the Keystone Landfill area with respect to its impact on the Hanover Borough water supply. This study concerns itself both with the present source of water in the streams and tributaries to the Long Arm Dam, the Sheppard-Myers Dam, and the Kitzmiller drainage basin, as well as the possible impact on future well sites which may be developed for additional water supply.

We were assisted in this study by R. E. Wright Associates, Inc., who are hydrogeologic and ground water experts with respect to the evaluation of the various hydrogeological data which was prepared by others with respect to the Keystone Landfill contamination situation. As you will recall, R. E. Wright Associates also assisted us in the identification of the potential well sites for future development of additional supply for the Borough as part of our study completed in 1983. It is appropriate that this firm assist us in this additional study as they have developed the major background material with respect to the ground water regime of the area in the development of the hydrogeological aspects of the 1983 report and the selection of the potential well sites.

Based on our evaluation of the existing material available with respect to the contamination at the Keystone Landfill site prepared by the State of Maryland, hydrogeologists for the PACE special interests group and the owner of the landfill, and additional information obtained from the Department of Environmental Resources and studies conducted by our associates, we are able to conclude that it does not appear that there will be any impact of this contamination on either the present well water source or any future ground water development at well sites identified in our earlier study. It should be noted, however, that a slight potential does exist at one of the proposed well sites, Site 8, which is addressed in the text of this report and which should have virtually insignificant impact from any contamination. However, this site should be test drilled and water quality sampling

performed in order to verify the conclusions reached in this study. We further are able to conclude that no additional studies are required by the Borough to satisfy the concerns with respect to the safety of the water supply from contamination from the Keystone Landfill area.

We trust that the material contained in this report and the conclusions reached are responsive to your request and will serve to relieve the Borough of any concern with respect to the quality of its present water supply. Should you have any comments or require clarification of any of the material presented in this report, we would be happy to meet with you to discuss your concerns.

Very truly yours,

CAPITOL ENGINEERING CORPORATION

Thomas S. Ladue

Thomas S. Ladue, P.E.
Senior Vice President

TSL/jdg
Encls.
xc: R. E. Wright Associates, Inc.

AR 101228A

(Red)

TABLE OF CONTENTS

FINAL
(Sd)

REPORT ON STUDY OF WATER SUPPLY CONTAMINATION POTENTIAL FROM KEYSTONE LANDFILL OPERATIONS FOR THE BOROUGH OF HANOVER

A. Purpose of Study:

The Hanover Borough Council has the primary responsibility to provide safe, potable drinking water to the customers supplied with water from its water system. Within the past two to three years, the landfill operation at the Keystone Landfill, a privately owned and operated landfill in Union Township, Pennsylvania has become suspect of contamination of the groundwater in the area from leachate from within the landfill site. The extent of this contamination has been the subject of several studies by the Maryland State Department of Health and Mental Hygiene, private special interest groups and the owner of the landfill. These studies are referenced in the report.

The present operation of the Keystone Landfill is contained within approximately 35 acres of the 60± acres owned by the operating entity. The Owner has made application to the Pennsylvania Department of Environmental Resources (DER) to expand its operation to 200± acres. This application is currently under review by DER and has raised considerable concern to the state of Maryland, private interest groups as well as the Borough of Hanover.

Hanover currently derives its entire water supply from surface water sources within one mile of the landfill site and anticipates the need to develop additional water supply from groundwater sources within this area. Results of recent analysis of the Hanover Water Supply have not indicated any contamination of volatile organics of any type including the volatiles which have been attributed to groundwater contamination by the landfill. Groundwater clean-up operations at the landfill site have been undertaken and have been operational for most of this past year.

Migration of contamination of this type in groundwater can proceed at various rates depending upon the nature of the sub-surface soil and rock types and conditions, and the degree of groundwater withdrawal by external development (pumping of wells, etc.). In general, migration of contaminates is rather slow. In this case, the clean-up operation (pumping and treatment of the groundwater from within site) will serve to retard, if not eliminate, the migration.

Considering the possibility of the migration of this present contamination in the direction of the Hanover water supply source, the potential for approval of an expanded landfill operation (also in the direction of the present water supply), and the potential for migration of the contamination in the direction of identified future well sites which may be developed for additional supply, the Hanover Borough Council has directed Capitol Engineering Corporation to study all available data with respect to the impact that the present and any future contamination of the groundwater resource may have on the present and future water supply of the Borough. Based on this study, Capitol was directed to determine the following:

(1) That sufficient data is available to assess the impact of contamination on the Borough water supply;

(2) If sufficient data is available, determine the impact on both the present and potential future water supply sources; and

(3) If sufficient data is not currently available, determine what additional studies must be performed in order to properly assess the impact.

B. Scope of Study:

Capitol initially proceeded to gather all available data relating to the nature and extent of the present contamination of the groundwater from the Keystone Landfill site. This data included reports on studies done by others on the existing conditions at the landfill (referenced in Exhibit I); review of DER files on inspection reports and review comments on reports by others; and review of the design report prepared by the owner's engineer for the proposed landfill expansion. This information was studied in detail to determine its applicability and completeness with respect to the nature and purpose of this study.

After this data was studied and considering the fact that the nature of the investigation was highly technical with respect to the hydrogeological aspects of the area in question, Capitol determined that the services of an experienced hydrogeologist would be necessary to properly evaluate the data and to determine its applicability to the impact of the groundwater regime on the Hanover water supply sources. Since Capitol does not have an individual with these qualifications on its staff, but does regularly retain an outside

associate on projects requiring this expertise, and since an outside associate was previously retained by Capitol in its work in identifying potential future wells for groundwater supply for Hanover, the services of R.E. Wright Associates, Inc. were again utilized to assist in this study.

Utilizing the data gathered by Capitol, R.E. Wright Associates, Inc. (REWAI) reviewed the hydrogeologic environment of Hanover and the Keystone Landfill area, and the information regarding existing and proposed landfill activities. From this information REWAI was able to identify the geologic structure of the area, the extent and nature of subsurface aquifers, a water table profile, the direction of groundwater flow from the landfill site, and the groundwater basins which exist between the landfill site and the Hanover water sources. A detailed discussion of the hydrogeologic investigation is attached as Exhibit I. This Exhibit presents the pertinent findings of this study.

C. Conclusions:

As a result of our investigation into the potential of contamination of the Hanover Borough water supply by leachate from the Keystone Landfill, it is our opinion that no water quality impact on the present water source which is contained within the Kitzmiller Dam groundwater basin is possible. This conclusion is based on the fact that there are at least three distinct drainage basins between the landfill site and the Kitzmiller basin which will intercept any groundwater in the shallow aquifer prior to its reaching the Kitzmiller basin. Any contamination which might find its way into the deeper aquifer through fractures in the rock formation cannot discharge into the surface waters which make up the supply for the Hanover system, but will instead discharge to a major water course at a significantly lower elevation.

One of the proposed well sites (Site 8) which may be developed for future water supply lies on a fracture which extends through a portion of the proposed expansion area of the landfill (Plate 1, Exhibit I). This is the only well site of those identified as potential sources of water supply for the Borough which has any potential of being impacted by contaminant flows orginating from Keystone Landfill. Because of the great distance between Site 8 and the landfill and the large area available for groundwater recharge to this site, any contaminants which would migrate to this site as a result of pumping should be sufficiently diluted to have an insignificant impact upon the water quality from this site.

ORIGINAL

With respect to the need for additional studies, we have concluded that the data available from studies performed by others and referenced in Exhibit I reasonably reflect all of the pertinent parameters of the hydrogeologic regime which are necessary to properly evaluate the impact of the Keystone Landfill upon the present and potential future water supplies of Hanover Borough. Therefore, we recommend that the Borough not consider additional studies with respect to the Keystone Landfill at this time.

Based on these findings it is our opinion and the opinion of our expert hydrogeologic associate, REWAI, that the operation of the Keystone Landfill at its present level and at the level of its proposed expansion should have no adverse impact on the existing or proposed surface water and groundwater supplies. In order to maintain this level of confidence particularly with respect to the proposed development of groundwater sources, it is important that the construction of the proposed expansion of the Keystone Landfill be closely monitored to assure that the proposed liner and leachate treatment facilities are installed properly and that the proposed leachate treatment system is properly operated and maintained.

Respectfully Submitted,

CAPITOL ENGINEERING CORPORATION

Thomas S. Ladue

Thomas S. Ladue, P.E.,
Senior Vice-President

ORIGINAL
(Red)

EXHIBIT I

R.E. WRIGHT ASSOCIATES, INC. LETTER REPORT

AR101223A

ORIGINAL
(Red)

r.e. wright associates, inc.
earth resources consultants

December 3, 1986

Mr. Thomas S. Ladue, P.E.
Capitol Engineering Corporation
124 W. Church Street
Dillsburg, PA 17019

Re: Impact of Keystone Landfill
Upon Existing and Proposed
Hanover Groundwater and
Surface Water Supplies
Project 86173

Dear Mr. Ladue:

Pursuant to your request, R. E. Wright Associates, Inc. (REWAI) initiated this study of the potential impact of the existing and proposed landfill sites of the Keystone Sanitation Company in Union Township, Adams County, Pennsylvania, upon the existing and proposed groundwater and surface water supplies for the Borough of Hanover. This study involved the review of existing information regarding the hydrogeologic environment of Hanover and the Keystone Landfill area and information regarding existing and proposed landfill activities. Numerous reports, letters, and raw data were analyzed to develop this evaluation. A listing of the information reviewed is contained in Appendix 1. Where information has been taken from the items in Appendix 1, these portions of the text have reference numbers in parentheses.

EXECUTIVE SUMMARY

The 60+ acre existing landfill property (35+ acres of which are landfilled) and the 200+ acre proposed landfill expansion of the Keystone Sanitation Company are underlain by a shallow major aquifer derived from the Marburg Schist, which is composed of saprolite, weathered bedrock, and the upper portions of competent bedrock. This aquifer, extending to depths of 130 feet, is relatively permeable, and contains almost all groundwater flow from the landfill. Groundwater flow degraded by potential discharges from the proposed or existing landfill would flow within this shallow major aquifer along relatively short flow paths and discharge into small local streams. The maximum potential area of contamination within this aquifer has been

3240 schoolhouse road middletown, pa 17057-3595 (717) 944-5501

identified on Plate 2 as the groundwater basin of the Keystone Landfill.

Because of decreasing piezometric head potential with increasing depth (downward gradient), the conditions for a deep groundwater flow system exist. Contaminated groundwater flow from the landfill could enter this deep groundwater flow system; but since the deep aquifer typically has very low permeability, only minor amounts of flow are expected to occur within it.

The existing Borough of Hanover water supply, consisting of surface water at the Kitzmiller Dam, is sustained by the Long Arm Creek, Long Arm Reservoir, South Branch Conewago Creek, and Sheppard-Meyers Reservoir. The Kitzmiller Dam groundwater basin supplying these surface water bodies has the same groundwater flow system conditions as the Keystone Landfill. Since several groundwater basins exist between the Keystone Landfill and the Kitzmiller Dam groundwater basin, there exists no potential for contamination through the shallow major aquifer between these areas. Potential for contamination through the deep groundwater flow system does not exist either, as the discharge point of the deep groundwater flow system would probably be a major water course.

The proposed (previously identified) well sites for the Borough of Hanover are located in the carbonate rocks to the north of the landfill. Under natural groundwater flow conditions, there exists little potential for contamination from the landfill through the shallow or deep aquifers and flow system. However, under pumping conditions, the imposed drawdown on the aquifer could induce groundwater flow from the Keystone Landfill groundwater basin through both the shallow flow system and the deep flow system. Well Site 8 would be the most susceptible to this due to its proximity to the Keystone Landfill groundwater basin and its location on a lineament that passes through the proposed landfill expansion. However, due to the great distance between Site 8 and the landfill and the large amount of other recharge area to the well, any water quality impacts should be insignificant. All other proposed well sites would be less susceptible to contamination from the landfill.

Therefore, it is REWAI's opinion that there exists no significant potential for contamination of existing or proposed Borough of Hanover groundwater or surface water supplies. However, we recommend that a qualified inspector be retained to ensure to the maximum degree possible that proper construction practices and results are obtained during the construction of the lined-landfill expansion.

LANDFILL DESCRIPTION

Presently, the Keystone Sanitation Company operates a 60+ acre natural renovation landfill (unlined) on a 60+ acre site for the disposal of primarily household and other municipal waste. A Phase 1 application for expansion has been submitted to the Pennsylvania DER for an adjacent 200+ acre tract. The expansion will be a synthetically-lined sanitary landfill for the disposal of similar wastes as presently accepted at the existing landfill. Collection and treatment facilities will be utilized to control and process leachate generated from the refuse.

HYDROGEOLOGY OF KEYSTONE LANDFILL AREA

Geology

The bedrock beneath the site consists of the Marburg Schist, a bluish-green to bluish-gray mica-chlorite-quartz schist. The Marburg Schist is complexly deformed and contorted in this area and ranges in metamorphic grade from phyllite to schist (7). Several other geologic formations exist within 20,000 feet of the landfill, including those composed of phyllite, carbonate (limestone and dolomite), sandstone, and diabase. The areal distribution and geologic description of each formation are shown on Plate 1 (7, 14, 15, 16).

Deformational stresses have caused numerous rock breakages (cleavage and joints) within the Marburg Schist. The dominant planar rock breakage is the regular and closely spaced cleavage, oriented approximately N62°E and dipping 80° to the southeast (7, 14). Four distinct joint sets have also been identified that crosscut this cleavage, but are much less dominant in regularity and extent (7).

Physical and chemical weathering processes have attacked the rock formation creating the following layered geologic framework with increasing depth:

1) soil,
2) saprolite,
3) weathered bedrock, and
4) competent bedrock

The depth of weathering and subsequent thickness of these units are quite variable, dependent primarily upon original mineralogic characteristics and rock fracturing (permeability). For instance, the depth to competent bedrock can range from less than 5 feet to depths greater than 100 feet.

Soil is characterized as highly micaceous silty clay and clay with some rock fragments, but containing no visible relict rock structures. Saprolite consists of highly micaceous soil-like textural material, having visible relict rock structure. Weathered bedrock consists of decomposed and broken phyllite and schist, having rock structure and strength. Competent bedrock consists of fresh and slightly weathered, hard phyllite and schist. Contacts between the above units are gradational.

Aquifer Characterization

Based upon drilling records, caliper logs, and geophysical data, the Keystone Landfill hydrogeologic framework can be characterized as a two-layer aquifer system (7,14). The shallow major aquifer layer consists primarily of saprolite, weathered bedrock and the upper portions of competent bedrock. Because of the relatively high permeability of these materials, almost all groundwater flow occurs within this layer. Even though some water-bearing zones were found by the Maryland investigators to the greatest depth drilled of 250 feet, the majority of water-bearing fractures occur above 130 feet (14). Based upon the drilling results and the geophysical (resistivity) investigation (7, 14), the bottom of the major aquifer has been assumed to be at approximately 130 feet. However, due to differential fracturing and weathering, there will be zones on-site and in the surrounding area where the thickness of the shallow major aquifer will be either larger or smaller. The deep aquifer layer can be characterized as hard, competent, largely unweathered bedrock. Permeabilities are typically one to two orders of magnitude lower than the shallow aquifer, indicating that much less groundwater flow occurs through the deep aquifer.

Groundwater Flow System

REWAI has prepared a water table contour map (Plate 2) based upon water levels from 47 wells in the vicinity of the Keystone Landfill, topography, and stream position. Appendix 2 summarizes the well data. Twenty-five of these wells are located on the Keystone Landfill property. This map defines the configuration of the water table surface within the shallow major aquifer within a square mile area around the landfill.

A comparison between the static water levels in wells adjacent to streams and stream levels and the configuration of the water table contours indicates that the streams dissecting the topography of the area are primarily groundwater supplied. Flow within the shallow major aquifer is dominated by relatively short flow paths (several hundred feet), flowing from the recharge

areas of hilltops and hillsides and discharging into the small streams and tributaries within the valleys. A cross-section oriented along the primary permeability (cleavage) showing conceptual groundwater flow paths within the shallow aquifer is included as Plate 3.

The direction of groundwater flow within the aquifer is determined by the slope of the local water table and the preferential orientations of existing bedrock fractures. Based on available information (7, 14), anisotropic permeability of the aquifer exists, probably aligned parallel to the dominant primary cleavage, an orientation of N62°E. This anisotropic permeability which pervades the saprolite, the weathered bedrock, and the competent bedrock may approach a ratio of 10:1, being greatest parallel to primary cleavage.

In order to determine the potential areas of contamination from the Keystone Landfill, the directions of groundwater flow and the groundwater basins were identified. Because field determination of the degree of anistropy has not been completed, the directions of groundwater flow under isotropic (1:1) conditions and 10:1 anisotropic conditions have been used to develop the areas of major contamination potential within the shallow major aquifer from the Keystone Landfill (see Plate 2). However, if permeability contrasts vary throughout the area in orientation and degree, any area within the maximum extent of groundwater contamination (groundwater basin) could be affected.

It is not likely that all areas within this groundwater basin are equally susceptible to contamination from Keystone Landfill. Rather, specific areas and zones are much more susceptible to flow from the landfill. However, with the limited state of knowledge with regard to the exact hydrogeologic conditions of the site, these zones cannot be definitively identified. Probable major areas of groundwater contamination potential are shown on Plate 2.

Even though permeabilities are relatively low in the deep aquifer, a deep groundwater flow system does exist within the site. Maryland cluster wells indicate the piezometric head gradient with depth is roughly two to three times greater than existing horizontal head gradient (14). Hence, a downward gradient inducing flow into the deep aquifer does exist, and contaminant migration in a vertical direction is a possibility. However, due to the low permeability of the deep aquifer, groundwater flow within this system is relatively minor and insignificant. Additionally, this flow would eventually discharge into a major surface water course. Groundwater flow path and a regional groundwater discharge zone (surface water course) are conceptually shown on Plate 3. The actual lateral direction

of groundwater flow in the dep aquifer is not known; and is shown only in schematic fashion.

There may be zones within this deep groundwater flow system where higher permeabilities pervade. REWAI has identified several lineaments within the vicinity of the landfill from satellite photographs that may be expressions of zones of higher permeability within the deep groundwater flow system (see Plate 1). With regard to specific sites and under a worst case scenario, it is necessary to consider these zones as potential paths for deep groundwater migration. Further discussion of these zones follows in later sections of this report.

EXISTING WATER QUALITY CONCERNS

Keystone Landfill has an operating five-well water quality monitoring system and has been the focus of at least two area-wide groundwater quality investigations. It is apparent from review of this acquired data that the Keystone Sanitation Company natural renovation landfill is presently discharging contaminants to the groundwater flow system. These contaminants, largely volatile organic chemicals, have been found in several off-site monitoring wells and springs. The priority pollutant volatile organics most frequently occurring on the site are 1,1-dichloroethane, 1,1-dichloroethylene, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene, and trans-1,2-dichloroethylene.

Total priority pollutant volatile organic concentrations within the on-site monitoring wells range from non-detected to 1,080 parts per billion (ppb) (see Appendix 3). Data from the area-wide groundwater sampling investigations (1, 3, 5, 14), where wells have been sampled as distant as three to four miles from the site, are quite sporadic. Based upon probable groundwater flow paths and off-site wells with priority pollutant volatile organics similar to those present in the landfill monitoring wells, it appears that the greatest concentration of priority pollutant volatile organics in any off-site well affected by the landfill is 199 ppb. This well, identified as Well 76, is located 700 feet northeast and downgradient of landfill monitoring well K1, which has the highest concentration of total priority pollutant volatile organics.

It is REWAI's opinion, that at least seven off-site sampling points have been affected by landfill activities. These include Wells 1, 14, 73, 76, MD-1, MD-2, and MD-3. Average concentrations of total priority pollutant volatile organics range from 10 to 199 ppb. They range in distance from 300 feet to 2300 feet from the existing landfill. If more wells had been constructed for the sole purpose of defining off-site contamination, higher

concentrations and a more regular distribution of priority pollutant volatile organics would probably have been found.

POTENTIAL FOR IMPACT ON HANOVER SURFACE WATER SUPPLIES

The Borough of Hanover existing water supply comes from an intake at Kitzmiller Dam shown on Plates 1 and 2. This dam receives flow from the South Branch Conewago Creek and the Long Arm Creek. Two large reservoirs, Long Arm Reservoir and Sheppard-Meyers Reservoir, provide low flow augmentation on these creeks for the Kitzmiller Dam intake.

The Kitzmiller Dam, the two creeks, and the two reservoirs are located within the same or a similar geologic unit (Marburg Schist or Harpers phyllite) as the Keystone Landfill. The surface water bodies receive their water through inflow from groundwater and from surface water runoff. All groundwater flow to these surface water bodies is probably through a shallow major aquifer, very similar to the one identified at the Keystone Landfill. Thus, the groundwater basin for the Kitzmiller Dam, which includes the two reservoirs and creeks, is dominated by short groundwater flow paths (several hundred feet), has recharge areas along hilltops and hillsides, and has discharge zones within the stream valleys and reservoirs.

The Kitzmiller Dam groundwater basin is situated 1,000 feet northeast of Keystone Landfill (see Plate 2). As many as three groundwater basins exist between the groundwater basin for the Keystone Landfill and the groundwater basin of Kitzmiller Dam. Under natural groundwater flow conditions, there can be no flow between groundwater basins through the shallow major aquifer. Therefore, no connection within the shallow major aquifer between the Keystone Landfill and the surface water bodies supplying the Kitzmiller Dam could exist.

With regard to the deep groundwater flow system, flow within the Kitzmiller Dam groundwater basin would likewise be downward into this deep system, as this basin is very similar topographically and hydrogeologically to the one in the vicinity of Keystone Landfill. In addition, the discharge point for the deep flow system is probably a major surface water course. Therefore, it is very unlikely that any adverse impact from deep groundwater flow from the Keystone Landfill exists.

In summary, any potential discharges from the Keystone Sanitation Company's existing or proposed landfills could not impact the water quality of the Kitzmiller Dam intake.

POTENTIAL FOR IMPACT ON PROPOSED WELL SITES

Several proposed well sites have been identified by REWAI south and west of the Borough of Hanover. In addition, several potential public supply wells exist on the Hanover Water Treatment Plant site. These well sites are located in the carbonate (limestone and dolomite) occupying this valley setting (see Plates 1 and 2). Carbonate bedrock aquifers are characterized by high permeability to depths as great as 600 to 700 feet; below which, permeabilities decrease significantly.

Under natural groundwater flow conditions, these well sites are outside the potential area of impact from the Keystone Landfill. However, under pumping conditions, the water table would be lowered in the vicinity of these wells and thus allow for some inducement of groundwater flow from other basins. Without already completing the wells and performing the pumping tests, it becomes exceedingly difficult to predict pumping impact upon the groundwater flow system. However, based on known hydrogeologic conditions and occurrences in similar hydrogeologic areas in other parts of the state, some general evaluations can be made.

It is likely that the pumping of a well constructed at Site 8 could lower the water table and induce groundwater flow from the basin containing Keystone Landfill. In addition, this well is located along a lineament identified from satellite photographs that extends directly beneath the proposed Keystone Landfill. Thus, some potential exists for the inducement of groundwater flow from the landfill area to Site 8 through both the deep groundwater flow system and the shallow major groundwater flow system. However, Site 8 is relatively distant from the landfill (1,200 feet apart). In addition, the large area of carbonate rock in the valley surrounding Site 8 will provide the majority of groundwater recharge to the well. Therefore, it is expected that any discharges from Keystone Landfill, even if they were able to eventually reach Site 8, would be sufficiently diluted by other groundwater to cause an insignificant impact.

The other well sites, which are further away from the Keystone Landfill groundwater basin and not located on a lineament passing beneath the landfill, are expected to have a much lower chance of being impacted by the Keystone Landfill.

CONCLUSIONS

Regarding the existing unlined Keystone Landfill and the proposed lined Keystone Landfill expansion, it is REWAI's opinion that no water quality impact to the Kitzmiller Dam groundwater basin is possible. Regarding the proposed well sites identified by REWAI for the Borough of Hanover, only Site 8 appears to have any

potential for being impacted by contaminant flows originating from Keystone Landfill. However, due to the great distance between Site 8 and the landfill and the large area of carbonate rock available for groundwater recharge to Site 8, any contaminants migrating with the groundwater from the landfill area should be sufficiently diluted to cause an insignificant impact upon the water quality of a well at Site 8.

Therefore, with regard to protecting the Borough of Hanover existing and proposed water supplies, the construction and operation of the proposed and existing Keystone Sanitation Company landfills in Union Township, Adams County, Pennsylvania, should have no adverse impact upon the development or use of proposed or existing groundwater and surface water supplies. However, REWAI would recommend that the Borough of Hanover, possibly in a cooperative effort with Littlestown Borough, Union Township, and Adams County, retain a qualified non-biased party to inspect the installation of the liner and other significant construction events for the landfill expansion, thus ensuring to the maximum degree possible the proper construction practices and results.

We appreciate very much the opportunity to perform this service on behalf of the Borough of Hanover; and if you should have any questions or concerns regarding this report, please do not hesitate to contact us.

Very truly yours,

R. E. WRIGHT ASSOCIATES, INC.

Herbert E. Fry, P.G.
Project Manager

Stephen M. Snyder, P.G.
Project Director

HEF:SMS:pc
Enclosure

ORIGINAL
(Red)

APPENDIX 1

Items Reviewed in This Study

1. 11/02/84 - letter report on the groundwater contamination from Keystone Landfill in Carroll County, MD - Wallace C. Koster (for Carroll County Ad-Hoc Committee)

2. 6/86 - review and comments on 11/2/84 report - Waste Management Administration/Maryland State Department of Health and Mental Hygiene (WMA)

3. 11/20/84 - letter report "Effect of Keystone Landfill on Groundwater" - Wallace C. Koster

4. 5/14/85 - review and comments on 11/20/84 report - PA Department of Environmental Resources (DER)

5. 9/30/85 - letter report on interpreting the water quality data generated by Maryland - Wallace C. Koster (for PACE)

6. 6/86 & 12/2/85 - review and comments on 9/30/85 report - WMA

7. 9/85 - Phase I Permit Application for Solid Waste Disposal Facility - Keystone Sanitation Company - Buchart-Horn, Inc.

8. 12/23/85 - review and comments on 9/85 application - Adams County Conservation District

9. 4/22/86 - review and comments on 9/85 application - DER

10. 6/16/86 - response to DER comments on 9/85 application - Buchart-Horn, Inc.

11. 9/26/86 - review and comments on 9/85 application - L. Robert Kimball & Associates (for Union Township)

12. 2/86 - letter report "Review of Keystone Area Monitoring System" - Wallace C. Koster (for PACE (probably))

13. 6/86 - review and comments on 2/86 report - WMA

14. 6/86 - Keystone Landfill, Maryland Monitoring System, Investigation and Report - WMA

15. 1981 - Summary Groundwater Resources of Adams County, Pennsylvania - Larry E. Taylor and Denise W. Royer, Pennsylvania Topographic and Geologic Survey

T01067

APPENDIX 1 CONT'D.

Items Reviewed in This Study

16. 1981 - Atlas of Preliminary Geologic Quadrangle Maps of Pennsylvania - Thomas M. Berg and Christine M. Dodge, Pennsylvania Topographic and Geologic Survey

17. 1982 - "Carroll County Water Resources Study Phase I" - R. E. Wright Associates, Inc.

18. 3/84 - "Groundwater Development Potential for the Area Surrounding the Borough of Hanover, Adams and York Counties, Pennsylvania" - R. E. Wright Associates, Inc.

T01068

ORIGINAL

APPENDIX 2

Static Water Level Elevations

Well No.	SWL Elevation*	Date Measured	Source**
K1	~750	10/85	14
K2	748	10/85	14
K3	755	10/85	14
K4	747	10/85	14
K5	727	10/85	14
K6	737	10/85	14
K7	711	10/85	14
K8	702	10/85	14
K10	712	10/85	14
K11	755	10/85	14
K12	737	10/85	14
K13	702	10/85	14
K14	703	10/85	14
K15	687	10/85	14
K16	718	10/85	14
K17	726	10/85	14
K18	745	10/85	14
K19	701	10/85	14
K20	747	10/85	14
K21	742	10/85	14
K22	725	10/85	14
K23	699	10/85	14
K25	732	10/85	14
K26	750	10/85	14
K27	744	10/85	14
MD-2	707	10/85	14
MD-5	720	10/85	14
MD-8	740	10/85	14
1	700	9/84	3
3	702	9/84	3
8	630	9/84	3
9	628	9/84	3
10	647	9/84	3
11	739	9/84	3
14	720	9/84	3
36	703	9/84	3
38	634	9/84	3
45	701	9/84	3
63	685	9/84	3
64	737	9/84	3
65	648	9/84	3
66	770	9/84	3
67	665	9/84	3
68	682	9/84	3
70	751	9/84	3
71	640	9/84	3
74	705	9/84	3

* estimated from USGS topography as a base
** numbers refer to items in Appendix 1

T01069

ORIGINAL
(Red)

APPENDIX 3

Volatile Organic Water Quality Data

Well No.	Average Concentration of Total Priority Pollutant Volatile Organics (in ppb)	Volatile Organics Found Above Trace Levels	No. of Samples	Sampling Dates	Source
K1	1080	A, B, C, D, E, F, G, L, M	20	8/23/83-1/16/86	14
K2	15	A, C, D, F, G	16	8/10/84-1/07/86	14
K3	6	H	6	8/23/84-1/07/86	14
K4	ND	--	4	7/09/84-1/07/86	14
K5	43	C, D, E, F, G	16	8/10/84-1/07/86	14
MD-1	12	A, F, K, M	7	4/23/85-4/07/86	14
MD-2	10	D, F, G	6	4/23/85-4/07/86	14
MD-3	24	E	6	4/23/85-4/07/86	14
MD-4	ND	--	6	4/23/85-4/07/86	14
MD-5	ND	--	6	4/23/85-4/07/86	14
MD-6	ND	--	6	4/23/85-4/07/86	14
MD-7	3	N	6	4/23/85-4/07/86	14
MD-8	ND	--	6	4/23/85-4/07/86	14
MD-9	ND	--	6	4/23/85-4/07/86	14
S-1	3	E	6	4/23/85-4/07/86	14
S-2	ND	--	6	4/23/85-4/07/86	14
S-3	ND	--	6	4/23/85-4/07/86	14
S-4	2	G	6	4/23/85-4/07/86	14
S-5	4	G	2	2/03/86-4/07/86	14
S-6	3	G	2	2/03/86-4/07/86	14
S-7	ND	--	1	2/03/86	14

* refers to item numbers in Appendix 1

T01069

APPENDIX 3 CONT'D.

Volatile Organic Water Quality Data

Well No.	Average Concentration of Total Priority Pollutant Volatile Organic (in ppb)	Volatile Organics Found Above Trace Levels	No. of Samples	Sampling Dates	Sourc
R-1	ND	--	10	5/31/84-4/08/86	14
R-1A	3	L	2	.3/20/86-4/08/86	14
R-2	ND	--	7	10/09/84-4/08/86	14
R-4	3	E	9	3/30/84-4/08/86	14
R-5	ND	--	9	5/31/86-4/08/86	14
R-6	5	M	5	9/27/86-4/08/86	[illegible]
1	26	C, M	1	3/07/84	3
14	168	B, C, E, F, G	1	8/84	3
63	ND	--	1	8/84	3
69	ND	--	1	8/84	3
73	168	B, C, E, F, G	1	8/84	3
76	199	B, C, D, E, F, G	1	8/84	3

* - refers to item numbers in Appendix 1
ND - Non-detected

A = methylene chloride
B = 1,1-dichloroethylene
C = 1,1-dichlorethane
D = trans-1,2 dichloroethylene
E = 1,1,1-trichloroethane
F = trichloroethylene
G = tetrachlorethylene
H = benzene
I = vinyl chloride
J = chloroethane
K = toluene
L = 1,2 dichloroethane
M = chloroform
N = ethyl ether

BUCHART-HORN, INC.
CONSULTING ENGINEERS and PLANNERS (Red)
55 South Richland Avenue / P.O. Box M-55 / York, Pennsylvania 17405
Telephone (717) 843-5561
Telex No. 820403

November 18, 1986

11/21/86

Mr. Scott Parrish [WH-548E]
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

NPL-03-3-L37

Reference: Findings of Fact and Conclusions
Keystone Landfill - Proposed Listing on National Priorities List
Keystone Sanitation Co., Inc., Union Township, Adams County, Pennsylvania
BH No. 64156

Dear Mr. Parrish:

The Keystone Landfill should not be placed on the National Priorities List. The data and facts developed and presented in several independent reports of investigation indicate the assumptions of the Mitre Model are not appropriate for this site.

The Keystone Landfill site has not been properly evaluated for inclusion on the National Priorities List (NPL). The migration score of 33.76 generated for the site using the Mitre Model is incorrect. The correct score for the Keystone Landfill site should be 16.65 (Attachment A). The incorrect migration score arises because a three mile radius is used to determine the population at risk. The three mile radius is neither representative of the aquifer of concern nor of the population at risk.

The incorrect evaluation of the site was performed without consideration of the site specific geologic and hydrogeologic information submitted during the comment period or in the follow-up response to EPA comments or in a subsequent report by the State of Maryland. Specifically the two areas in which the facts were omitted from the evaluation process are:

1. The maximum possible migration path of any potential groundwater contamination.

2. The maximum population at risk being less than 1,000 people.

Information specifically directed at these two areas of concern was presented to the US EPA by Buchart-Horn, Inc. (Report of Investigation of the Hydrogeology at the Keystone Landfill Site) prior to the end of the 30 day comment period. It was also discussed with US EPA personnel at the time of formal report submittal. Furthermore, this matter was addressed by the Commonwealth of Pennsylvania as early as 1984 in a letter from Mr. Joseph

ORIGINAL
(Red.

Kozlosky of PA DER (Attachment B). Since then two comprehensive site investigations have been performed at and around the Keystone Landfill site. In addition to the conclusions reached by Buchart-Horn, Inc. and the Commonwealth of Pennsylvania concerning the three mile radius concept, and the population at risk, the following Agencies and firms have independently concurred in a series of reports:

1. State of Maryland Waste Management Administration (Report of Investigation submitted by the State of Maryland to the US EPA - Philadelphia Region III).

2. Capital Engineering Corp., Dillsburg, Pennsylvania (Attachment C).

3. R.E. Wright Associates, Milldetown, Pennsylvania (Attachment D).

4. L. Robert Kimball Associates, Ebensburg, Pennsylvania (Attachment E).

Finding of Facts

1. The aquifer of concern does not have a 3 mile radius around the site.

2. The maximum potential population at risk is less than 1,000.

3. Natural groundwater flow boundaries restrict the potential impact to the groundwater (See Figure 1).

Two separate governmental regulatory agencies and several consulting firms support these geologic and hydrogeologic facts.

The Buchart-Horn Report of Investigation developed five major geologic and hydrogeologic conclusions for the Keystone Landfill site.

Hydrogeologic Investigation Keystone Sanitary Landfill by Buchart-Horn, Inc. - June 1985

Page 11-Conclusions:

"The greatest lateral extent of potential groundwater contamination originating from the Keystone Sanitation Company Landfill is shown in Figure 3. This site specific conclusion is based on the following hydrogeologic and geologic factors:

1. Cleavage and fractures close at shallow depths.

2. There are no deep-seated fractures present at the site which conduct groundwater or serve as conduits between the aquifer of concern and any deep-seated regional aquifers.

3. There is no evidence to indicate the presence of a deep-seated regional aquifer.

4. The boundaries shown in Figure 3 are groundwater discharge areas.

5. Groundwater flow does not by-pass the discharge areas at this site.

"Consequently, the potential population that could be affected is limited to the delineated area shown in Figure 3, which by actual count numbers 22 houses or a population of 84 at 3.8 persons per household."

The Pennsylvania Department of Environmental Resources raised concerns about the improper use of the 3 mile radius to define the population at risk. They concluded that the 3 mile radius should not be used at the Keystone site because the aquifer of concern did not extend that far. The Department calculated that there was a maximum potential of 513 people at risk from the facility. This value is under 1,000 people at risk. In addition the Department requested to have the site evaluated with the existing technical data that was available at the site. This information would reduce the migration score to 16.65. The following is an exerpt from the letter from the Pennsylvania Department of Environmental Resources to the United States Environmental Protection Agency on November 8, 1984, concerning the incorrect 3 mile radius.

"Groundwater Route - Targets (Page 5)

"We agree that there are approximately 600 homes located within three miles of this site that utilize domestic wells. We do not believe that the entire population (estimate 2,280) within the 3-mile radius is at risk from drinking groundwater contaminated by leachate from the Keystone Landfill. The application of a universal 3-mile model to a groundwater contamination case involving, for example, an abandoned hazardous waste site of which little or no hydrogeological information exists, may have some merit. The 3-mile radius may not be appropriate for a site for which extensive data has been generated including geological logs, pump tests, well yields,

groundwater flow patterns, geophysical surveys, and groundwater quality analyses. When such information is available, it may be more appropriate to evaluate each site based on its unique hydrogeologic conditions.

"The lithology underlying Keystone Landfill consists of Marburg schist, a member of the Wissahickon Formation. A shallow, seasonal perched water table (landfill seeps) and a single, unconfined aquifer exist beneath the site. The Marburg schist is notorious for low well yields, because of relatively "tight" bedrock. Secondary porosity in the form of fractures controls both the storage and local flow properties of the aquifer. Major fractures manifest themselves as ravines, which serve as groundwater discharge areas. Schistosity, which generally trends northeast to southwest, controls local groundwater flow rates and directions in conjunction with fractures. No other known aquifer exists underneath the site."

"In referring to the Uncontrolled Hazardous Waste Ranking System-Users' Manual, the presence of groundwater boundaries (perennial watercourses) are considered when the distance to the nearest well from a site is determined, yet groundwater discontinuities are not specifically considered when the population served by groundwater is cored (Page 25-HRS Users' Manual). Again, this is understandable for sites located, for example, over carbonate terrain where it is possible that contaminants may migrate significant distances through solution channels. However, the instructions state that "people within three miles who do not use water from the aquifer of concern are not to be counted" Other key words in the instructions are "at risk".

"A better approach in this case would be to roughly delineate the groundwater flow systems'' boundaries, as we have done on the enclosed map. The enclosed map is a very liberal approximation of the limit of groundwater potentially affected by Keystone Landfill. The limits (shown in blue) were determined based on topographic and hydrogeologic considerations, including schistosity. An estimated 45 dwellings were counted within this groundwater discharge perimeter. The 45 dwellings were tripled (135 dwellings) to reflect recent and future development in the area. The tripled number of dwellings (135) with 3.8 persons per household gives a population of about 513 people at risk of drinking contaminated groundwater, as compared to the 2,280 individuals who live within the 3-mile radius of the site. We feel this approach is more appropriate and is supported by existing technical information.

> "The HRS document appears to be well prepared, yet we question the application of the 3-mile groundwater radius model to this site. Based on our above comments, the Department recommends the draft HRS Report for Keystone Sanitary Landfill be recalculated."

The Buchart-Horn Report was reviewed by the United States Environmental Protection Agency, Office of Research and Development, Environmental Monitoring Systems Laboratory - Las Vegas. Conclusions from the review (July 1985) stated:

"Conclusions:

> "A deep-seated regional aquifer (elevation approximately 200 feet) may exist in the area. The water bearing zones of the deep wells in the area should be investigated. The electrical resistivity soundings that were conducted did not have sufficient sensitivity to detect a conductive zone down to these depths (150 metes). There is no basis to conclude that fractures are closed at shallow depths."

> "On this same basis it is questionable whether the resistivity survey would be able to detect thin, dipping fracture zones that could interconnect near surface contaminated zones with a deeper lying aquifer. Two-dimensional modelling would put a limit on the thickness that could be detected. In conclusion, the results of the resistivity survey, as was presented, have not established a limit on the greatest lateral extent of groundwater contamination from the Keystone Sanitation Company Landfill."

There is no evidence to support the concept that a deep-seated regional aquifer exist.

A background literature review from the pennsylvania Topographic and Geologic Survey, Water Resources Report #52 - Summary Groundwater Resources of Adams County, Pennsylvania (1981) does not support the deep regional aquifer concept. The Report states "yielding zones in the igneous and metamorphic rocks are generally quite shallow. Few zones are reported at depths greater than 300 feet and most are within 100 feet of the surface."

This is the case at the Keystone site. There is no deep-seated regional aquifer at the site. The State of Maryland expended $222,300 to investigate the Keystone site. They concluded.

> "The presence of a deep groundwater aquifer is not substantiated within the study area."

(Red)

APPENDIX J

PUMP TEST DATA

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD BY _____ DATE _____ JOB NO. _____

WELL CAVITY

TIME INTERVAL	TIME	MONITORING WELL No. 1 T.O.C. 785.3		OBSERVATION WELL No. 1 T.O.C. 790.3'		OBSERVATION WELL No. 2 T.O.C. 787.0		OBSERVATION WELL No. 3 T.O.C. 783.5		REMARKS
		MEASUREMENT	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	
2 MIN.										
4 MIN.										
6 MIN.										
8 MIN.										
10 MIN.	11:41							38' 10"		
20 MIN.	11:49							38' 10"		
30 MIN.	11:59							38' 10"		
40 MIN.	12:09							39' 10"		
50 MIN.	12:19							39' 10"		
60 MIN.										
70 MIN.	12:39							39' 10"		

WELL CLOTH TOOLE

TIME INTERVAL	TIME	MONITORING WELL No. 1 T.O.C. 785.3		OBSERVATION WELL No. 1 T.O.C. 790.3		OBSERVATION WELL No. 2 T.O.C. 787.0		OBSERVATION WELL No. 3 T.O.C. 783.5		REMARKS
		MEASUREMENT	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	
80 MIN.										
90 MIN.	12:59							38'10		
100 MIN.										
110 MIN.	1:29							38'10		
120 MIN.	1:39							38'10		

PY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB NO. _____

AR101255

BUCHART - HORN, INC.
CONSULTING ENGINEERS AND PLANNERS

Well 3" in Trace

Time Interval	Time	Monitoring Well No. 1 T.O.C. 785.3 Measurement	Monitoring Well No. 1 T.O.C. 785.3 Elev.	Observation Well No. 1 T.O.C. 790.3 Meas.	Observation Well No. 1 T.O.C. 790.3 Elev.	Observation Well No. 2 T.O.C. 787.0 Meas.	Observation Well No. 2 T.O.C. 787.0 Elev.	Observation Well No. 3 T.O.C. 783.5 Meas.	Observation Well No. 3 T.O.C. 783.5 Elev.	Remarks
				49'4		DRAW DOWN		Time Sec		
2 min	11:28							120		
4 min.	11:30			50		.67'	.7'	240		
6 min.	11:32			50"11		1.58'	1.6'	360		
8 min.	11:34			51"6½		2.21	2.2'	480		ORIGINAL (Red)
10 min	11:36			52"1½		2.79	2.8'	600		
20 min.	11:46			53"7		4.25	4.2'	1200		
30 min.	11:56			54"9		5.42	5.4	1800		
40 min.	12:06			55"7		6.25	6.2	2400		
50 min.	12:16			56"4		7.00	7.00	3000		
60 min.	12:26			57"½		7.71	7.7	3600		
70 min.	12:36			57"8		8.33	8.3	4200		

SHEET NO. ____ OF ____
JOB NO. ____
SUBJECT ____
DATE ____
BY ____ DATE ____

AR4KH 256

BUCHART - HORN, INC.
CONSULTING ENGINEERS AND PLANNERS

Well [illegible] Test

Time Interval	Time	Monitoring Well No. 1 T.O.C. 785.3 Measurement	Monitoring Well No. 1 T.O.C. 785.3 Elev.	Observation Well No. 1 T.O.C. 790.3 Meas.	Observation Well No. 1 T.O.C. 790.3 Elev.	Observation Well No. 2 T.O.C. 787.0 Meas.	Observation Well No. 2 T.O.C. 787.0 Elev.	Observation Well No. 3 T.O.C. 783.5 Meas.	Observation Well No. 3 T.O.C. 783.5 Elev.	Remarks
						Drawdown		Tm sec		
8 min.	12:46			58'3		8.92	8.9	4800		
90 min.	12:56			58'8½		9.38	9.4	5460		
100 min.	1:06			59		9.67	9.7	6000		ORIGINAL (Red)
110 min.	1:16			59'4		10.00	10.00	6600		
120 min.	1:26			60		10.67	10.7	7260		

BY [illegible] DATE 4/10/25 SUBJECT _____ SHEET NO. ____ OF ____

CHKD. BY _____ DATE _____ JOB NO. _____

BUCHART - HORN, INC.
CONSULTING ENGINEERS AND PLANNERS

SHEET NO ____ OF ____

JOB NO. ____

SUBJECT ____

BY 8210258 DATE 8/10/82

CHKD. BY ____ DATE ____

WELL DRAWDOWN TABLE

TIME INTERVAL	TIME	MONITORING WELL No. 1 T.O.C. 785.3		OBSERVATION WELL No. 1 T.O.C. 790.3		OBSERVATION WELL No. 2 T.O.C. 787.0		OBSERVATION WELL No. 3 T.O.C. 783.5		REMARKS
		MEASUREMENT	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	
1 MIN.	11:34	52'-0"	733.3							ORIGINAL (Red)
2 MIN.	11:35	53'-0"	732.3							
3 MIN.	11:36	54'-0"	731.3							
4 MIN.	11:37	55'-0"	730.3							
5 MIN.	11:38	56'-0"	729.3							
6 MIN.	11:39	57'-0"	728.3							
7 MIN.	11:40	58'-0"	727.3							
8 MIN.	11:41	58'-6"	726.8							
9 MIN.	11:42	59'-0"	726.3							
10 MIN.	11:45	60'-0"	725.3							

BUCHART - HORN, INC.

CONSULTING ENGINEERS AND PLANNERS

WELL CO-OP TRACE

TIME INTERVAL	TIME	MONITORING WELL No. 1 T.O.C. 785.3		OBSERVATION WELL No. 1 T.O.C. 790.3		OBSERVATION WELL No. 2 T.O.C. 787.0		OBSERVATION WELL No. 3 T.O.C. 783.5		REMARKS
		MEASUREMENT	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	MEAS.	ELEV.	
20 MIN.	11:55	60'-0"	725.3							
30 MIN	12:05	61'-0"	724.3							(Red)
40 MIN.	12:15	62'-0"	723.3							
50 MIN.	12:25	62'-6"	722.8							
60 MIN.	12:35	63'-0"	722.3							
70 MIN.	12:45	64'-0"	721.3							
80 MIN.	12:55	64'-3"	721.1							
90 MIN.	1:05	64'-6"	720.8							
100 MIN.	1:15	65'-0"	720.3							
110 MIN.	1:25	66'-0"	719.3							
120 MIN.	1:35	66'-6"	718.8							

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB NO. _____

APR 10 1959

BUCHART - HORN, INC.

CONSULTING ENGINEERS AND PLANNERS

The State of Maryland addresses several specific points in their report including the absence of a deep-seated aquifer and the limits of possible contamination. As part of the Maryland investigation nine monitoring wells were constructed south and southwest of the landfill site. The locations are shown in Figure 2 of their report.

Conclusions of the investigative effort with regard to the aquifer are provided in the Maryland Report of June 1986, a portion of which follows:

Keystone Landfill Maryland Montoring System Investigation and Report by State of Maryland - June 1986

"AQUIFER EVALUATION DATA

6. Conclusions

A. The deeper zone of the bedrock is extremely impermeable and has a poor capability to transmit groundwater.

B. Even when a vertical gradient from the intermediate zone to the deeper zone is forced by pumping the deeper zone well, there is limited groundwater movement to the deeper zone because of its poor permeability.

C. Therefore, since the deeper zone is incapable of providing and/or transmitting groundwater, no deep groundwater aquifer (a water-bearing zone which produces water in usable quantities) exists within the study area."

The State of Maryland investigated the possibility of a deep aquifer using multiple techniques including monitoring wells, pump tests and downhole geophysical logs. The conclusions appear to be based on proper methodology and resulting technical data concerning the hydrogeology."

The geology and hydrogeology are described in the Executive Summary of the Maryland report as follows:

"GEOLOGY AND HYDROGEOLOGY

Concurrent with the collection of groundwater data, an investigation of the geology and hydrogeology in the study area was conducted.

B. Geology

1. The dominant rock Type is the Babylon Phyllite member of the Marburg Schist. This is a dense crystalline rock which is essentially impermeable. However, water can flow in a well-developed fracture system within the rock which parallels the fine, continuous cleavage that the rock exhibits.

2. The Babylon Phyllite contains abundant, naturally occurring minerals which have the potential to leach inorganic constitutents into the groundwater."

"Hydrogeology

1. Surface water and shallow groundwater moves southward and southwestward, respectively, from only the southern portion of the Keystone Sanitation , Inc. landfill to the small tributary of Piney Creek In Maryland. This is the only potential impact area in Maryland for contamination from the landfill.

2. Surface and shallow groundwater moves northward and northeastward, respectively, from the Humbert Schoolhouse Road area to the small tributary of Piney Creek. This region cannot be affected by contamination from the Keystone Sanitation, Inc. landfill.

3. There is no evidence of a deep groundwater aquifer in the study area."

The Maryland Report addresses several important facts pertaining to the site, specifically the cleavage and fractures which close at shallow depths.

The Maryland Report addressed this fact on Page 6 using information from the downhole logs.

C. "A caliper log (measures the smoothness of the bore hole) from the deep MD-W-1 shows that no fractures or openings are apparent below a depth of 100 feet. However, the same log shows that above 80 feet numerous fractures are present (Appendix II).

"The fracturing and the cleavage openings change the bedrock into an aquifer. The questions of a deep aquifer was investigated. Buchart-Horn, Inc. stated:

ORIGINAL
(Red)

There is no evidence to indicate the presence of a deep-seated regional aquifer."

Page 8 of the Maryland Report states:

3. "Deep Groundwater - The presence of deep groundwater aquifer is not substantiated within the study area. Well logs from the Maryland monitoring system show limited fractures and/or porosity below a depth of 100 feet (Appendix II). In addition, there are limited water bearing zones below a depth of 130 feet (Appendix II). Finally, all three of the deep Maryland monitoring wells have a poor to almost nonexistent rate of groundwater recharge. MD-W-1 has a static water level of about 200 feet lower than its companion surface and shallow wells, and demonstrates an almost nonexistent recharge capability (Appendix II). Although MD-W-4 and 7 both have static water levels similar to their companion surface and shallow wells, they both have poor yields and recharge very slowly after being pumped. (Appendices II and IV).

   "The slow rate of recharge, poor yields, and low static water levels are interpreted to be related to: (a) the low permeability of metamorphic rocks at depth, in general, (b) the low permeability of the phyllite specifically, and (c) the inability of surface water to penetrate to this depth. This is further exemplified by the results of pump tests performed on MD-W-4 and 7. These deep wells have been pumped and their companion shallow and intermediate wells observed. The lack of a significant drawdown response after 72 hours is indicative of the poor hydraulic connection between the shallow aquifer and the deeper zone (Appendix IV).

   "The closing of the fractures in the aquifer and the absence of a deep regional aquifer eliminate the potential for surface contaminates to migrate into the deep zone. The possibility that fracture traces conduct groundwater into the deep zone was investigated by the State of Maryland."

All nine of the Maryland monitoring wells were placed on fracture traces.

Page 11 of the Maryland Report states:

> "Each well cluster was made up of a shallow, an intermediate, and a deep monitoring well. The three clusters were placed (as determined by aerial photography interpretation and resistivity testing) to intercept either of two possible fracture trace trends in this study area - the fracture traces running parallel to major drainage swales and the dominant fracture traces running parallel to the major cleavage trend."
>
> "There is hydrogeologic evidence that near vertical fractures are not transmitting groundwater to a deep aquifer."

The concern has arisen as to the maximum extent of contamination. Buchart-Horn, Inc. concluded that:

> "Groundwater flow does not by-pass the discharge areas at this tie."

The Maryland Report supports the Buchart-Horn statement and states on page 9:

> 4. "Shallow Aquifer Description - From all of the above information, there appears to be strong evidence for a shallow aquifer in a permeable and fractured zone that is related to and influenced by the weathered cleavage surfaces.
>
> "Shallow groundwater flowing southwest, and parallel to the cleavage, from the southern portion of Keystone Sanitation, Inc. landfill discharges into the small tributary of Piney Creek. The shallow aquifer does not flow under this tributary because it is opposed by a northeast flow within the same aquifer from under the Humber Schoolhouse Road ridge (Figure 10A and 10B). In act, this northeast flow from under Humber Schoolhouse Road is greater than the southwest flow from the landfill because of the higher groundwater gradient that exists there (Figure 7, 8, 10A and 10B)."

Figure 10B from the Maryland Report shows groundwater discharging to Piney Creek.

The bottom of the aquifer restricts the extent that contamination can migrate in the vertical direction. The lateral extent of migration is confined by the groundwater discharge zones. The local streams are discharge zones which limit the lateral extent of potential contamination.

The site specific data that was generated by the Buchart-Horn Report resulted in several hydrologic and geologic facts which control and limit the potential

ORIGINAL
(Red)

spread of contamination at the site. The Maryland Report documents the same geologic and hydrogeologic conclusions in the investigation. Conclusions reached by each report concerning the geology and hydrogeology were identical.

L. Robert Kimball Associates was retained by the Union Township Board of Supervisors to review and evaluate the hydrogeologic and soils investigation conducted at the Keystone site. L. Robert Kimball Associates stated in the Solid Waste Application Phase I Review and Evaluation Report, March 17, 1986.

> "The engineering consultant conducted a thorough soils and hydrogeologic investigation of the proposed disposal site and provided adequate technical data regarding the findings of his investigation. The geophysical information was reviewed and evaluated with the following:

Borehole	VES	Relative Closeness	VES Base of Aquifer	Test Boring Depth to last Lithology	Difference (ft.)	%
85-17	13-1	< 50'	101.4	90	+11.4	12.6
85-16	13-4	<200'	62.3	48.5	+13.8	28.4
85-15	10-6	<100'	37.1	47	- 9.9	21.0
85-3	8-3	<200'	24.9	10	+14.9	
85-1	22-6	<200'	65.9	63	+ 2.9	4.6
85-6	15-4	<100'	67.3	60	+ 7.3	12.2

> NOTE: This comparison is valid only if drilling was continued into the base of the aquifer. This assumption is reasonable because all borings end in gray schist; modified in 85-1 as "gray to brown schists, hard, dry".

> > "It is clear that the geophysical method was successful in determining the bottom of the aquifer. The limiting bottom of the aquifer acts as a groundwater flow boundary."

Concern over the possible contamination to the Hanover reservoirs which is within the 3 miles radius was investigated by R.E. Wright Associates. A letter report of July 5, 1984 states:

> "The distance from the landfill to the nearest potential well site identified in the hydrogeologic study prepared for Hanover Borough is approximately 2 1/2 miles." Typically, the extent of groundwater contamination from a site such as this in this geologic environment would not exceed several thousand feet, at

ORIGINAL
(Red)

> most. Because of time of travel and the distance from the landfill, it is highly unlikely that significant degradation of groundwater quality could be caused by the Keystone Landfill in the area in which Hanover is anticipating developing a groundwater supply."

In addition to the Wright Report the concept of a 3 mile radius of concern is not supported by Capital Engineering Corporation. A recent new release states that the Hanover water supply is not in danger from the Keystone site. Captial Engineering Corporation is submitting this report to the Hanover Borough. It becomes obvious that the 3 mile radius is not an acceptable concept.

The hydrogeologic and geologic facts are based, not on a single method of investigation, but rather a multitude of different techniques including: surface geophysics, exploratory wells, piezometric nest, hydrogeologic pump test and downhole geophysics in addition to other conventional methods. The results are supported by several different regulatory agencies and consulting firms.

Conclusion

The Keystone Landfill site should not be placed onto the NPL. When properly evaluated the site does not rank a score large enough for consideration onto the NPL. The site has distinct groundwater flow boundaries (Attachment F) that limit the maximum potential migration path for any groundwater contamination at the site. Consequently the size of the population at risk has previously been greatly over estimated which has in turn caused a incorrect evaluation of the site. The site migration score has been recalculated at 16.65, this is below the 28.5 cut off limit for listing on the NPL. Therefore, the site does not qualify for placement onto the National Priority List.

Very truly yours,

BUCHART-HORN, INC.

Timothy E. Saylor, Director
Chemistry and Earth Sciences Division

TES/11b

Attachments

cc: Franklin Kury, Esq.
Robert Emmett, Esq.
Kenneth Noel/Bill Bryant
George Bloom, Esq.
Charles Wolf, Esq.

In Affected Area.

ORIGINAL
(Red)

ATTACHMENT A

Ground Water Route Work Sheet						
Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)	
1 Observed Release	0 (45)	1	45	45	3.1	
If observed release is given a score of 45, proceed to line 4. If observed release is given a score of 0, proceed to line 2.						
2 Route Characteristics					3.2	
Depth to Aquifer of Concern	0 1 2 3	2		6		
Net Precipitation	0 1 2 3	1		3		
Permeability of the Unsaturated Zone	0 1 2 3	1		3		
Physical State	0 1 2 3	1		3		
Total Route Characteristics Score				15		
3 Containment	0 1 2 3	1		3	3.3	
4 Waste Characteristics					3.4	
Toxicity/Persistence	0 3 6 9 12 15 (18)	1	18	18		
Hazardous Waste Quantity	(0) 1 2 3 4 5 6 7 8	1		8		
Total Waste Characteristics Score			19	26		
5 Targets					3.5	
Ground Water Use	0 1 2 (3)	3	9	9		
Distance to Nearest Well/Population Served	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1	10	40		
Total Targets Score			19	49		
6 If line 1 is 45, multiply 1 x 4 x 5. If line 1 is 0, multiply 2 x 3 x 4 x 5			16245	57,330		
7 Divide line 6 by 57,330 and multiply by 100		S_{gw} = 28.33				

FIGURE 2
GROUND WATER ROUTE WORK SHEET

ORIGINAL
(Red)

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If observed release is given a value of 45, proceed to line 4. If observed release is given a value of 0, proceed to line 2.					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 (1) 2 3	1	1	3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1	2	3	
Distance to Nearest Surface Water	0 1 (2) 3	2	4	6	
Physical State	0 1 2 (3)	1	3	3	
Total Route Characteristics Score			10	15	
3 Containment	0 1 2 (3)	1	3	3	4.3
4 Waste Characteristics					4.4
Toxicity/Persistence	0 3 6 9 12 15 (18)	1	18	18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1	1	8	
Total Waste Characteristics Score			19	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3	6	9	
Distance to a Sensitive Environment	(0) 1 2 3	2	0	6	
Population Served/Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 36 40	1	0	40	
Total Targets Score			6	55	
6 If line 1 is 45, multiply 1 x 4 x 5. If line 1 is 0, multiply 2 x 3 x 4 x 5			3420	84,150	
7 Divide line 6 by 84,150 and multiply by 100		S_{sw} =	5.31		

FIGURE 7
SURFACE WATER ROUTE WORK SHEET

ORIGINAL

	S	S^2
Groundwater Route Score (S_{gw})	28.33	802.59
Surface Water Route Score (S_{sw})	5.31	28.20
Air Route Score (S_a)	NF	NA
$S_{gw}^2 + S_{sw}^2 + S_a^2$		830.79
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		28.82
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		16.65

FIGURE 10
WORKSHEET FOR COMPUTING S_M

ATTACHMENT

Post Office Box 2063
Harrisburg, Pennsylvania 17120
November 8, 1984

(717) 783-7383

ORIGINAL

Mr. Neal Swanson (3HW23)
U.S. Environmental Protection Agency
Region III
6th and Walnut Streets
Philadelphia, PA 19106

Dear Mr. Swanson:

Re: Draft HRS Report and SI Report
Keystone Sanitation Landfill
Union Township, Adams County

This office has reviewed the draft HRS Report and the Site Inspection Report, both of which were prepared by the NUS Corporation for the Keystone Sanitation Landfill site. The following comments are offered after discussions with DER Regional staff who were involved with this case:

1. Site Inspection Report

Introduction (Pages 1-1 to 1-2)

The summary states that a variety of volatile organic compounds have been detected in residential wells through analyses performed by Franklin Analytical Labs, retained by the local citizens, in February, 1984. Based upon Franklin Lab's analytical results, PADER conducted follow-up sampling and full volatile organic analyses at DER's lab in Harrisburg, Pennsylvania. It should be noted that PADER's sampling survey, which was quite extensive, showed that most of the residential wells were mostly free of organic contaminants. PADER's Lab results do not agree with Franklin Lab's results. It should be noted in the Site Inspection Report that Franklin Labs is not qualified for organic analysis under EPA's Drinking Water Lab Certification Program. We ask that volatile organic compound levels determined by Franklin Labs be deleted from the top paragraph of Page 1-2, since they are questionable at best. We also request that Appendix F, which contains Franklin Lab analysis sheets, be removed entirely from the Site Inspection Report unless copies of PADER lab sheets are also included in the report as a separate appendix.

Any references in the Site Inspection Report to the "PA Department of Health" should be changed to the PA DER. It should be noted that the Maryland Department of Health has also conducted extensive volatile organic analysis sampling near the site, and those results, if available, should be included as an appendix in the Site Inspection Report.

Site Use History and Permit Action (Page 2-2)

This site has been used as a landfill from 1966 to date. The landfill was permitted by PADER in 1980. The landfill operates under Solid Waste Management Permit No. 100001. Please make the appropriate corrections in the first and second paragraphs in this section.

Environmental Setting--Climate and Meteorology (Page 3-2)

The average annual precipitation in Central Pennsylvania is 40-42 inches, not 92 inches.

Field Trip Report--Site Observations (Page 5-4, 5-5)

The inactive southern portion of the landfill has a stable vegetative cover of crown vetch which was approved by the Department. The fourth paragraph on P. 5-4 states that it is covered by weeds which is incorrect.

The second and sixth paragraphs on Page 5-5 describe local streambeds consisting of "clayey" silt. Clay soils are not characteristic of phyllite formations in Central Pennsylvania, therefore the word "clayey" should be deleted.

Laboratory Data--Upon review of the Site Inspection samples taken by NUS, it is unfortunate that four out of five blanks were found to be contaminated. It is also difficult to understand how background surface water samples contain significant levels of organics, some of which are higher than downgradient samples. The incident of 7 VOA vials arriving at the CPL Lab with inverted septa leads us to question field sampling procedures, which can easily affect lab analysis results and their interpretation. However, the follow-up volatile organic sampling on August 23, 1984 and subsequent analysis by EPA's Annapolis Lab appears to have yielded valid results.

II. HRS Document

Direct Contact-Containment (Page 18)

It is stated that "acetone was detected in a seep area on the landfill". This appears to refer to the Site Inspection analysis result (sample C-8305) for the Line Road seep. It should be noted that 1,700 ug/l of Acetone was detected in one of the aqueous blanks, and that acetone is also a common laboratory contaminant. Is it possible that this might have been overlooked in the quality assurance review? We generally agree with the direct contact score, since the seep is obviously affected by lateral leachate flow.

Groundwater Route-Targets (Page 5)

We agree that there are approximately 600 homes located within three miles of this site that utilize domestic wells. We do not believe that the entire population (estimate 2,280) within the 3-mile radius is at risk from drinking groundwater contaminated by leachate from the Keystone Landfill. The application of a universal 3-mile model to a groundwater contamination case involving, for example, an abandoned hazardous waste site of which little or no hydrogeological information exists, may have some merit. The 3-mile rule may not be appropriate for a site for which extensive data has been generated including geological logs, pump tests, well yields, groundwater flow patterns, geophysical surveys, and groundwater quality analyses. When such information is available, it may be more appropriate to evaluate each site based on its unique hydrogeologic conditions.

The lithology underlying Keystone Landfill consists of Marburg schist, a member of the Wissahickon formation. A shallow, seasonal perched water table (landfill seeps) and a single, unconfined aquifer exists beneath the site. The Marburg schist is notorious for low well yields, because of relatively "tight" bedrock. Secondary porosity in the form of fracture controls both the storage and local flow properties of the aquifer. Major fractures manifest themselves as ravines, which serve as groundwater discharge areas. Schistosity, which generally trends northeast to southwest, controls local groundwater flow rates and directions in conjunction with fractures. No other known aquifer exists underneath the site.

In referring to the Uncontrolled Hazardous Waste Ranking System-Users' Manual, the presence of groundwater boundaries (perennial watercourses) are considered when the distance to the nearest well from a site is determined, yet groundwater discontinuities are not specifically considered when the population served by groundwater is scored (Page 25-HRS Users' Manual). Again, this is understandable for sites located, for example, over carbonate terrain where it is possible that contaminants may migrate significant distances through solution channels. However, the instructions state that "people within three miles who do not use water from the aquifer of concern are not to be counted". Other key words in the instructions are "at risk".

A better approach in this case would be to roughly delineate the groundwater flow systems' boundaries, as we have done on the enclosed map. The enclosed map is a very liberal approximation of the limit of groundwater potentially affected by Keystone Landfill. The limits (shown in blue) were determined based on topographic and hydrogeologic considerations, including schistosity. An estimated 45 dwellings were counted within this groundwater discharge

ORIGINAL
(Red)

perimeter. The 45 dwellings were tripled (135 dwellings) to reflect recent and future development in the area. The tripled number of dwellings (135) with 3.8 persons per household gives a population of about 513 people at risk of drinking contaminated groundwater, as compared to the 2,280 individuals who live within the 3-mile radius of the site. We feel this approach is more appropriate and is supported by existing technical information.

The HRS document appears to be well prepared, yet we question the application of the 3-mile groundwater radius model to this site. Based on our above comments, the Department recommends the draft HRS Report for Keystone Sanitary Landfill be recalculated.

We appreciate the opportunity to comment on the Keystone Landfill HRS Report, and welcome any response concerning this site. Please let me know if any additional information is needed.

Respectfully,

Joseph A. Kozlosky
Emergency and Remedial Response Section
Division of Operations
Bureau of Solid Waste Management

ATTACHMENT C

(POOR)

ORIGINAL (Red)

BRIEFLY

Report says water supply not in danger

11-4-86 SUN HANOVER

HANOVER — Hanover's present water supply is not in danger of contamination, according to an engineering consultant retained by the borough to study the impact of Keystone Landfill.

Borough Manager Joseph O'Brien said today the preliminary report expected Nov. 14 from Thomas LeDew of Capitol Engineering in Dillsburg will indicate the present source of Hanover's water supply will not be endangered by the proposed expansion of Keystone Landfill in Union Township.

LeDew said the final report should be available Dec. 1 and will address the impact of the landfill's expansion on proposed future sources for Hanover area water supply.

O'Brien said, "They are satisfied right now, here again, that normal expansion of the landfill to handle ordinary municipal waste, which is the kind of permit they have applied for, will not endanger future water supply sources."

ATTACHMENT I

ORIGINAL (Red)

r.e. wright associates, inc.
earth resources consultants

July 5, 1984

Mr. Tom Ladue
Capitol Engineering Corporation
124 West Church Street
Dillsburg, PA 17019

Re: Hanover Groundwater Study
Project 83110

Dear Tom:

Regarding your question concerning the potential threat of the Keystone Landfill (see attached map) with respect to the Hanover area groundwater development potential, we have prepared the following comments. R. E. Wright Associates has no information which indicates that the Keystone Landfill presents potential threat to groundwater production from the well sites we indicated in our report dated March 27, 1984. We have recently given a very cursory look at the topographic mapping surrounding the Keystone Landfill and have been in contact with the PA DER with regard to this potential problem and offer the following information which may be helpful:

1. Surface drainage from the landfill area appears to flow to the north, northwest and south of the landfill. The potential for groundwater flow, although we cannot confirm this, is probably also in these three directions. The primary drainage direction is probably to the north into a tributary which joins the south branch of Conewago Creek downstream of the Hanover Reservoir intake.

2. In discussing the Keystone Landfill with Mr. Tom Miller, Hydrogeologist of the Solid Waste Division of the Department of Environmental Resources (DER), he told us that at least one of the monitoring wells on the northeast side of the site has shown some volatile organic compounds which are of concern to DER. The DER is requesting and, as I understand, has received a proposal from the landfill which should address this problem.

3240 schoolhouse road middletown, pa. 17057 (717) 944-5501

3. The distance from the landfill to the nearest potential well site identified in the hydrogeologic study prepared for Hanover Borough is approximately 2 1/2 miles. The majority of the area between the landfill and that well site is underlain by the Harpers Formation, which is a dark gray quartzose phyllite and has a relatively low transmissivity. Because of time of travel and the distance from the landfill, it is highly unlikely that significant degradation of groundwater quality could be caused by the Keystone Landfill in the area in which Hanover is anticipating developing a groundwater supply.

The information that is not presently available to us relates to the extent of observed groundwater contamination in areas contiguous with the Keystone Landfill. Typically, the extent of groundwater contamination from a site such as this in this geologic environment would not exceed several thousand feet, at most. Putting some trust in the DER to continue close monitoring and to enforce remediation should or if a groundwater problem occurs, the likelihood that the Keystone Landfill will affect the Hanover groundwater development potential is small. A better assessment of this potential would involve some extensive groundwater and surface water sampling and analysis, groundwater contour mapping, earth fracture analyses, and a simulation of groundwater withdrawal conditions that may result from a Hanover groundwater development project. If you require more specific information, please do not hesitate to call.

Very truly yours,

R. E. WRIGHT ASSOCIATES, INC.

Stephen M. Snyder, P.G.
Project Manager

SMS:mp
Enclosure

ORIGINAL
(F-

- Both water table maps (Appendix J) were developed with data obtained in August, when groundwater levels approach their lowest levels because of low infiltration due to evapotranspiration. Seasonal fluctuations should be near their highest in March or April. We feel that water table maps prepared using March or April water levels would be more appropriate to show seasonal high water tables and possibly areas where uplift forces on the liner may be expected.

- Appendix A is the site map in both small and large (1" = 2000'; 1" = 200') scale. The 1"= 200' map shows location of springs, spring houses, measured strike and dip of joints, cleavage and outcrops. Except for the cell "J" excavation, outcrop exposures appear limited to the perennial stream valley and what appears to be a roadcut or Clousher Road. Twenty strike and dip measurements are shown for joints and another twenty for cleavage.

- Appendix B is groundwater flow maps at both small and large (1" = 2000'; 1" = 200') scale. These maps show perennial and intermittant streams, groundwater divide, fracture and cleavage flow directions. A stream identified as perennial flows through the eastern portion of the site. The narrative describes what data and information was used as a base for this map.

- Appendix C contains domestic well locations, owners and a few con

- Appendix D-Soils contains a U.S.D.A. soils map, narrative and three soil classificatio gradation curves.

- Appendix E contains geophysical models and a station summary fro the Vertical Electrical Soundings(VES). The summary provides top and bottom of aquifer depths and elevations for each station. Fiel work was performed in August 1984. Thickness and 'A' spacing in the individual models are in meters and subsequently converted to feet in the summary.

- Appendix F contains twenty exploratory boring logs. These borings were drilled in August 1985. From the narrative, an unknown numbe of wells were constructed to evaluate the piezometric surface. Static water level readings are provided for all twenty borings o August 15, 1985. Module 2-Phase 1 (Page 9) identifies the method o drilling as air rotary for at least one boring, Exploratory Well 22

6RE0315.2

ORIGINAL
(Red)

- Appendix G contains exploratory test pit logs for sixty one test pits. Two of the pits, #11 and #31, ended in water at 74 and 63 inches, respectively.

- Appendix H shows the location of the Vertical Electrical Sounding cross-sections, but not the location of the individual VES stations; they are in Appendix N.

- Appendix I contains cross-sections A through G. These cross-sections show ground surface, water table and bottom of aquifer. Undulations in the water table and bottom of aquifer between vertical electric soundings are shown in some places. Data other than vertical electric soundings were used for these cross-sections although not documented. This data may have come from Appendix K and J1.

- Appendix J contains two maps titled "Water Table August 1984" (J1) and "Water Table August 1985" (J2). J1 is apparently based on the VES data as well as some unreported monitoring well water table readings in the vicinity of the presently permitted area. J2 is apparently based on the static water level readings of August 15, 1985 and some additional unreported levels from the monitoring wells. Both maps refer to the drawn contours as "piezometric surface contour". GROUNDWATER, Freeze and Cherry, 1979, p. 600 equates piezometric surface and potentiometric surface, and p. 49 limits potentiometric surface to confined aquifers. As a matter of semantics, perhaps "groundwater contour" should be used in place of "piezometric surface" to eliminate any implication of groundwater conditions. In some cases the difference in water level between J1 and J2 at the same point is more than 10 feet.

- Appendix K is a map showing the base of the aquifer. The basis for this map is apparently the VES supplemented by the exploratory drilling.

- Appendix L is an Aquifer ISOPACH Map. This appendix is not mentioned in the narrative and its derivation is unknown. As the water table fluctuates through the year (See page 9, Section V.B) the isopach thickness could be expected to vary similarly, unless the aquifer is confined. Since Appendix J1 is titled "Water Table August 1984", perhaps this Appendix should be retitled "Aquifer Isopach" with the date of the data on which it is based.

- Appendix M is Bedrock Depth. This map is probably based on the VES, exploratory drilling and test pit excavations. No data is provided.

- Appendix N is a map of the VES locations.

6RE0315.3

ORIGINAL (Red)

- Appendix O is a map of Exploratory Site Locations. This map shows the approximate locations of the exploratory wells, test pits and existing monitoring wells. No record of exploratory wells 85-4 or 85-19 as shown on the map was found in Appendix F.

- Combining Appendices O and N shows the areal coverage through the investigation. No attempt was made to correlate test pit information with Appendix M-Bedrock Depth.

- An overlay was prepared containing the VES and the exploratory drilling locations. On this overlay six of the exploratory drilling holes occurred within 200 feet of the VES location. The following table lists the borings, VES numbers and some comparative information:

Borehole	VES	Relative Closeness	VES Base of Aquifer	Test Boring Depth to last Lithology	Difference (ft.)	%
85-17	13-1	<50'	101.4	90	+11.4	12.6
85-16	13-4	<200'	62.3	48.5	+13.8	28.4
85-15	10-6	<100'	37.1	47	- 9.9	21.0
85-3	8-3	<200'	24.9	10	+14.9	
85-1	22-6	<200'	65.9	63	+ 2.9	4.6
85-6	15-4	<100'	67.3	60	+ 7.3	12.2

NOTE: This comparison is valid only if drilling was continued into the base of the aquifer. This assumption is reasonable because all borings end in gray schist; modified in 85-1 as "gray to brown schist, hard, dry".

- On Form No. 1, Phase No. 1, the applicant is requesting that 198.5 acres of the total 211.85 acres be permitted. The Site Map (Appendix A2) apparently shows the 211.85 acre property boundry, but does not identify the 198.5 acres proposed for permitting. What area(s) will be excluded?

6RE0315.4

- Chapter 75, Solid Waste Management Rules and Regulations, Subchapter C, 75.23, states that the grid system on the maps submitted "may not exceed 200 ft. square sections". The grid system on the maps submitted is in 500 ft. square sections.

In summary, although the comments underlined above could be legitimately submitted to the DER for clarification, they would have little or no impact regarding site suitability; with the possible exception of the first item concerning flooding frequency. Based on our review and evaluations of the Phase I Permit Application, the proposed site appears suitable for sanitary landfill development provided; (1) the engineering design is acceptable, (2) the synthetic liner is properly installed, (3) all construction activitites are in accordance with the design plans, and (4) the landfill is operated in compliance with the approved plan and applicable DER rules and regulations.

We strongly suggest that the Board of Supervisors closely scrutinize the Phase II submission as soon as it is available to evaluate the following major factors:

- The overall quality of the engineering design.
- Adequacy of the proposed leachate collection, storage, treatment and disposal system.
- Procedure to be employed in preparing the disposal area(s) and installing the synthetic liner.
- How will the development of such a large, lined disposal facility be phased?
- Soil erosion and sedimentation controls to be employed.
- Proposed groundwater monitoring system.
- Availability of sufficient quantity of acceptable cover material.
- Methods proposed to control vectors, odors, litter and methane gas.
- Condition of access roads to the site including weight restrictions.
- Proposed closure plan

6RE0315.5

ORIGINAL
(Red)

Since the installation of an acceptable liner, combined with leachate collection and treatment minimizes the potential for ground water and surface water contamination, the impact the proposed landfill will have on human health and the environment will depend primarily on the engineering design and operatonal procedures employed.

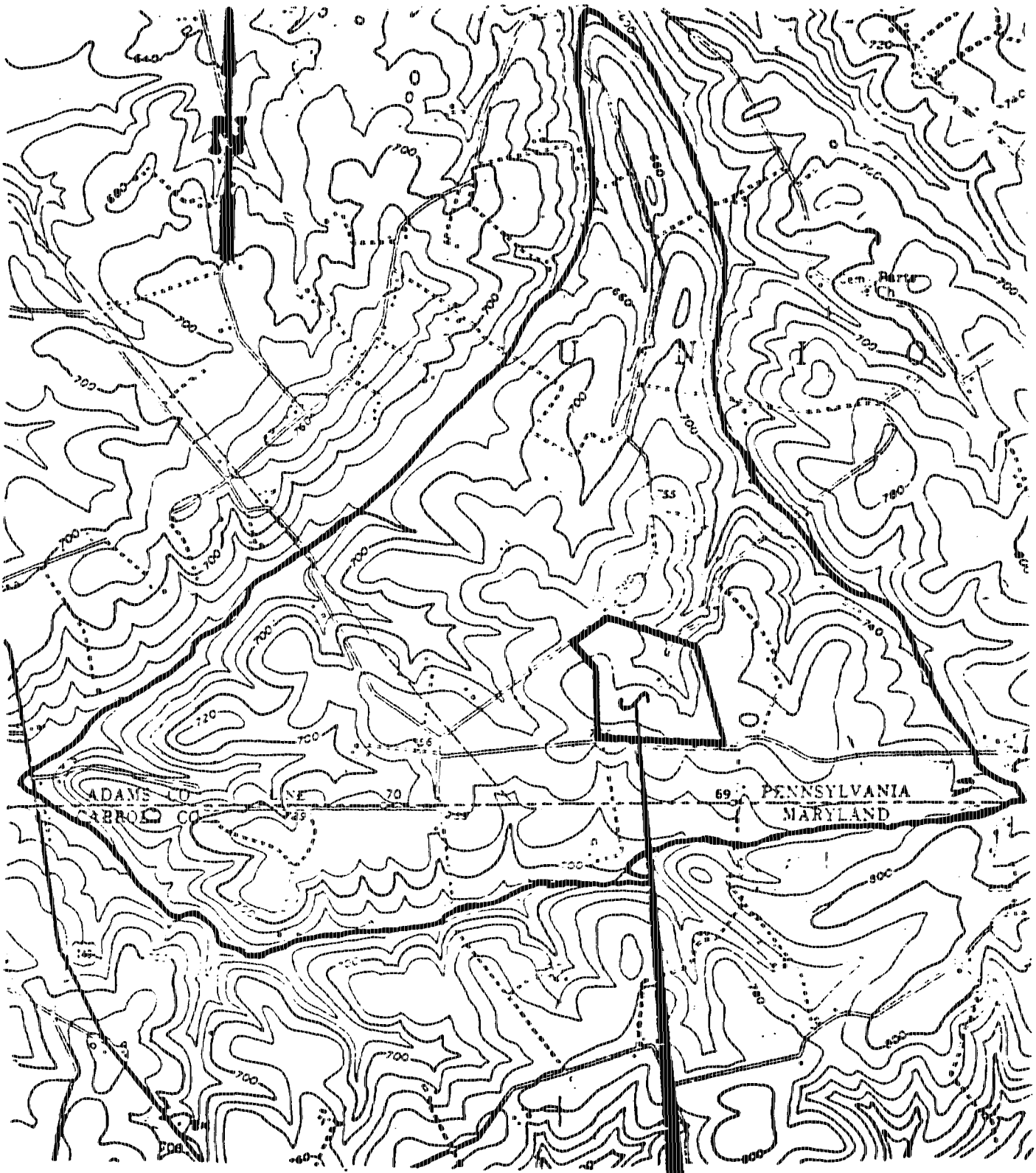
Respectfully Submitted,

Glenn J. Learn, Manager
Department of Environmental Engineering

6RE0315.6

ORIGINAL
(Red)

ATTACHMENT F



USGS - LITTLESTOWN QUADRANGLE PENNA.

SCALE: 1" = 2,000'

BUCHART-HORN, INC. Consulting Engineers & Planners YORK, PA. WASHINGTON, D.C. LEMOYNE, PA. BALTIMORE, MD. NEWPORT, DEL. NEW ORLEANS, LA. WILLIAMSBURG, VA. CHARLESTON, W.VA.	KEYSTONE SANITATION CO. LANDFILL UNION TOWNSHIP, ADAMS CO., PA. LIMITS OF MAXIMUM POTENTIAL GROUND WATER IMPACT	JOB NO. 02209 FIGURE 3

AR101283