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RECORD OF DECISION

REMEDIAL ALTERNATIVE SELECTION

Site: Millcreek Site, Erie County, Pennsylvania

DOCUMENTS REVIEWED

I am basing my decision primarily on the following documents describing the analysis of cost-effectiveness of remedial alternatives for the Millcreek site:

- Millcreek Remedial Investigation (NUS Corporation, August, 1985)
- Millcreek Feasibility Study (NUS Corporation, August, 1985)
- Technical Support Documents prepared by EPA Region III staff to establish groundwater protection goals, soil criteria, and sediment criteria.
- Staff summaries and recommendations
- Summary of Remedial Alternatives Selection
- Responsiveness Summary

DESCRIPTION OF SELECTED REMEDY

- Soil excavation and consolidation under a RCRA cap to meet proposed soil criteria (criteria to be reevaluated during design).
- Sediment excavation and consolidation under a RCRA cap to meet proposed sediment criteria (criteria to be reevaluated during design).
- Site grading.
- Soil cover over remaining low level contaminated soils not exceeding criteria.
- Construction of surface water management basins and ditches.
- Revegetation of soil cover and cap.
- Installation of additional monitoring wells.
- Construction of flood retention basin on property owned by Millcreek Township.
- Pumping and treating of contaminated groundwater.
- Design of the remedy which will require additonal sampling and well installation.
- Operation and maintenance will be implemented by the State of Pennsylvania on the RCRA cap, flood retention basins, surface

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water management systems and monitoring systems six months after construction of these systems. The groundwater pumping and treatment program, and associated monitoring, will be operated as a source control remedial action for a period of at least two years and will be eligible for Trust Fund monies.

DECLARATIONS

Consistent with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), and the National Contingency Plan (40 CFR Part 300), I have determined that the described selected alternative provides adequate protection of public health, welfare, and the environment. The Commonwealth of Pennsylvania has been consulted and agrees with the approved remedy.

I have also determined that the action being taken is appropriate when balanced against the availability of Trust Fund monies for use at other sites. In addition, the on-site secure disposition is more cost-effective than other remedial actions, and is necessary to protect public health, welfare or the environment.

5/7/86
Date

James M. Seif
Regional Administrator

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PENNSYLVANIA
DER
Bureau of Waste Management

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
Post Office Box 2063
Harrisburg, Pennsylvania 17120

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(Red)

April 29, 1986

717-783-7816

Mr. Thomas Voltaggio, Chief
Superfund Branch
U.S. Environmental Protection Agency
Region III
841 Chestnut Building
Ninth and Chestnut Streets
Philadelphia, PA 19107

Dear Mr. Voltaggio:

The draft Record of Decision for the selection of the alternative for the remediation of the Millcreek site has been reviewed by DER staff members. We concur with your assessment of the proposed alternatives and with the selection of the final remediation measures. Soils and sediments exceeding the proposed criteria should be excavated and consolidated under the proposed RCRA cap, along with any drums found containing non-RCRA wastes. Drums containing RCRA hazardous liquids or solids should be disposed of off-site where appropriate. The floodwater retention basin and the surface water management basins and ditches should be installed to help prevent the infiltration of precipitation, and of possible floodwaters, in order to reduce the chance of future leachate generation. A design study should be undertaken to further characterize the extent of contamination and to determine the technical feasibility of the proposed groundwater contaminant source reduction program.

We should proceed as expeditiously as possible with the design study in order to determine more fully the extent of contamination at the Millcreek site. With this information, we can then ensure that the proposed remedial alternative will adequately protect the public health and the environment of the Commonwealth.

If you have any questions or comments concerning this matter, do not hesitate to contact Don Becker or Eric Tartler.

Sincerely,

James P. Snyder

James P. Snyder
Assistant Bureau Director

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SITE DESCRIPTION AND SUMMARY OF REMEDIAL ALTERNATIVE SELECTION FOR THE MILLCREEK SITE

Site Location and Description

The Millcreek site is a 84.5 acre tract of land located in Millcreek Township, Erie County, Pennsylvania. It is situated approximately two miles west of the city of Erie as shown in Figure 1 . The property is presently owned by Millcreek Township (4 acres), Ralph Riehl, Jr. (57 acres) Joseph Halmi (13.5 acres), and James Sitter (10 acres).

The topography of the site is relatively flat except for several isolated mounds of foundry sand and debris. Flood potential maps of the area show that the site is located within a 100-year and 500-year flood zone. Flooding occurs frequently, though, east of the site in a residential area during heavy rains.

The site is bordered to the north, northeast, and northwest by residential areas. A commercial trucking firm borders the site to the east, and a children's baseball field to the west. Erie International Airport is located about 2000 feet west of the site. At least 2,000 people work or reside within a 2500 foot radius from the center of the site.

Ground water for drinking water purposes is utilized by municipal wells located about 1200 feet south (hydraulically upgradient) of the site boundary. Ground water is not presently utilized downgradient of the site. Sometime during the past 15 years, unknown parties bulk disposed of halogenated volatile solvents in soils in the eastern portion of the site. This disposal has resulted in significant ground water contamination both onsite and offsite. Unit cancer risk calculations reveal that offsite ground water contamination exceeds 10^{-2} cancer risk levels adjacent to the eastern portion of the site. There are presently no State, County, or Municipal restrictions against ground water use in the site area.

Shallow ground water discharges to a stream (Marshalls Run) east of site during high water table conditions (spring, summer). Marshalls Run discharges to Lake Erie 1.2 miles downstream from the site. Aquatic life (fish and macroinvertebrates) are abundant near the mouth of Marshalls Run near Lake Erie.

In addition to identifying volatile organic compound contamination in ground water, Region III's Remedial Investigation discovered extensive soil and sediment contamination. The major classes of compounds detected included: polychlorinated biphenyls (PCBs), polynuclear aromatic hydrocarbons (PNAs), phthalates, volatiles, phenols, and metals such as lead and copper.

The perimeter of the site is deciduous forest, while the central, southern, and southwestern portions are composed of fill material. A wetland of about 4 acres lies on the southern perimeter of the site.

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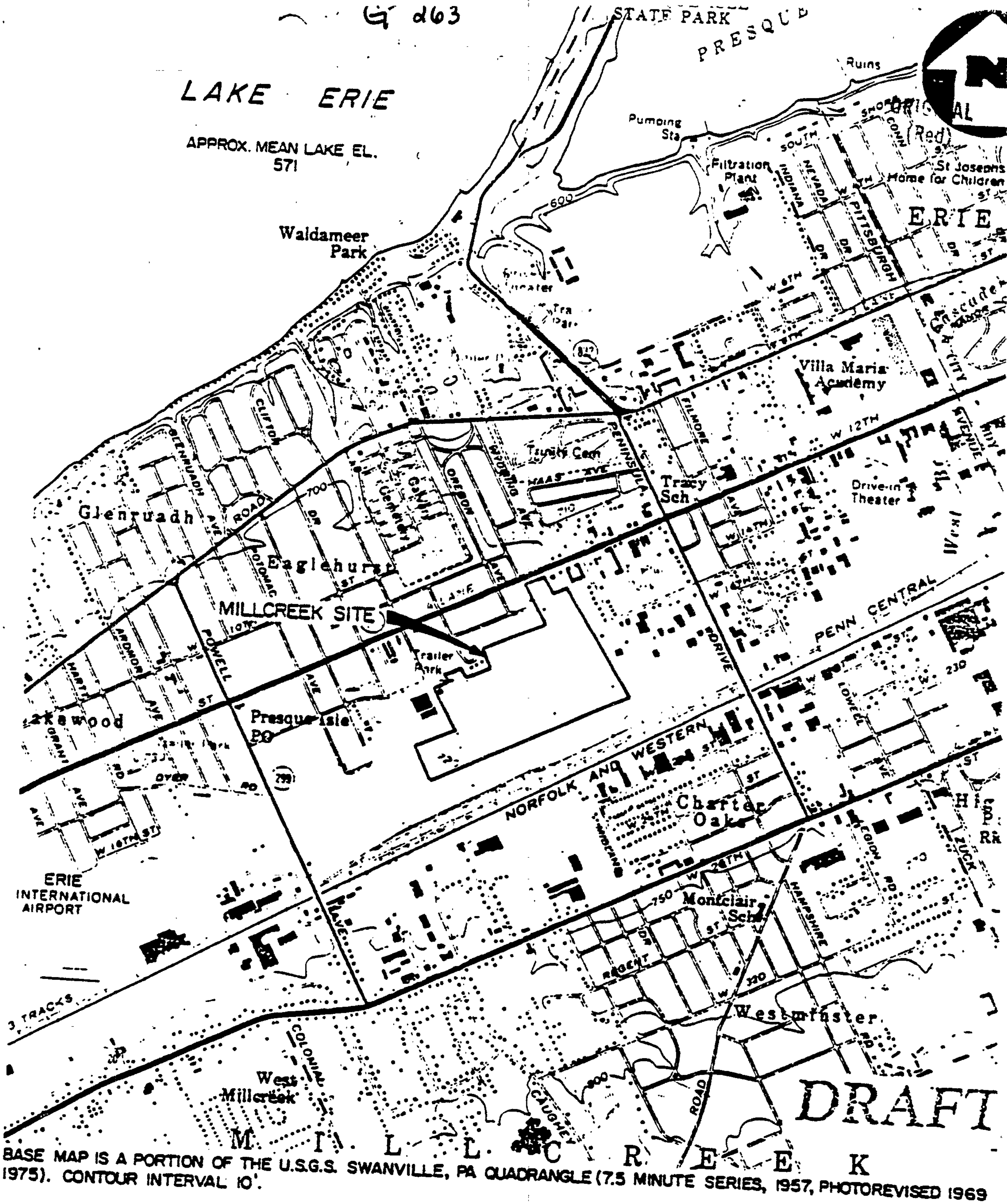

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BASE MAP IS A PORTION OF THE U.S.G.S. SWANVILLE, PA QUADRANGLE (7.5 MINUTE SERIES, 1957, PHOTOREVISED 1969 1975). CONTOUR INTERVAL 10'.

FIGURE 1

LOCATION MAP
MILLCREEK SITE, MILLCREEK TWP., PA

SCALE: 1" = 2000'

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Debris such as junk cars, and abandoned machinery are strewn throughout the site along with numerous drums of foundry sand and slag.

Site History

The site was once a 75 acre freshwater wetland. During the past 40 years, though, all but 4 acres have been filled in with foundry sand, industrial and municipal waste. The site operated as an unpermitted active landfill during this time.

During the past 10 years, waste oils containing high concentrations of PCBs were bulk disposed in site fill, along with phthalates, phenols, polycyclic aromatic hydrocarbons (PNAs), and heavy metals. These contaminants and tentatively identified compounds (TICs) were detected in site fill during the Remedial Investigation (RI).

In April, 1981, the Pennsylvania Department of Environmental Resources (PADER) discovered dumping of drums in the central portion of the site. The drums were later sampled and found to contain trichloroethene (TCE). The PADER later closed the site in 1981. In August, 1982, the Erie County Health Department (ECHD) discovered drums on the surface of the site while investigating a natural gas well fire on the Halmi portion of the site.

In November, 1982, EPA dispatched its Environmental Response Team (ERT) to conduct drum, soil, sediment, ground water, and surface water sampling at the site to evaluate potential health risks. In November, 1983, EPA conducted a planned removal of 75 liquid filled drums which contained waste oils, solvents, and antifreeze.

The four property owners, except for Millcreek Township, owned their property at the time of filling. In 1973, the Sitter brothers purchased the Sitter portion, and from 1974 to 1979 filled it in with foundry sand. In 1981, Millcreek Township purchased a 4 acre parcel of land from Mr. Riehl for the purpose of constructing a flood control structure. PADER denied a permit for construction in 1982 pending the results of EPA's RI/FS study.

Personnel who worked on the Riehl property indicated that from 1977 to 1979, an unknown amount of nonhalogenated solvents and ink wastes, 300 drums a year of polyester resins, 6,600 gallons a year of caustics, 3,000 drums total of paint wastes, and 180 drums a month of slag were disposed of at the site. Most liquid disposal is believed to have occurred by bulk methods. The operators also ran a metals reclaiming facility in the eastern portion of the site and constructed a deep pond to supply water for foundry sand washing.

Current Site Status

EPA Region III completed a Remedial Investigation/Feasibility Study (RI/FS) at Millcreek in August, 1985. Data collected in the RI and in previous studies done by EPA's Environmental Response Team (ERT), Pennsylvania Department of Environmental Resources (PADER), and the Erie County Health Department (ECHD) were used to describe the nature and extent of contamination. Additional soil, sediment, surface water, and ground water samples will be collected during design.

Pathways and receptors are described in detail along with known or suspected risks posed by contaminants in the Remedial Investigation and Feasibility Study Reports and in the EPA Region III Technical Support Documents.

The following is a brief summary of the types and concentrations of contaminants detected in soil, sediment, ground water and surface water:

° Soil

- elevated levels of polychlorinated biphenyls (PCBs) were detected in the eastern and south central portions of the site. Concentrations of PCBs were found up to 31 mg/kg wet weight.
- elevated levels of polynuclear aromatic hydrocarbons (PNAs) were detected through out the site, especially in the southwestern portion. Concentrations of PNAs were found to 539 up mg/kg wet weight.
- elevated levels of phthalates were also detected throughout the site. The predominant area of contamination was found to be in the southern portion of the site. Concentrations were found up to 72 mg/kg wet weight.
- elevated levels of phenols were detected in the southern and eastern portion of the site in concentrations up to 7 mg/kg wet weight.
- volatiles were detected in the south central portion of the site in concentrations up to 6 mg/kg. Volatiles are also believed to be concentrated in the eastern portion of the site as indicated from monitoring well data. Soil concentrations in this area will be determined during design since this portion of the site did not undergo test pitting or soil boring during the RI.
- metals were also detected throughout the site at various concentrations. Two metals of concern, copper and lead, were found in concentrations up to 20,500 and 2,375 mg/kg, wet weight.

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- High concentrations of tentatively identified compounds (TICs) were detected throughout site soil. Most TICs are believed to be hydrocarbon derivitives possibly resulting from the bulk disposal of oil. The RI contains a complete list of all TICs detected in soil. The list probably exceeds 1000 compounds. TICs were detected in concentrations over 1000 mg/kg. Because toxicological information on many of the TICs is sparse, the RI risk assessment only considered Hazardous Substance List (HSL) compounds present in soil. The risk posed by TICs will continue to be evaluated during predesign and design.

° Sediment

- Except for volatiles, which were not detected, many of the same compounds detected in soil were detected in sediments of the wetland in the southern portion of the site, in ditches within and on the perimeter of the site, and in Marshalls Run bordering the eastern portion of the site.

- PCBs were detected in concentrations up to 1.50 mg/kg wet weight.

- phthalates were detected in concentrations up to 5.0 mg/kg wet weight.

- phenols were detected up to 0.99 mg/kg wet weight.

- metals such as lead and copper were detected in concentrations up to 0.67 and 6.61 mg/kg wet weight respectively.

- TICs were found in concentrations up to 115 mg/kg wet weight.

° Ground Water

- Except for the metals, manganese and iron, elevated levels of detectable ground water contaminants were restricted to the eastern portion of the site.

- Volatiles were detected in concentrations over 30 mg/l. The list below outlines the most frequently occurring volatile organic compounds (VOCs) and their corresponding maximum concentration detected during the RI.

Compound	Max. Conc. (ug/l)
1-1-dichloroethane (1,1-DCA)	260
1,1-dichloroethene (1,1-DCE)	16
1,2-dichloroethene (1,2-DCE)	29,000
trichloroethene (TCE)	300
1,1,1-trichloroethane (1,1,1-TCA)	960
vinyl chloride (VCM)	220

- phthalates were also detected in ground water. Diethyl phthalate was found in concentrations up to 41 ug/l while di-n-butyl phthalate was detected at a concentration of 21 ug/l.

- iron and manganese were detected in concentrations up to 20,800 and 1,920 ug/l respectively. These represent filtered (0.45 um) samples.

- TICs were also detected in ground water in the eastern portion of the site. A total of 16 TICs were identified and present in concentrations over 1000 ug/l.

° Surface Water

- Marshall's Run and drainage ditches throughout the site were dry during the RI so evaluations are based on previous sampling attempts and sampling in the wetland located in the southern portion of the site which is wet throughout the year.

- Volatiles were detected in Marshall's Run during the 1982 ERT investigation. The list below summarizes VOCs and corresponding concentrations.

VOC	Concentration (ug/l)
VCM	18
1,1,1-TCA	93

- Metals were detected in the wetland in the southern portion of the site and in Marshalls Run. The list below summarizes elevated levels of metals detected and corresponding concentrations.

Metals	Concentrations (ug/l)
Copper	9,560
Iron	21,600
Manganese	1,580
Lead	1,940
Zinc	6,270
Aluminum	6,270
Mercury	0.81
Nickel	386
Tin	385
Cadmium	3.7

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Alternatives Evaluation

This section will briefly define the public health and environmental objectives of remediation; screening methods to determine appropriate remedial technologies; and specific alternatives considered. The Feasibility Study contains a more in-depth analysis of these discussions.

° Public health and environmental remediation objectives:

- prevent onsite air dispersal of particles containing potentially hazardous substances.
- prevent direct dermal contact with potentially hazardous substances.
- prevent offsite transport of contaminated soil and sediment via erosion or storm transport.
- remediate offsite ground water contamination to ground water protection goals. Tentative levels established for cost estimating purposes are outlined in Table 1.
- remediate soil contamination to safe soil levels capable of preventing future ground water contamination. Tentative levels established for cost estimating purposes are in Table 2.
- remediate sediment contamination capable of causing an impact on aquatic life or wildlife in the wetlands and Marshalls Run. Tentative levels established for cost estimating purposes are outlined in Table 3.
- remediate potential surface water contamination by remediating ground water, soil and sediment contamination. Tentative levels used for cost estimating purposes are outlined in tables 1, 2, and 3.

The tentative soil and sediment criteria and the groundwater protection goals were based on a site-specific risk analyses presented in the EPA Region III technical support documents. The exception is the soil criteria for PCBs, which was based on a consensus policy for residential areas proposed to EPA by a committee of environmental organizations and industry groups which is under consideration by EPA for use as the basis for a TSCA PCB policy. will use 10 ppm unless additional information becomes available during design which would require the use of a lower number. A site specific analysis for the other compounds was necessary because there are no existing regulations for those compounds.

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Table 1

Ground Water Protection Goals

Compound	(ug/l)
Organics	
*vinyl chloride	0.015 (10^{-6} UCR)
*trichloroethene	1.8 (adjusted 10^{-6} UCR)
*1-2-dichloroethene	70 (adjusted 10^{-6} UCR)
*1,2-dichloroethane	0.95 (10^{-6} UCR)
1,1,1-trichloroethane	22 (HA)
*1,1-dichloroethene	0.24 (10^{-6} UCR)
*chloroform	0.19 (10^{-6} UCR)
*benzene	0.70 (10^{-6} UCR)
xylene	440 (HA)
toluene	2000 (HA)
ethyl benzene	680 (HA)
phenols	300 (taste)
phthalates	3 (aquatic life)
Base/Neutral	
Inorganics	
lead	11 (aquatic life)
copper	27 (aquatic life)
arsenic	50 (HA)
cadmium	3 (aquatic life)
chromium III	341 (aquatic life)
chromium VI	11 (aquatic life)
mercury	0.012 (aquatic life)
zinc	710 (aquatic life)
nickel	150 (HA)
iron	300 (taste)
manganese	50 (taste)
HCN	5 (aquatic life)
NH_3(unionized)	128 (aquatic life)

* Carcinogens

° UCR - Unit cancer risk

° HA - Health Advisory Level

° For Inorganics, assume 260 ug/l $CaCO_3$ hardness, pH=7.5, and T=15°C

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Table 2

Soil Criteria For Organics

Compound	Criteria (ug/kg dry weight)
*vinyl chloride	<10 (Detection Limit)
*trichloroethene	<10 (Detection Limit)
*1-2-dichloroethene	594
*1,2-dichloroethane	<10
*1,1-dichloroethene	<10
*chloroform	<10
*benzene	<10
1,1,1-trichloroethane	540 (10^{-6} UCR)
xylene	41,926
toluene	1,783
ethyl benzene	26,396
phenols	9,000
Base/Neutral	
phthalates	338,000
*PNAs	2,940 (10^{-6} UCR)
*PCBs	10,000

* Carcinogens

Table 3

Sediment Criteria For Organics

Compound	Criteria (ug/kg dry weight)
phenols	1843
phthalates	7183
*PNAs	1730
*PCBs	40 (background)

* Carcinogens

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Table 4

Surface Water Criteria Goals (ug/l)

Compound	Concentration
volatiles	1000 (aquatic life)
phenols	2560 (aquatic life)
phthalates	3 (aquatic life)
*PNAs	0.03 (wildlife and human health)
*PCBs	0.005 (background)
Inorganics	
lead	11 (aquatic level)
copper	27 (aquatic level)
arsenic	190 (aquatic level)
cadmium	3 (aquatic level)
chromium III	341 (aquatic level)
chromium VI	11 (aquatic level)
mercury	0.012 (aquatic level)
zinc	710 (aquatic level)
nickel	197 (aquatic level)
iron	1000 (aquatic level)
cyanide	5 (aquatic level)
ammonia (unionzed)	128 (aquatic level)

Assume: Ca CO_3 hardness = 260 mg/l, pH = 7.5 and T = 15°C

* Carcinogens

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Compliance with ground water protection goals, soil, sediment, and surface water criteria will be determined in an additive fashion separately for carcinogens and non carcinogens. The criteria outlined in Tables 1 through 4 will be in calculations of fractions of risk posed by each contaminant. The individual fractions cannot exceed unity.

° <u>Factors Used in Screening Remedial Technologies</u>

- Technical Criteria
    - ° applicability to site conditions (geology, topography, etc.)
    - ° applicability to waste characteristics
    - ° effectiveness and reliability
    - ° implementability (construction), operation, and maintenance)
- Environmental and Public Health Criteria
    - ° except for risk posed by direct contact or atmospheric dispersal of contaminants, criteria to protect human health and the environment are presented in Tables 1 through 4.
- Cost Criteria
    - ° increased cost offering no greater reliability or effectiveness
    - ° increased cost offering no greater protection of public health or environment as established by criteria
- Institutional Criteria (Compliance with other environmental laws)
    - ° TSCA
    - ° RCRA
    - ° CWA
    - ° NPDES
    - ° etc.

For a detailed analysis of technologies screened out see Section II of the FS.

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Technologies Considered in Detail Include:

- ground water remediation
  - ° no action
  - ° monitoring
  - ° pumping with injection
- ground water treatment
  - ° no action
  - ° monitoring
  - ° flow equalization
  - ° precipitation of metals
  - ° filtering
  - ° air stripping of volatiles
  - ° GAC filtering of exhaust gases associated with air stripping
- surface water remediation
  - ° same technologies as ground water treatment
- soil remediation
  - ° no action
  - ° covering
  - ° capping
  - ° excavation
- soil treatment
  - ° offsite disposal
  - ° onsite disposal under RCRA cap
- sediment remediation
  - ° same technologies as soil
- sediment treatment
  - ° same technologies as soil

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° Alternatives Considered in Detail.

Five alternatives incorporating the technologies considered in detail were evaluated for remedial action. These 5 alternatives were:

1) No action with ground water and surface monitoring.

2) Grading, surface water diversion, soil cover, revegetation, and ground water and surface water monitoring.

3) Alternative 2 with ground water pumping and treatment.

4) Alternative 3 with capping of soils exceeding criteria in Table 2 and dredging of sediments exceeding criteria in Table 3 with incorporation under onsite cap areas.

5) Alternative 3 with excavation or dredging of soils and sediments exceeding criteria which would be incorporated under a RCRA cap constructed in the central portion of the site.

Excavation of contaminated soil to background levels with offsite disposal in a RCRA regulated facility was not considered in detail because of the high costs associated with this option. If it is assumed that the average depth of foundry sand is 7 feet, 35 acres of land are contaminated, and the average offsite disposal cost per cubic yard is $300, this option would cost about 118 million dollars.

<u>Alternative 1:</u> No action with monitoring of ground water and surface water, would function as a detection system to warn of increasing contaminant concentrations in ground water or surface water. This alternative is not appropriate because:

For Ground Water

- present offsite ground water contamination exceeds levels considered safe for human ingestion. Present offsite unit cancer risk equals 10^{-2}.
- EPA Region III calculations show that active restoration will remediate ground water to safe levels much more rapidly than natural restoration.
- ground water pumping is technically feasible and a well accepted practice to reduce ground water contaminant levels.
- EPA policy requires remediation of offsite contamination.

For Soil

- air dispersal of contaminated soil particles presents a potential human health impact.

For Soil

- air dispersal of contaminated soil particles presents a potential human health impact

- not remediating soil below criteria outlined in Table 2 could cause continued or potential future ground water contamination.
- present site conditions could cause contaminated soils to be carried offsite during heavy storms by surface runoff.
- present soil contaminant levels may cause a direct contact risk through dermal contact and ingestion by children.

For Sediment

- not remediating sediment below criteria outlined in Table 3 may cause continued surface water contamination by desorption.

For Surface Water

- not remediating sediment and surface soil will cause continued surface water contamination through desorption of organics and surface runoff from soil. Ground water discharge to surface water could also impact surface water quality.

Cost

The FS estimates that this alternative would cost about $1,500,000 over a 30 year period. Monitoring would include analysis of present monitoring wells and selected surface water locations.

Alternative 2: Grading, soil cover, revegetation, surface water management, and monitoring of ground water and surface water.

In this alternative, the site would be graded to prepare a soil cover. Exposed solid waste or slag drums would be buried during grading activities. The soil cover would consist of 18 inches of borrow material below 6 inches of top soil. All exposed areas would be covered with soil. Three or four storm water runoff ponds would be constructed, along with erosion central benches and surface water diversion ditches.

The advantages of this alternative include:

- ° elimination of public health risk caused by atmospheric dispersal of contaminated soil.
- ° reduction or elimination of erosion and surface water runoff containing contaminated particles thus increasing surface water quality.
- ° decrease in percolation of rainfall through the unsaturated zone thus reducing the contaminant migration through soil.
- ° elimination of direct contact risk.

Disadvantages associated with this alternative include:

- ° reduced, but continued flow of contaminants through the unsaturated zone, thus impacting ground water. Remediation to proposed soil levels in Table 2 is necessary to eliminate future ground water contamination.
- ° no remediation of present ground water contaminant which may pose a risk to future downgradient users or aquatic life or wildlife living in or subsisting in Marshall's Run. Ground water remediation to ground water goals is necessary to prevent future risk to human health, aquatic life or wildlife.
- ° no remediation of sediment, thus impacting surface water quality from the desorption of contaminants. Excavation to Table 3 levels is necessary to prevent future risks to aquatic life and wildlife.
- ° in general, this alternative provides greater protection, but still is insufficient to prevent risks posed by contaminants.

Costs

Capital and operation and maintenance costs were obtained from the FS. Capital costs include:

- stormwater basin construction = $1,226,000
- soil grading, clearing, cover, and revegetation = $2,064,000
- offsite disposal of exposed drums containing solid wastes = $37,000

Total Capital Costs = $3,000,000

Operation and maintainance costs obtained from the FS, including monitoring:

= $1,700,000

Therefore, total costs are estimated to be $5,000,000

Alternative 3: Alternative 2 plus ground water remediation.

Ground water remediation would consist of up to 24 months of pumping with some effluent being reinjected to upgradient ground water to increase flow velocity. The construction and placement of reinjection and pumping wells is illustrated in the FS. It is estimated that 435 gallons per minute of effluent would be discharged to Marshall's Run over the two year period. Effluent must be discharged to Marshall's Run instead of in a POTW because Millcreek Township's POTW sewer system is at capacity and the closest server system in the city is also near capacity and would require an additional pipeline.

Marshall's Run presently undergoes severe flooding on Harper Road at the eastern boundary of the site during heavy rainstorms. This discharge will cause more frequent flooding and worse flooding during rain storms which could eventually cause onsite flooding. To remedy this situation, it is recommended that a flood retention basin be constructed along the eastern border of the site. Since Millcreek Township has already purchased land to construct a flood retention basin, and since soil contamination is present on Millcreek Township's property above soil criteria levels, this soil would have to be excavated anyway.

Excavation would have to proceed to safe sediment levels, since basin soils would be in direct contact with surface water. If sediment contaminant levels are suitable after ground water remediation, the flood control basin could be seeded to also function as a wetland to some restored area lost to previous filling.

The level of ground water treatment will be determined by a NDPES permit which will be developed during design. For costing purposes, it is assumed that treatment will be extensive: precipitation, filtration, air stripping and granular activated carbon.

The advantages and disadvantages of Alternative 3 are the same as Alternative 2, except ground water risks would be reduced with this alternative, while the ground water pumping and treatment program is in operation. However, a disadvantage would be that continued long term contamination of the ground water and surface water would occur because contaminants in the soil and sediments would remain in place and continue to leach.

Cost

Total costs are the same as Alternative 2 with the exception of ground water pumping and treatment and the construction of a flood retention basin which would cost an additional $3,012,000 and $500,000 respectively. Therefore, total costs =

$5,036,000 + $3,072,000 + $500,000

= $8,608,000 or about $8,600,000

Ground water pumping and treatment and construction of the flood retention basin are considered capital costs. Operation and maintenance costs would vary with the duration of pumping. If pumping occurs over a maximum of 2 years, O & M costs would be similar to Alternative 2.

Alternative 4: Alternative 3 with capping

Alternative 4 is the same as Alternative 3 except it would require capping over areas exceeding soil criteria and excavation of sediments exceeding sediment criteria. This alternative would require additional sampling of soil and sediment to determine all areas on site exceeding established criteria. Excavated sediment would be incorporated under one of several of the areas onsite. Also, since the flood retention basin area contains contaminated soils, excavated soil would have to be incorporated under one of several of the capped areas.

Advantages

This alternative would hydraulically isolate soil contaminants in the unsaturated zone exceeding soil criteria, and thus provide a high degree of protection. Sediment exceeding criteria would also be excavated, surface water would also be adequately protected. Overall, this alternative is technically feasible.

Disadvantages

The predominant disadvantage of this alternative is that most soils exceeding the soil criteria levels lie in the eastern portion of the site bordering Marshall's Run. The eastern portion of the site lies in a flood plain and therefore capping in this area would not be in compliance with RCRA regulation. Flooding could damage the cap by scouring. Also, areas of soil contamination exceeding criteria could be scattered throughout the site and thus cause capping at many areas around the site. This could cause difficulty in monitoring the capped areas for possible seepage. It would be more effective to cap one area and install additional monitoring wells to ensure ground water compliance.

Costs

If it is assumed that an area 1200 feet by 500 feet would be capped adjacent to Marshall's Run along with an additional 250,000 ft^2 throughout the site, and that contaminated soil from the retention basin and sediment from the wetland and Marshall's Run is incorporated under one or more of the caps, a total capped area of at least 1,000,000 ft^2 or about 7 acres would be required. Past experience has shown caps to cost about $400,000 per acre, so the capped area would cost at least $2,800,000. Excavation of sediments could cost an additional $500,000 to $700,000 based on the potential excavation of all sediments in the wetland on Marshall's Run and additional sampling and analysis could cost $450,000. Additional sampling would be considered as part of design and thus would be funded as such.

Therefore, capital costs could approach

$$\$6{,}900{,}000 + \$2{,}800{,}000 + \$700{,}000 + \$450{,}000$$

$$= \$10{,}850{,}000$$

O & M costs are expected to be about $1,700,000 over a 30 year period. Total costs are expected to be about $12,550,000.

Alternative 5: Alternative 3 with Excavation

Alternative 5 would be the same as Alternative 4 except that soils and sediments exceeding established criteria would be excavated or dredged and consolidated under an onsite, RCRA cap. The cap would be outside the flood plain area. As with Alternative 4, Alternative 5 provides a high degree of protection, but does not have Alternative 4's disadvantages. A comprehensive ground water monitoring system would be established both upgradient and downgradient of the capped area and involve additional installation of monitoring wells. Alternative 12 in the FS most closely resembles Alternative 5, therefore, total costs should be similar except for the required additional sampling and installation of monitoring wells. Additional sampling could cost about $ 450,000. The additional monitoring wells could cost approximately $60,000.

The Concept of Alternative 5 is as follows:

1) Pump ground water for an initial period of time determined during design not to exceed 2 years. After the initial period has passed, groundwater protection goals will be reevaluated to determine their technical feasibility. At that time, pumping could continue at the same or new goals or be discontinued if the designed goals were met. This strategy is necessary because the effectiveness of pumping to reduce VOC contaminants to ug/l levels over a long time period is unknown. The proposed goals for the first period are outlined in Table 1. These goals will be reevaluated during design to ensure technical feasibility and protection of human health and the environment.

2) Treat ground water to levels consistent with NPDES permit standards. Treatment would include the construction of a flood retention basin on Millcreek Township's property for flow equalization and prevention of onsite and offsite flooding. Ground water may also be treated for inorganic and organic removal by precipitation, filtration, air shipping and granular activated carbon. Cost estimates assumed extensive treatment. The NPDES standards will consider technical feasibility and protection of aquatic life and humans or wildlife which may ingest aquatic life.

3) Excavate soil to proposed levels outlined in Table 2 and incorporate under an onsite RCRA cap. Region III will reevaluate the criteria during design. Criteria for PCBs and PAHs are in Table 2. The criteria presented in this ROD are for cost estimates only.

Technologies to reduce contaminant levels to soil criteria will be considered to decrease the volume of excavated soils and their associated costs prior to excavation.

As previously explained, soil criteria are calculated using many variables, two of which are the area and concentration within that area of contaminants. Further sampling will be required during design to gain additional information on the areal extent of soil contamination, especially in the eastern part of the site where elevated concentrations of volatiles are expected to be present.

4) Excavate sediment to proposed levels outlined in Table 3 and incorporate under an onsite RCRA cap. As with soil criteria, sediment criteria in Table 3 are for cost estimates only. Region III will also reevaluate sediment criteria during design.

5) Any drums found during sampling or earth moving activities will be sampled, either individually or as a composite, as appropriate. Drums containing solid non-RCRA waste will be consolidated under the cap. Any liquid filled drums or drums containing RCRA hazardous wastes will be disposed of off-site.

6) Place soil cover over remaining areas of site not exceeding soil criteria to protect against atmospheric dispersion of contaminated soil.

7) Grade and revegetate soil and cap areas.

8) Construct surface water management basins to control run on, run off and erosion.

9) Install additional monitoring wells around the cap and other areas on site to detect possible future releases.

Total capital costs ranges for 10^{-4}, 10^{-5}, and 10^{-6} UCR values are estimated to be 9-11, 10-12, and 12-18 million dollars. EPA has chosen a 10^{-6} UCR value which is consistent with policy and EPA's long-term ground water protection strategy. Therefore, including additional sampling and monitoring wells, costs are expected to range from 12 million to 18 million. These costs are estimates based on the soil criteria developed by EPA Region III.

Figure 2 illustrates a conceptual sketch of this alternative.

Recommended Alternative

Alternative 5 is the only alternative complying with other environmental laws and remediating the site to safe ground water, surface water, soil, and sediment levels to protect human health, aquatic life, and wildlife. Based on our evaluation of the cost-effectiveness of each of the proposed alternatives, the comments received from the public, the state, and potentially reponsible parties, information from the RI/FS and Region III technical support documents, Region III recommends that Alternative 5 be implemented.

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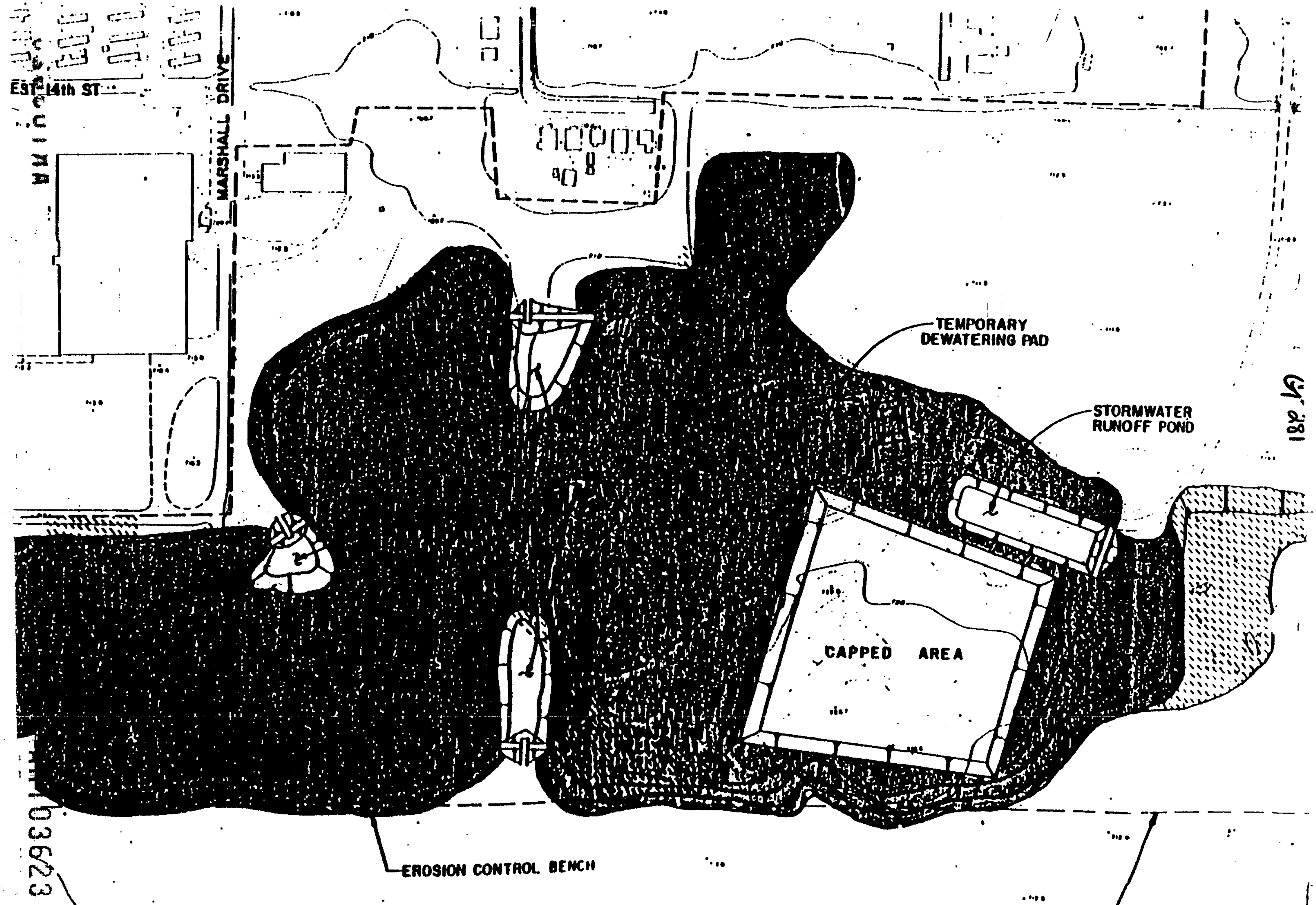

FIGURE 2

Consistency With Other Environmental Laws

The recommended alternative was evaluated to determine consistency with applicable or relevant and appropriate environmental laws.

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The transport and offsite disposal of drums will have to comply with all applicable RCRA regulations regarding the transport and disposal of hazardous wastes.

The surface water discharge from the groundwater treatment facility will comply with NPDES discharge requirements.

The cap will be designed and constructed to comply with the RCRA capping requirements of 40 CFR §264.310(a).

EO 11988, Floodplain Management, will be complied with through the construction of a flow equalization and prevention basin which will minimize the impact of this action on flood hazards. Additonally, contaminated soils and sediments will be removed from the floodplain and the soils will be consolidated and capped outside the floodplain.

EO 11990, Protection of Wetlands, will be complied with through the construction of the flow equalization and prevention basin which can be constructed and revegetated to serve as a wetland providing the benefical uses described in EO 11990. In addition, contaminated sediment will be removed from the remaining wetlands on-site. The action to remove the sediments will be designed to minimize the harm such action will have on the wetlands.

The basin and the run-off/run-on control system will be designed to meet the requirements of the RCRA regulations in 40 CFR §264.301(c), (d), (e).

The establishment of soil and sediment criteria, consolidation of material exceeding these criteria under a RCRA cap and a ground water monitoring program to verify that the ground water protection goals are met, complies with the CERCLA policy for consistency with the Safe Drinking Water Act and RCRA regarding ground water contamination and RCRA Closure/ Soil Contamination Requirements. This CERCLA policy is described in the preamble to the National Contingency Plan published in the <u>Federal Register</u> on November 20, 1985, on pages 47922-47923.

The recommended alternative is also consistent with the EPA's forthcoming Superfund groundwater strategy as discussed in a March 24, 1986 memorandum from J. Winston Porter, Assistant Administrator for Solid Waste and Emergency Response, to James Seif, Regional Administrator, Region III.

Costs

The projected costs were developed in accordance with EPA policy for estimating costs within a reasonable range (-30% to +50%) of the actual implementation costs. Total projected present worth costs range from $14,800,000 to $20,800,000 with a baseline estimate of $17,800,000.

Design Costs -

Additional sampling and monitoring wells will be considered as part of the design. Design is estimated to cost approximately $1,000,000. Design will be funded 100% by trust fund monies.

Capital Cost-

Capital cost estimates vary from $12,000,000 to $18,000,000, with an estimated baseline cost of $15,000,000. For these estimates, capital costs included all costs associated with excavation, regrading, revegetating, capping and groundwater pumping and treating for two years (although pumping may be needed for a period beyond two years, two years was selected for cost estimating purposes). Trust fund monies will be used to pay for 90% of these costs and the State of Pennsylvania will finance 10% of these costs.

Operation and Maintenance (O & M)-

Total present worth costs for O & M is $1,763,000.

The components of the recommended alternative that may require operation and maintenance are:

- RCRA Cap
- Surface water management systems
- Flood retention basin
- Monitoring (excluding that necessary to monitor the effectiveness of the pumping and treatment program while it is being financed by the trust fund).

The above listed items will be considered normal operation and maintenance and will be the responsibility of the State of Pennsylvania six months subsequent to completion of construction.

The ground water pumping and treatment program will be considered part of the approved remedy for a period of at least two years. If targets are not reached after two years of remedial activity the Regional Administrator will determine if it is technically feasible to reach those targets. If further pumping and treatment are required, this will also be considered as part of the approved remedy and eligible for Trust Fund monies with 90% of the program financed with trust fund money and 10% financed with State money.

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Schedule

Approve ROD	4/86
Start Predesign	6/86
Complete Predesign	12/86
Award Superfund IAG to U.S. Army Corps for Design	1/87
Start Design	3/87
Complete Design	12/87
Award Superfund Contract for Construction	2/88
Start Construction	5/88
Complete Construction	12/88

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Table 1: Descriptions of Alternatives Considered at the Millcreek Site

Alternative	Total Cost x 1000	Public Health and Environmental Goals	Compliance With Other Environmental Laws
Alt. 1: No Action with Surface Water and Ground Water Monitoring	1,500	Does not meet ACL, soil, sediment, or surface water criteria or goals. Site would continue to pose a potential risk to public health, aquatic life, and wildlife. This alternative would do little but warn of worsening conditions.	Would not comply with RCRA closure requirements nor with EPA's current ground water protection strategy.
Alt. 2: Grading, Soil Cover, Revegetation, Surface Water Management, and Monitoring	5,000	Would eliminate risk posed by direct contact and inhalation of contaminated particles. Would decrease future surface water contamination by preventing runoff. This alternative, though, would not remediate ground water, soil, and sediment contamination to acceptable levels, and thus provides inadequate protection to receptors.	Same as above.
Alt. 3: Alt. 2 Plus Ground Water Remediation	8,600	Offers same benefits previously described in Alt. 2 plus remediation of ground water. This alternative, though, would not eliminate the potential for future ground water and surface water contamination caused by soil and sediment levels exceeding criteria.	Would comply with EPA's ground water protection strategy and RCRA's closure policy for ground water contamination. It would not comply with RCRA's closure requirements for contaminated soil and sediment
Alt. 4: Alt. 3 plus Capping of Areas Exceeding Soil Criteria	12,500	By capping areas exceeding soil criteria and excavating sediment exceeding sediment criteria, this alternative would provide a high degree of protection. Contaminated sediment would be incorporated under an onsite cap area. A major disadvantage of this alternative is that the predominant area of capping lies in a flood plain.	Would not comply with RCRAs closure requirements since capping would be required in a flood plain.
Alt. 5: Alt. 3 plus Excavation of Soils and Sediment Exceeding Criteria with On Site Disposal under a RCRA CAP	14,800 to 20,800	Would provide a high degree of protection meeting all criteria and standards established.	Complies with all applicable environmeantal laws.

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Millcreek Responsiveness Summary

A responsiveness summary usually accompanies a Record of Decision (ROD) to provide EPA an opportunity to respond to comments made or submitted by citizens, environmental groups, or Potentially Responsible Parties (PRPs) on the Remedial Investigation/Feasibility Study (RI/FS) or other previous studies conducted by Federal or State agencies used to formulate a remedial action at a CERCLA site. The responsiveness summary, along with public meetings, informs concerned citizens and PRPs of EPA's assessment of data collected and recommended means of remediating any risk posed to public health or the environment.

EPA, Region III, conducted a public meeting on September 11, 1985, to inform citizens of the findings from the RI/FS and to propose a recommended remedial alternative. The topics discussed during the public meeting are outlined in Appendix RS-1.

Since any comments submitted by citizens or PRPs should be a matter of public record, all correspondence received by EPA is contained in Appendix RS-2.

PRPs' Comments

The PRPs' comments will first be summarized and responded to since their comments are the most extensive and in-depth. To aid in the technical review of the RI/FS, the PRPs consulted with the IT and Environ Corporations.

° Ground Water

The first major topic is that EPA's RI/FS does not have sufficient data to properly characterize and assess the risk posed by ground water contamination, and that there is no need for active remediation because ground water is not utilized downgradient of the site. Specifically, the PRPs claim that:

° temporal (time-variant) characterization of ground water quality cannot be assessed with present data.

° insufficient data to evaluate the extent to which natural restoration will occur.

° downgradient ground water is not currently being used and is unlikely to be used in the future because of the proximity of Lake Erie and the current distribution system servicing residents of Millcreek Township.

° the upgradient public water supply (Yoder Wells) is unlikely to be affected because of hydrogeological factors and the fact that the wells only use 1 part well water for 3 parts Lake Erie water in their distribution system.

° downgradient use is rendered even less likely because the Millcreek Township supervisors are willing to pass an ordinance restricting any future use.

° EPA has been confronted previously with similar decisions at other sites (2 within Region III; Wade and Drake Chemical) at which it has decided not to take active ground water remedial measures.

° available data indicate that ground water contamination is decreasing with time and is thus already naturally restoring itself.

° EPA's analysis of biodegradation of TCE into vinyl chloride which would increase the risk of concern from potential ingestion is incorrect. There do not appear to be any temporal or spatial trends in ground water data which indicate that biodegradation is occurring. In addition, current literature indicates that biodegradation of TCE should not occur in conditions present in Millcreek ground water.

Response:

The decision whether to pursue active ground water remedial measures involves not only a technical risk assessment, but a policy decision on EPA's part to protect currently unused aquifers. Because of the latter concern, Region III delayed the issuance of the ROD in order to obtain clear guidance from EPA-HDQS. EPA is currently uncertain about the long term effectiveness of institutional controls as a means of restricting ground water use. As a result, the Superfund program generally does not encourage ground water remedies with long time-frames. EPA's preference is for rapid restoration as may be achieved by pumping ground water (e.g. 2 years) as opposed to long term restoration which may take in excess of 100 years as calculated in Appendix A.

In response to specific comments, Region III collected additional ground water samples in December, 1985, to better characterize temporal trends in the eastern portion of the site. Sampling points were restricted to monitoring wells in the eastern portion of the site since this is the only area where contaminants of concern were detected.

With the December VOC sampling Region III believes that sufficient data is available to generally characterize the temporal ground water trends onsite.

In regard to the possibility that the upgradient public supply wells will be affected by the site, EPA could conceive of a problem during a prolonged severe drought. EPA will recommend periodic upgradient monitoring well sampling if these conditions should occur.

In regard to the decision of the Millcreek Township supervisors to restrict future downgradient use, refer to their recent letter to the Regional Administrator in Appendix RS-2.

In regard to other ROD decisions such as Drake and Wade, a decision on Drake has been deferred and ground water at Wade was not remediated because it lies adjacent to a major river (Delaware) where the areal extent of the aquifer was very restricted. Therefore, at this site there is a set of conditions distinct from Wade in both dimension and time of contamination, and in the technical feasibility of ground water restoration.

As previously mentioned, during the December resampling, EPA sampled two sump pumps on Harper Drive. In one sump pump hole, 15 ug/l of vinyl chloride was dectected. Subsequent CLP analysis detected 190 ug/l of vinyl chloride. The owner of the residence explained to the EPA project manager that he experiences periodic basement flooding during high water table conditions. The year-around presence of water in his sump hole indicates that his basement is very close to the ground water table as are other basements in the area. There is a possibility of volatilization of volatile organic chemicals such as 1,1,1-trichloroethane, vinyl chloride, and 1,2-dichloroethene from the water table into people's living space near the site. EPA intends to sample this basement air for volatiles where vinyl chloride was detected to confirm or deny this possibility.

EPA agrees that chlorination of drinking water raises the VCR associated with ingestion, but this matter is irrelevent to the decision to pursue active ground water measures. Chlorinating an already contaminated ground water supply would aggravate an already potentially harmful situation. Also, ground water contamination may last for decades, whereas an alternate means of disinfection could be utilized in a shorter period of time. Also, chlorination at present offers a benefit to consumers, whereas chemical VOC contamination offers none.

Finally, in regard to TCE biodegradation, the following response is provided. Although there is considerable controversy concerning the dehalogenation of short chain chlorinated aliphaties, specifically trichloroethene (TCE), and 1,1,1-trichloroethane (1,1,1-TCA) in environmental matrices, a growing body of evidence seems to indicate that biologically controlled dehalogenation can occur under favorable field or laboratory conditions. The Environ Corporation presented a summary of some available data that indicating that degradation occurs during reducing, anaerobic conditions in ground water and in aqueous laboratory samples. Recently, a number of researchers from EPA, Ecology and Environment, Inc. and the University of Missouri showed that anaerobic degradation of TCE can also occur in soil (Environ Sci-Technicol, 1985 - 19, 277-279). TCE and 1,1,1-TCA have also been observed to undergo dehalogenation under reducing anaerobic conditions in ground water near municipal landfills and solvent recovery facilities (Management of Uncontrolled Hazardous Waste Sites, November 1984, Page 217). It is interesting that at one solvent recovery site, the ground water table was shallow and within 15 feet of the surface as is Millcreek.

Environ stated that biodegradation of TCE in ground water at the Millcreek site is highly improbable because ground water at the site is probably anaerobic and monitoring data show no clear patterns suggestive of degradation. Region III disagrees with the latter statement and believes that monitoring data strongly suggests that conversion of TCE in 1,2-DCE and VCM is occurring. This finding is explained in more detail in Appendix A. Degradation is resulting hehalogenation which could conceivable be caused by hydroyses but is more like to be caused by biodegradation. When one compares the concentration of TCE to its breakdown

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products in umoles/1, a clear pattern emerges which not only suggests biodegradation but a probable source area for TCE.

On the question of the absence of a reducing environment, an assumption should not be made that just because an aquifer is shallow that it will always be aerobic. Besides, the literature indicates that although degradation occurs more rapidly during anaerobic conditions it may also occur in aerobic conditions at a much reduced rate. Region III attempted to determine the reducing potential in ground water with an Eh Meter but was unsuccessful due to the malfunctioning of the instrument. EPA did, however, obtain measurements of dissolved oxygen which varied from 1.60 to 4.30 ppm onsite. Most values were around 2.0 ppm. This indicates a low oxygen but not an anaerobic environment. It is interesting though that the concentrations of dissolved iron and manganese are very high in onsite ground water and that ground water seepage to drainage ditches appears as an orange tainted ooze. Orange seepage near landfill and swampy areas are indicative of iron and manganese oxidation occurring when water containing reduced iron and manganese come in contact with air. Dissolved iron and manganese are typically found in reduced forms when these two inorganics are detected in high concentrations in ground water. Therefore, the ground water at Millcreek could be in a reducing environment.

Even if the ground water is only slightly reduced, degradation could still occur at slower rates. One point that must be emphasized from laboratory studies is that laboratory tests are not sensitive enough to detect biodegradation rate slower than 0.001 days $^{-1}$. This is pointed out several times in Environ literature review. It must be remembered that ground water is an extremely slow medium and that persistent contaminants such as TCE typically persist for decades. Region III calculated the biodegradation rate of TCE into 1,2,-DCE and 1,2-DCE into VCM based on their predicted mass balances in the aquifer. The degradation rate for the former was estimated at 0.0003 days $^{-1}$ while the degradation rate for the latter was estimated at 0.000008 days $^{-1}$. While these appear as extremely low rates under laboratory conditions, they are meaningful in site ground water when reactions occur in years or decades intead of weeks in laboratory conditions. The point that TCE degradation can slowly proceed under weakly reducing or even anaerobic conditions is supported by a number of researchers as evidence in Environ literature survey. Another indication that biodegradation is occurring perhaps even as secondary metabolic reaction, is the presence of low concentrations of TIC hydrocarbons (1 ppm) in ground water in the eastern part of the site. Some studies have shown that microbes can use other organics in ground water as a carbon source and metabolize halogenated alkenes and alkanes by cometabolism.

Thus in conclusion, Region III believes it has sufficient evidence to document degradation of TCE and perhaps also 1,1,1-TCA. The literature provided by Environ provides for a better understanding of the process, but does not disprove that TCE, and 1,2-DCE are undergoing biodegradation at this site.

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° Soil Contamination

The other major area where IT submitted comments is on soil contamination, specifically the mobility of PCBs, PAHs, and metals. The following summarizes their comments.

° EPA has no scientifically valid data to assess VOC subsurface soil contamination since most VOC data was rejected during validation.

° A scientifically sound determination as to the need for soil removal to prevent ground water contamination cannot be made because analyses of waste fill and natural soils were not differentiated in the RI and no leachate data from direct field measurements or column tests exist. The existing data suggest soil removal is not necessary at this site.

° Adequate surface soil data does not exist to allow a delineation of "clean" vs. "contaminated" soil at the site.

° All highly mobile VOC may have already entered the ground water from the soil column.

° EPA's method of determining soil criteria from partition coefficients and completely reversible linear isotherms is not a scientifically valid approach. A better method is using batch or column desorption test or monitoring ground water samples to show that metals, PAHs, and PCBs are not migrating to the ground water.

° EPA has developed PCB soil criteria at other sites such as Lehigh Electric at 10 to 50 ppm yet the PCB criteria at the Millcreek is much lower.

Responses

Only a minor fraction of the VOC soil contamination data was rejected during validation. For the most part, surface and subsurface VOC data are believed to be accurate with the exception of the detection of acetone and methylene chloride. These two contaminants are common field and laboratory contaminants. The distribution pattern of acetone and methylene chloride in soil indicates that they are probably blank contaminants.

In regard to the determination of the need for soil removal to protect ground water, Region III will conduct additional field and laboratory work especially with more hydrophobic chemicals like PCBs and PAHs.

In regard to PCB soil contamination, surface soil is obviously contaminated with moderate levels of PCBs. Most PCB contaminated soil seem to be on Millcreek Township's property and in the south central portion of the site near the existing wetland. Test pit samples indicate

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PCBs in foundry sand at various depths. Test pit 016 contained PCB-1248 in natural soil at a concentration of 357 ug/kg. PCBs were detected in two borehole samples, one of which is offsite directly southeast of the site where previous bulk disposal is suspected. In both borings, PCBs were detected in natural soils at depths up to 10.5 feet.

Test pit and boring data is very limited, but there is an indication that PCBs have migrated in low concentrations in natural subsoil. Boring 20A indicates that PCB-1254 has migrated to the aquifer.

The fact that PCBs have not been detected in monitoring wells is expected. Most monitoring wells onsite and in suspected PCB contaminated areas lie below silty or clayey residual soil which would significantly attenuate PCB migration to the aquifer. Very few monitoring wells monitor perched water zones lying above clayey or silty residual soil in foundry sand. PCBs could be concentrated in these areas. Another reason why PCBs were not detected in ground water is that the CLP detection limits are too high. Depending on the isomer class, the aqueous detection limits for PCBs are either 0.5 or 1 ug/l. PCBs could cause long term health effects in the part per trillion range.

Therefore, it is inaccurate to state that PCBs have not migrated and are not contaminating ground water at levels which may be of concern. Likewise, it is also inaccurate to state that PCBs will not migrate in the future. Data needed to confirm or deny the presence of PCBs in ground water will be gathered during design.

It is not generally recognized that hydrophobic compounds will, in fact, migrate in moderate or low concentrations. PCBs were probably bulk disposed with solvents or oils which could have carried them through the soil column without significant adsorption. PCBs could then be released from soil via desorption or molecular diffusion. This occurrence is commonly observed in creosote pits or coal tar spills. It should be recognized also, that dissolved organic carbon competes with organic carbon in soil for hydrophobic adsorption sites. Hydrophobic compounds, especially phthalates, are commonly observed in landfill leachate where DOC can exceed 1000 mg/l. It should be noted that garbage was disposed throughout the site and in some areas where PCBs were detected. Garbage would naturally generate DOC and serve as an adsorbent for PCBs.

To confirm the presence of PCBs and other hydrophobic molecules in subsurface water, additional monitoring wells or lysimeters need to be installed and anaylsis performed with lower detection limits. These activities will be recommended during design along with desorption tests to aid in determining safe, residual PCB levels in foundry sand and soil.

In regard to PAH soil contamination, PAHs have been detected in surface soil throughout the site at concentrations exceeding 800 ppm in soil. The highest concentrations seem to be located in the southern and western portions of the site. The distribution pattern of PAH contamination indicates that they are the result of either massive and widespread bulk disposal or were used with foundry sand as a binding agent. Phenols are also commonly used in foundries and were detected with PAHs in many instances. It appears that for most parts of the site, PAH contamination was from the

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latter mechanism. IT suggest that PAH contamination could be from coal powered locomotives which were common in the past. Region III, though, believes that this is unlikely since PAHs are distributed in moderate concentrations throughout the soil column (a condition that would be unlikely because of strong hydrophobic binding) and because the highest concentrations of PAHs were detected on property which was only filled in 15 or 20 years ago.

The well boring samples may provide some indication of the transport of PAHs to the underyling residual soil. While this is important in respect to the potential for aquifer contamination it must be remembered that PAHs are distributed fairly evenly in foundry sand, and local perched water tables commonly encroach 1 or 2 feet into foundry sand. Perched water conditions may enhance the ability of PAHs to desorb from foundry sand and eventually migrate to the aquifer. It is believed that PAHs were not detected in ground water for the same reasons that PCBs were not.

Borings provide the best opportunity to observe any possible migration. In B-21A, several PAHs were detected below CLP detection limits (commonly about 1500-2000 ug/kg) at 9-10.5 feet. This may be significant since the fill only extends to 5.5 feet. The same situation was observed in boring 18. In boring 18, PAHs were detected in foundry sand at 3-4.5 feet at a concentration of 539,510 ug/kg. In the same boring at 4.5-6 feet, PAHs were detected but at concentrations below the CLP detection limit. Residual soil was found at 5.5 feet.

In regard to inadequate sampling data being available to delineate areas of contaminated soil, sufficient data is available to arrive at an order of magnitude cost estimates (+50% to -30%) of potential remedial alternatives. Region III agrees that additional sampling must be done during design to refine the estimates. Soil criteria is based on the physical, biological and chemical properties of the compound and soil to which it is adsorbed and on the area and depth of contamination. Only in this way can an estimate be made of contaminants percolating to the perched or real water table. These are tentative criteria which will be redeveloped during design based on additional sampling, field, and laboratory desorption tests.

In regard to all VOCs having already left the soil column, test pit samples reveal that low to moderate levels of VOCs still exist in soil in some areas. For instance, in test pit 7 at 2.5 feet, 733 ug/kg and 307 ug/kg of vinyl chloride and 1,2-dichloroethene were detected. Additional sampling will be conducted during design to more precisely define the full extent of VOC contaminated soil.

In regard to selecting lower PCB levels than had already been chosen in previous RODs, Region III is not bound to previous soil criteria selected by other Regions or within Region III itself. The proposed PCB criteria is a health based number for residential areas. This is appropriate because the site is frequented by hunters and children and borders residential areas.

Marshall's Run

° There is no current information on conditions in Marshall's Run. Thus the need, if any, for remedial action to limit surface water exposure cannot be determined.

Response

Both the onsite pond and Marshall's Run support wildlife and migratory fowl. Hunters use the swamp area during spring and fall for hunting waterfowl. Red tail fox and other wildlife have been seen onsite. Wildlife and fowl ingest surface water and phytoplankton such as duck weed growing in surface water. Also aquatic life such as shiners and small bass were found adjacent to the site in Marshall's Run. Rainbow trout and other cold water fish species use Marshall's Run for spawning at the mouth of Lake Erie. Existing data shows that the existing wetland and Marshall's Run are viable pathways to wildlife receptors.

Air

° No organic vapor or particulates analyses of air samples were conducted. Thus, no data exist to justify eliminating or reducing potential air exposure routes.

Response

EPA's consultant, the NUS Corporation, conducted volatile air monitoring during field reconnaissance test pitting and monitoring well drilling. During test pitting, the OVA meter registered over 1000 ppm thus signifying the presence of volatiles in high concentration. EPA did not collect tenax air samples though for subsequent analysis nor samples for particulate analysis. EPA's assessment of the risk posed by inhalation of particulates is based on the presence of known carcinogens in high concentrations in soil and the possibility of air dispersion of soil.
On windy days, especially in areas with little vegetative cover, significant air dispersal of dusts may occur.

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Response to Comments Other than PRPs

Erie County Department of Health

Comments:

Agree with proposed remedial action alternative except that soil exceeding determined criteria should be removed offsite instead of incorporated onsite under an impermeable cap because it would still be exposed to ground water.

Response:

Soil exceeding determined criteria would be hydraulically isolated from lateral ground water flow and percolating rainfall because soil would be placed above ground and then capped.

Millcreek Township

Comments:

Township favors the construction of a storm water retention basin on its parcel of land on the site to reduce offsite flooding.

Township acquired its parcel after the site was no longer being used as a landfill.

Township is concerned that placing a cap over contaminated soil will fail to contain hazardous substances within the site.

Township is concerned that Yoder Wells be protected and that adequate monitoring be maintained to ensure a safe water supply.

Response:

EPA will contruct a storm water retention basin onsite if it is needed to equalize ground water discharge to Marshall's Run, or is more cost-effective than backfilling the PCB contaminated areas with clean soil. A retention basin may also be needed to prevent erosion of PCB-containing residual soils during flooding conditions since PCB contaminated soils are within a 100 year flood plain.

EPA's enforcement personnel are aware of conditions involving purchase of property formerly owned by Ralph Reihl.

The cap will eliminate lateral ground water flow and greatly reduce rainwater percolation through contaminated soil. Complete hydraulic isolation is not technically feasible, but contaminants present in seepage should be in low concentrations and dilute to levels protective of public health by the time they migrate offsite.

EPA will work with the Erie County Department of Health to establish a periodic sampling strategy for the Yoder Wells. Monitoring wells both upgradient and downgradient of the site will also be sampled periodically to determine if offsite migration of ground water contaminants is occurring. If the Yoder Wells become threatened by the site, EPA or PADER will expeditiously take action to remedy the situation.

<u>Northwest Citizens for a Clean Environment Comments</u>:

Concerned that capping will not effectively eliminate the threat posed by the site. Request that EPA provide documentation that capping is an effective means to isolate wastes.

Believes that additional monitoring wells should be placed beyond the landfill.

Believes that ground water pumping and treatment should be established on a cycle of two year pumping to purify water.

Request more frequent monitoring well sampling.

Signs and a fence should be installed.

What specific responsibility will be assigned to agencies for operation and maintenance.

RI/FS states that a health survey is being developed and the citizens committee would like to be kept informed of its progress.

Request a more thorough written explanation of EPA's intent to develop site specific criteria.

Request that EPA specify responsibilities of EPA, DER, Erie County Health Department, and Millcreek Township during cleanup and monitoring.

Request that a time schedule be presented for cleanup.

Want responsible parties at fault to be prosecuted and bear the full costs of cleanup.

Favor the construction of a holding basin.

Concerned that recommended alternative may prove more costly in the long run.

If better technologies are available at a later time for site remediation that they be applied at the site.

Response

Capping has proved to be an effective method of greatly reducing rainwater infiltration at hazardous wastes facilities and is an established engineering practice. Capping must be strictly evaluated in this context and viewed as part of the overall cleanup strategy. By excavating contaminated soils capable of causing continued ground water contamination, EPA will greatly reduce the leachate generation caused by lateral ground water flow. By incorporating this contaminated soil underneath a clay cap with a permeability of no more than 10^{-7} cm/s, EPA will ensure leachate generation caused by rainwater percolation is kept at a minimum. Subsequent dilution in ground water will result in acceptable levels offsite.

EPA is evaluating the need for additional monitoring wells to ensure that any future release would be quickly recognized and remediated if necessary. Sampling of monitoring wells is an essential mechanism in determining the success of cleanup activity and thus EPA places great importance in the location and sampling frequency of wells.

EPA intends to install warning signs around the site when funds become available. Also, EPA is again evaluating the need for a fence around the site and will make a decision when funds become available.

EPA's Remedial Investigation/Feasibility Study consultant believes that removing most of the volatile organic contaminants from the ground water and pore spaces within the ground water may require removing 12 pore volumes of water which could take two years in time. If monitoring wells indicate that ground water remediation is accomplished in less than two years, pumping wells may be turned off. EPA will establish acceptable levels of ground water contamination and then pump to meet those levels.

Frequency of monitoring well sampling will be established to detect a ground water release as soon as possible.

It will be EPA's specific responsibility to develop a remedial action alternative and implement it through the Army Corps of Engineers. It is then DER's responsibility to provide future maintenance of the remedial action and sampling of the monitoring wells. The Erie County Department of Health will be responsible to periodically sample the Yoder Wells.

A health study has not been initiated at this site. Available data indicates that sufficient information is not available to warrant an epidemiological study. EPA may however request the Centers for Disease Control (CDC) assistance in conducting a study if additional soil sampling during design reveals information which may warrant it.

A more thorough explanation of soil criteria is contained in Appendix B.

A cleanup schedule is provided in the ROD.

Concerning the long-term cost of cleanup, EPA has attempted to be conservative in its calculations to minimize any possible risk in the future and thus reduce any possible future costs.

In regard to the use of better technology at a later date, EPA may consider this option if unforeseen events occur which produce a significant risk to public health or the environment and it is apparent that the technology originally used is not alleviating this risk.

Parent Teacher Association - Tracey Elementary School

Comments:

Ask that PRPs be prosecuted to the full extent of the law.

Ask that site area be completely fenced in.

If a storm water retention basin is constructed it should be fenced in if it could cause a potential hazard.

Wish for more extensive monitoring of the Yoder Wells.

If contaminants are air - dispersed during site activities, every precaution should be taken to prevent any possible health risks.

Response:

EPA is actively negotiating with the PRPs for implementation of the remedial design and action. If the PRPs refuse to implement the above, it is EPA's opinion that they are liable for costs of Superfund actions implemented at the site and are subject to the cost recovery provisions of Section 107 of CERCLA.

If a storm water retention basin is constructed EPA will ensure that it does not present an acute or chronic health risk.

EPA will work with the Erie County Department of Health to ensure that the wells are periodically sampled.

EPA will evaluate the possible risks posed by air dispersal of soil during remedial action. EPA will take sufficient precautions to ensure that air dispersal is kept to a minimum.

Section 1

Compounds Dectected in Ground Water and Their Physical and Chemical Properties

G299

ORIGINAL
(red)

Introduction

Establishment of Ground Water Goals at Millcreek

Ground water goals are established at the edge of a waste management area for hazardous constituents identified in ground water at levels which will not pose a substantial present or potential hazard to human health or the environment. In terms of human considerations, the regulations require assessments of toxicity, exposure pathways, and exposed population. The relevent factors listed in §264.94(b) include:

- physical and chemical characteristics of the waste,
- hydrogeological characteristics of the site,
- ground water flow rate and direction,
- proximity and withdrawal rates of ground water users,
- proximity of surface waters to the site,
- current and future uses of ground water in the area,
- current and future uses of surface waters in the area and any applicable standards,
- potential health risks of each waste constituent,
- persistence and permanence of potential adverse effects.

Threshold and non-threshold effects must be distinguished. Allowable concentrations of carcinogens should be within the 10^{-4} to 10^{-8} range. As a general rule, a level of 10^{-6} should be used as a point of departure to establish risk levels at the point of potential exposure. The risk level at the receptor would not be exceeded as long as the ACL at the waste management facility boundary is not exceeded.

When establishing goals, the following factors should be considered:

1) other environmental health factors borne by the affected population,
2) level of uncertainty in the data base and models used in the risk analysis,
3) expected effectiveness and reliability of man-made systems affecting exposure,
4) current and expected future use of the affected resources,
5) impacts upon the environment at any surface water to which the plume will be discharged,
6) the total population that is currently exposed or likely to be exposed in the future,
7) the cost effectiveness of the corrective action.

G-301

ORIGINAL
(red)

1. 40 CFR Part 261, Appendix VIII Compounds Detected in Ground Water During RI

Sustance	Number of Occurrences	Concentration Range (ug/l)
Total xylenes	1	L5
Methylene chloride	17	1 - 1,200Q
Chloroethane	3	5.5 - 44
1,1-dichloroethane	6	<5 - 260
1,2-dichloroethane (EDC)	2	6.0 - 7.6
1,1-dichloroethene	5	6.4 - 16
1,2-dichloroethene (1,2-DCE)	12	5.1 - 28,000
Trichloroethene (TCE)	6	5 - 300
1,1,1-trichloroethane (TCA)	6	6.9 - 960Q
Vinyl chloride (VCM)	11	6.1 - 220
Isophorone	1	73
Diethylphthalate	4	<10 - 41
Di-n-butyl phthalate	1	21
Iron (Fe)	18	386 - 20,800
Manganese (Mn)	21	100 - 1,920
Arsenic (As)	2	16 - 37
Barium (Ba)	16	128 - 312
Mercury (Hg)	1	0.22
Tin (Sn)	14	21 - 234
Zinc (Zn)	12	10 - 61
Aluminum (Al)	1	495
Cadmium (Cd)	1	18

2. Other Appendix VIII Compounds Detected in Ground Water by PA DER * and ERT†

Sustance	Number of Occurences	Concentration Range ug/l
Chloroform	1	400
Toluene	1	54
Ethyl Benzene	1	12

High concentrations of metals were detected during ERT investigation but not included because samples were not filtered.

* Pennsylvania Department of Environmental Resources

† EPA Environmental Response Team

Q - Lab qualifier indicating result quantified from a secondary ion

3. Tentatively Identified Compounds (TICs) Detected in Ground Water Samples During RI

Compound	Number of Occurrences	Concentration Range (ug/1)	Purity Range
hexahydro-2h-azepin-2-one	11	33-230	77.1-92.1
tetradecanoic acid	1	15	73.3
(Z)-9-octadecen-1-ol	1	37	67.1
hexadecanoic acid	2	55,36	79.9,79.4
3,7,11-trimethyl-(7,E)-2,6,10-dodecatrien-1-ol	3	21-51	44.8-66.6
5-methyl-4-nonene	4	93-1000	67.3-75.1
3,3,5-trimethyl cyclohexanol	1	39	80.9
(Z)-9-octadecenamide	1	55	68.8
2,6,10,15,19,23-hex - 2,6,10,14,18,23 - tetracosahexane	1	36	22.6
6-amino-hexanoic acid		375-93J	86.6-89.2
Toluene	7	323-440	N/A
1-octyne	1	24	67.3
9-octadecanal	1	37	63.4
2-methylpropyl-cyclohexane	1	21	78.4
dodecanoic acid	1	29	74.7
4(1,1-dimthyl ethyl) phenol	1	?	94.3

J - indicates values is an estimate

G-303

ORIGINAL
(red)

4. Molecular Weight of Appendix VIII Organic Compounds

Cas. No.	Compound	Physical or Chemical Property: Molecular Weight
1330-20-7	xylenes	106.16
75-09-2	methylene chloride	84.94
75-00-3	chloroethane	64.52
107-06-02	1,1-dichloroethane	98.96
75-35-4	1,2-dichloroethane	98.98
540-59-0	1,2-dichloroethene	96.94
79-01-6	trichloroethene	131.39
71-55-6	1,1,1-trichloroethane	133.41
75-01-04	vinyl chloride	62.50
78591	isophorone	135.0
84-66-2	diethylphlhalate	222.23
84-72-2	di-n-butyl phthalate	278.34
67-66-3	chloroform	119.38
108-95-2	toluene	94.11
100-41-4	ethyl benzene	106.16

5 Solubility of Appendix VIII Org~~g~~anic Compounds

Compound	Physical or Chemical Property: Solubility (mg/l)	Reference
O-xylene	175 A_t 20°	
P-xylene	198 A_t 25°C	
methylene chloride	13,200 to 20,000	Pearson & McConnell 1975 to Dean 1973
chloroethane	5,740 A_t 20°C	Verschueren 1977
1,1-dichloroethane	5,500 A_t 20°C	Verschueren 1977
1,2-dichloroethane	8,690 A_t 20°C	Verschueren 1977
1,1-dichloroethene	400 A_t 20°C	Pearson & McConnell 1975
1,2-dichloroethene	600 A_t 20°C	Verschueren 1977
trichloroethene	1100 A_t 20°C	Pearson & McConnell 1975
1,1,1-trichloroethane	480-4400 A^t 20°C	Pearson & McConnell 1975 to Verschueren
vinyl chloride	1.1 A_t 25°C,60	Verschueren 1977, Pearson and McConnell
isophorone	12,000	
diethyl phthalate	1000 A_t 32°C, 896 A_t 25°C	Peakall 1975, Wolfe et. al 1979
di-n-butyl phthalate	13 A_t 25°C	Wolfe et al 1979
chloroform	8200 A_t 20°C	Pearson & McConnell 1979
toluene	93,000 A_t 25°C	Morrison and Boyd 1973
ethyl benzene	152 A_t 25°C	Verschueren 1977

6. Log Kow for Appendix VIII Organic Compounds

Compound	Physical or Chemical Property: Log Octanol-Water Partition Coefficient (Kow)	Reference
O-xylene	2.77	
M-xylene	3.20	
P-xylene	3.15	
methylene chloride	1.25	Hansch *et al* 1975
chloroethane	1.54	Leo *et al* 1971
1,1-dichloroethane	1.79	Hansch *et al* 1975
1,2-dichloroethane	1.48	Radding *et al* 1977
1,1-dichloroethene	0.73	Radding *et al* 1977
1,2-dichloroethene	1.48	Calc. by Tute 1977
trichloroethene	2.29	Leo *et al* 1971
1,1,1-trichloroethane	2.17	Calculated from Tute 1971
vinyl chloride	0.60	Radding *et al* 1977
isophorone	1.7	Johnson 1978
diethyl phlhalate	3.22	Calc by Leo 1971
di-n-butyl phthalate	5.2	Calc by Leo 1971
chloroform	1.97	Hansch *et al* 1971
toluene	1.46	McCall 1975
ethyl benzene	3.15	Tute 1971

7. Log Koc values for Organic Appendix VIII Compounds

Compound	Physical or Chemical Property: Log Organic Carbon Partition Coefficient (Koc)	Reference
O-xylene	2.56	2
M-xylene	2.99	2
P-xylene	2.94	2
methylene chloride	1.38-1.28	1
chloroethane	1.51	1
1,1-dichloroethane	1.63	1
1,2-dichloroethane	1.51	1
1,1-dichloroethene	2.26	1
1,2-dichloroethene	2.26	1
trichloroethene	2.09	1
1,1,1-trichloroethane	2.74	1
vinyl chloride	0.39	1
isophorone	1.49	2
diethyl phthalate	3.01	2
di-n-butyl phthalate	4.99	2
chloroform	1.58	1
toluene	1.25	2
ethyl benzene	2.94	2

1. Derived by equation developed by Chiou et al for chlorinated hydrocarbons Log Koc = - 0.557 log S + 4.277, where S = solubility in umoles/l. Developed using 15 compounds with correlation coefficient of 0.99 and range of solubilities from 0.002 - 100,000 umoles/l.

2. Derived by equation developed by Karickhoff et al for aromatics, Log Koc = Log Kow 0.21. Correlation coefficient = 1.00 with Kow range from 100 - 4,000,000.

8. BCF values for Appendix VIII Organic Compounds

Compound	Physical or Chemical Property: Bioconcentration Factor (BCF)
O-xylene	75
M-xylene	159
P-xylene	146
methylene chloride	5
chloroethane	9
1,1-dichloroethane	14
1,2-dichloroethane	2
1,1-dichloroethene	8
1,2-dichloroethene	8
trichloroethene	32
1,1,1-trichloroethane	47
vinyl chloride	2
isophorone	7
diethyl phlhalate	117
di-n-butyl phthalate	5272
chloroform	19
toluene	8
ethyl benzene	146

Derived using equation developed by Veith *et al* Log BCF = 0.76 Log Kow - 0.23 with correlation coefficient of 0.83 and range of Kow from 7.9 to 8.1 x 10^6.

9. Vapor Pressure for Appendix VIII Organic Compounds

Compound	Physical or Chemical Property: Vapor Pressure (torr)	Reference
O-xylene	5 A_t 20°C	
M-xylene	6 A_t 20°C	
P-xylene	6.5 A_t 20°C	Pearson & McConnell 1975
methylene chloride	362.4 A_t 20°C	Verschueren 1977
chloroethane	1000 A_t 20°C	Verschueren 1977
1,1-dechloroethane	180 A_t 20°C	Verschueren 1977
1,2-dichloroethane	61 A_t 20°C	Verschueren 1977
1,1-dichloroethene	591 A_t 25°C	Verschueren 1977
1,2-dichloroethene	200 A_t 14°C	Verschueren 1977
trichloroethene	57.9 A_t 20°C	Pearson & McConnell 1975
1,1,1-trichloroethane	96.0 A_t 20°C	Pearson & McConnell 1975
vinyl chloride	2,660 A_t 25°C	Verschueren 1977
isophorone	0.38	Verschueren 1977
diethyl phlhalate	0.05 A_t 70°C	Patty 1963
di-n-butyl phthalate	0.1 A_t 115°C	Patty 1963
chloroform	50.5 A_t 20°C	Pearson & McConnell 1975
toluene	0.5293 A_t 20°C	Andon et al 1960
ethyl benzene	7 A_t 20°C	Verschueren 1977

10. Henry's Constants for Appendix VIII Organic Compounds

Compound	Physical or Chemical Property: Henry Constant (atm-M^3/mol)
O-xylene	3.991×10^{-3}
M-xylene	4.23×10^{-3}
methylene chloride	2.03×10^{-3}
chloroethane	1.479×10^{-2}
1,1-dichloroethane	4.261×10^{-3}
1,2-dichloroethane	9.142×10^{-4}
1,1-dichloroethene	1.88×10^{-1}
1,2-dichloroethene	4.252×10^{-2}
trichloroethene	9.101×10^{-3}
1,1,1-trichloroethane	$3.511 \times 10^{-2} - 3.830 \times 10^{-3}$
vinyl chloride	3.65 - 199
isophorone	5.63×10^{-6}
diethyl phlhalate	1.632×10^{-5}
di-n-butyl phthalate	2.817×10^{-3}
chloroform	2.883×10^{-3}
toluene	7.048×10^{-7}
ethyl benzene	6.435×10^{-3}

Derived using equation $H=(Pvp \times M.W)/(760 \times S)$ where
Pvp = vapor pressure of compound (mm Hg)
M.W = Molecular weight in (gm/mole)
S = Solubility in (mg/l)

11. Volatilization Half-Life of Appendix VIII Organic Compounds

Compound	Physical or Chemical Property: Volatilization Half-Life (Hours)
O-xylene	2.4
M-xylene	2.4
chloroethane	1.3
1,1-dichloroethane	2.3
1,2-dichloroethane	2.5
1,1-dichloroethene	2.2
1,2-dichloroethene	2.2
trichloroethene	2.6
1,1,1-trichloroethane	2.7 - 2.6
vinyl chloride	1.3
diethyl phthalate	24.0
di-n-butyl phthalate	3.9
chloroform	2.5
toluene	310
ethyl benzene	2.3

Note: Calculations were performed by EPA's GEMS modeling system in Research Triangle Park where water depth = 1 foot, wind velocity = 10 mph, water velocity = 0.25 ft/s and ambient temperature = 79°F.

G311

ORIGINAL
(red)

12. Estimated Log Kow values for Tentatively Identified Compounds (TICs)

Compound	Physical or Chemical Property: Log Kow
Hexahydro-2h-azepin-2-one	*
Tetradecanoic acid	6.26
(Z)-9-octadecen-1-ol	7.66
Hexadecanoic acid	7.30
3,7,11-trimethyl-(7,E)-2,6,10-dodecatrien-1-01	3.17
5-methyl-4-nonene	4.50
3,3,5-trimethyl cyclohexanol	2.12
(Z)-9-octadecenamide	7.99
2,6,10,15,19,23-hex-2,6,10,15,19,23-tetracosahexane	*
6-amino-hexanoic acid	0.05
1-octyne	2.22
9-octadecanal	8.43
2-methylpropyl-cyclohexane	5.55
dodecanoic acid	5.38
4 (1,1-dimethyl ethyl) phenol	3.74

Valves derived using Leo's Fragment Constant method described in Handbook of Chemical Property Estimation Methods by Lyman, Reehl, and Rosenblatt.

* Not determined because unable to find molecular structure in literature.

13. Estimated Log Koc values for TICs

Compound	Physical or Chemical Property: Log Koc
Hexahydro-2h-azepin-2-one	?
Tetradecanoic acid	6.05
(Z)-9-octadecen-1-ol	7.45
Hexadecanoic acid	7.09
3,7,11-trimethyl-(7,E)-2,6,10-dodecatrien-1-01	2.96
5-methyl-4-nonene	4.29
3,3,5-trimethyl cyclohexanol	1.91
(Z)-9-octadecenamide	7.78
2,6,10,15,19,23-hex-2,6,10,15,19,23-tetracosahexane	?
6-amino-hexanoic acid	-0.16
1-octyne	2.01
9-octadecanal	8.22
2-methylpropyl-cyclohexane	5.34
dodecanoic acid	5.17
4 (1,1-dimethyl ethyl) phenol	3.53

Values derived using equation developed by Karickhoff et al Log Koc = Log Kow - 0.21 with correlation coefficient of 1.00 and Kow range of Log 2 to log 6.6.

Table A1-1

Physical and Chemical Properties of [illegible] Compounds Detected in [illegible] Network

Prepared By
Approved By

	Molecular weight (g/mole)	Solubility (mg/L)	Log Kow	Log Koc	BCF	Vapor Pressure (torr)	Henry's Constant (atm-m³/mol)	Volatilization Half-life (hrs)
HSL compounds								
chloroethane	64.52	5740	1.43	1.52	9	1000	1.48×10⁻²	[illegible]
1,1-dichloroethane	98.96	5500	1.79	1.48	[illegible]	180	4.31×10⁻³	[illegible]
1,2-dichloroethene	96.95	6300	1.48	[illegible]	2	61	2.14×10⁻²	2.5
1,1,1-trichloroethane	133.41	480–4400	2.17	2.18	[illegible]	[illegible]	3.23×10⁻³	[illegible]
vinyl chloride	62.50	1.1×10³	0.60	0.39	[illegible]	2660	4.19	[illegible]
1,1-dichloroethene	96.94	400	1.48	2.26	[illegible]	591	1.90×10⁻¹	[illegible]
1,2-dichloroethane	98.96	8690	1.48	2.28	[illegible]	200	[illegible]×10⁻³	[illegible]
trichloroethene	131.40	1100	2.29	2.00	[illegible]	[illegible]	9.10×10⁻³	3.6
methylene chloride	84.94	13,200–20,000	1.25	1.27–1.30	5	362.4	[illegible]	[illegible]
diethyl phthalate	222.20	1000	3.22	2.34	117	0.05	1.6×10⁻³	[illegible]
o-xylene	106.17	175	2.77	2.11	24	[illegible]	3.78×10⁻³	2.4
m-xylene	106.17	[illegible]	3.20	2.22	157	6	[illegible]	[illegible]
p-xylene	106.16	198	3.15	2.31	146	[illegible]	4.20×10⁻³	2.4
cyclohexanone	[illegible]	[illegible]	1.20	1.19	7	[illegible]	[illegible]	[illegible]
di(n-butyl)phthalate	[illegible]	13	5.20	4.19	5924	0.1	[illegible]×10⁻³	3.7
chloroform	119.38	8200	1.97	1.52	10	152	2.88×10⁻³	[illegible]
toluene	92.14	535	2.74	1.95	19	28.1	7.45×10⁻³	3.0
ethyl benzene	106.16	152	3.15	2.74	1.78	7	6.44×10⁻³	3.3
TICs								
hexahydro-1H-azepin-[illegible]								
tetradecanoic acid	228		6.26	5.45	24,000			
(Z)-9-octadecen-1-ol	270		7.46	7.43	410,000			
hexadecanoic acid	256		7.30	7.21	135,000			
3,7,11-trimethyl-(Z,E)-2,6,10-dodecatrien-1-ol	222		5.77	2.86	100			
5-methyl-4-nonene	142		4.50	4.09	1400			
3,3,5-trimethylcyclohexanol	142		2.12	1.91	14			
(Z)-9-octadecenamide	270		7.79	7.20	460,000			
2,6,10,15,19,23-hexamethyl-2,6,10,14,18,22-tetracosahexaene								
6-amino-hexanoic acid	132		0.04	-0.16	0.3			
1-octyne	110		3.02	2.47	19			
4-octadecanol	270		8.43	7.22	71,000			
2-methylpropyl-cyclohexane	140		5.53	5.14	41,800			
dodecanoic acid	200		5.58	5.17	44,100			
4(1,1-[illegible]methyl ethyl)phenol	150		3.44	3.43	227			

ORIGINAL
(red)

14. Estimated BCFs for TICs

Compound	Physical or Chemical Property: BCF
Hexahydro-2h-azepin-2-one	?
Tetradecanoic acid	22,300
(Z)-9-octadecen-1-ol	258,000
Hexadecanoic acid	138,000
3,7,11-trimethyl-(7,E)-2,6,10-dodecatrien-1-01	100
5-methyl-4-nonene	1020
3,3,5-trimethyl cyclohexanol	16
(Z)-9-octadecenamide	460,000
2,6,10,15,19,23-hex-2,6,10,15,19,23-tetracosahexane	?
6-amino-hexanoic acid	0.5
1-octyne	19
9-octadecanal	994,000
2-methylpropyl-cyclohexane	6430
dodecanoic acid	4840
4 (1,1-dimethyl ethyl) phenol	271

ORIGINAL
(red)

DRAFT

TABLE 7-12

HSL ORGANIC AND INORGANIC SUBSTANCES IDENTIFIED IN GROUNDWATER SAMPLES
[12 Samples Collected By ERT (12/5/82)]
MILLCREEK SITE

Substance	Number of Occurrences	Concentration Range (ug/l)
trichloroethene	1	27
1,1-dichloroethane	3	29-68
1,2-dichloroethene	6	93-26,000
1,1,1-trichloroethane	3	36-100
vinyl chloride	3	81-110
chloroform	1	400
methylene chloride	2	22-470
toluene	1	54
ethylbenzene	1	12
lead	13	50-500
cadmium	3	13-40
chromium	10	25-1,120
arsenic	1	90
mercury	1	500
copper	12	40-190
antimony	8	250-500
nickel	10	50-850
zinc	12	40-1,450
tellerium	1	310

ORIGINAL
(red)

DRAFT

TABLE 7-14

HSL ORGANIC AND INORGANIC SUBSTANCES IDENTIFIED IN GROUNDWATER SAMPLES MILLCREEK SITE

[21 Samples Collected by NUS (8/14/84)]

Substance	Number of Occurrences	Concentration Range (µg/l)
total xylenes	1	<5
methylene chloride	17	<5–1,200Q
chloroethane	3	5.5–44
1,1–dichloroethane	6	<5–280
1,2–dichloroethane	2	6.0–7.8
1,1–dichloroethene	5	6.4–16
1,2–dichloroethene	12	5.1–29,000
trichloroethene	6	5–300
1,1,1–trichloroethane	6	6.9–960Q
vinyl chloride	11	6.1–220
isophorone	1	73
diethylphthalate	4	<10–41
di–n–butylphthalate	1	21
iron	18	386–20,800
manganese	21	100–1,920
arsenic	2	16–37
barium	16	128–312
mercury	1	0.22

TABLE 7-14
HSL ORGANIC AND INORGANIC SUBSTANCES IDENTIFIED IN GROUNDWATER SAMPLES
MILLCREEK SITE
[21 Samples Collected by NUS (8/14/84)]
PAGE TWO

Substance	Number of Occurrences	Concentration Range (µg/l)
tin	14	21-234
zinc	12	10-61
aluminum	1	495
cadmium	1	18

< denotes that chemical was detected below the detection limit indicated.
Q indicates that concentration was quantitated with a secondary ion.

ORIGINAL
(red)

DRAFT

TABLE 7-15

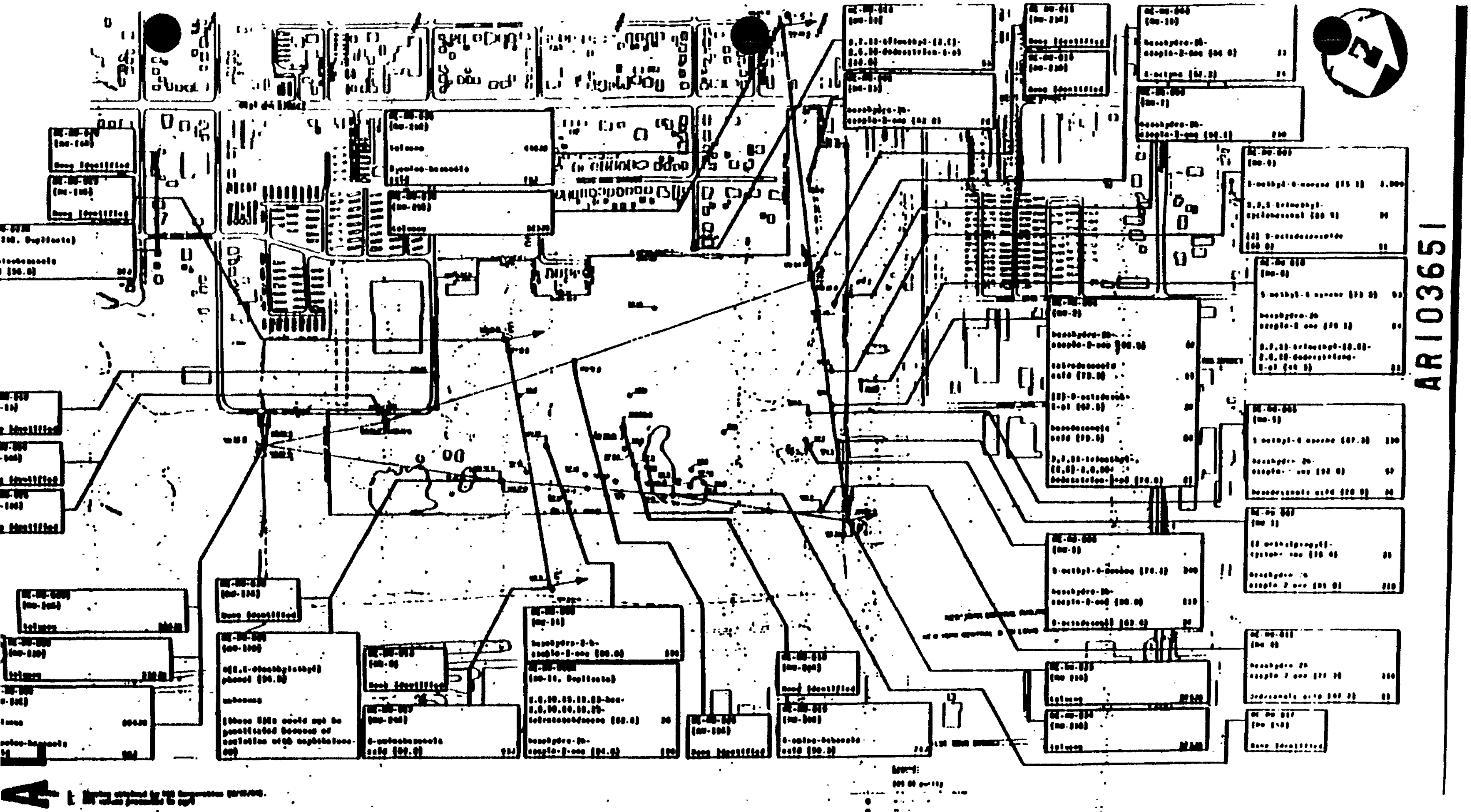
pH VALUES FOR GROUNDWATER
(MARCH 29, 1985)
MILLCREEK SITE

Well No.	pH
1	7.23
2	7.02
4	7.49
5	7.24
6	6.94
7	7.00
8	7.90
9	6.88
10	6.85
11	6.60
12	7.68
13	6.66
14	7.42
15A	7.84
16A	11.65*
16B	7.7
17A	7.02
17B	7.24
18A	10.32*
18B	7.35
19A	7.94
20A	10.01*
20B	7.24
21A	7.46
21B	7.33
22A	8.26
22B	7.66
22C	7.43
23A	7.55
23B	6.71
24A	7.61
25A	7.09
25B	5.53

Note: Average value for pH = 7.3. Standard deviation = 0.5.

* Not included in statistical analysis. Grout interference possible.

ORIGINAL
(red)



TENTATIVELY IDENTIFIED COMPOUNDS, GROUNDWATER SAMPLES

MILLCREEK SITE, MILLCREEK TWP., PA

SCALE 1" = 500'

FIGURE 7-13

NUS CORPORATION

A Halliburton Company

ORIGINAL
(red)

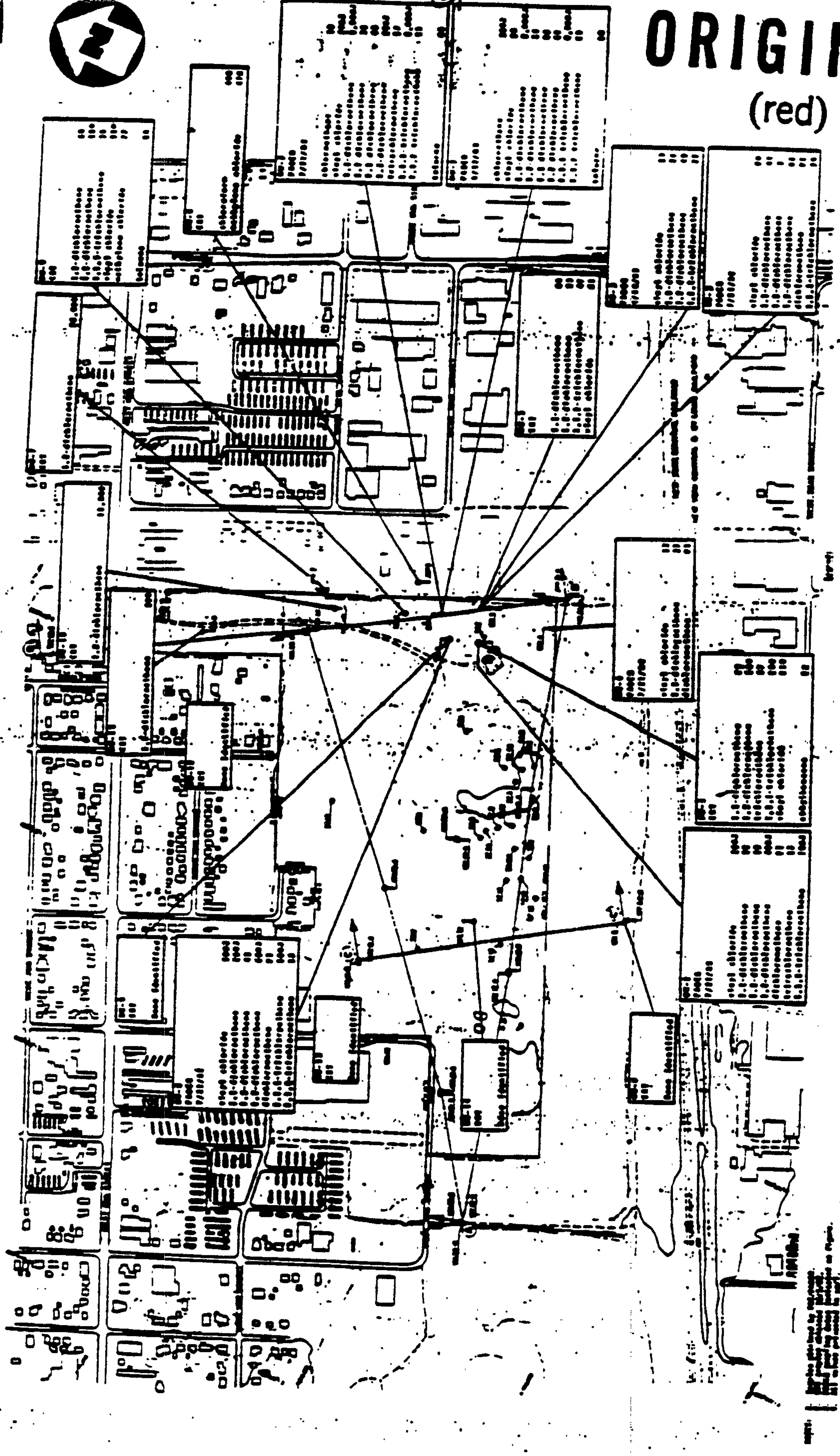


FIGURE 7-9

NUS CORPORATION
A Halliburton Company

500 0 500
SCALE IN FEET

HSL ORGANIC COMPOUNDS, GROUNDWATER
MILLCREEK SITE, MILLCREEK TWP., PA
SCALE 1"=500'

ORIGINA
(red)

TABLE 4
VOLATILE ORGANIC RESULTS FROM GC SCREENING OF GROUNDWATER, SURFACE WATER, AND RESIDENTIAL SUMP SAMPLES
DECEMBER 9-10, 1985
MILLCREEK SITE
PAGE 1 of 2
(UG/L)

SAMPLE NO. LOCATION PARAMETER	METHOD BLANK-1	MI-RW-000 FIELD BLANK	METHOD BLANK-2	MI-RW-001 SUMP SAMPLE 1325 HARPER DRIVE	MI-RW-001A (DUPLICATE) 1325 HARPER DRIVE	MI-RW-002 SUMP SAMPLE 1322 HARPER DRIVE	METHOD BLANK-3	MI-SW-201 MARSHALL'S RUN SOUTHEAST CORNER OF SITE	MI-SW-202 MARSHALL'S RUN AT WEST 12TH STREET	MI-SW-203 MARSHALL'S RUN OPPOSITE MW-10	MI-SW-203A (DUPLICATE)
VINYL CHLORIDE	ND	ND	ND	•	15	ND	ND	ND	3J	ND	ND
CHLOROETHANE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHENE	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1-DICHLOROETHANE	ND	1JD	1J	ND	1JDR	ND	1J	1JDR	110	1JDR	ND
1,2-DICHLOROETHENE	ND	ND	ND	33	50	ND	ND	1J	10	1J	ND
1,2-DICHLOROETHANE	ND	1J	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,1,1-TRICHLOROETHANE	3	ND	2J	4DR	6DR	2JDR	8	14DR	34DR	9DR	6DR
1,1,2-TRICHLOROETHENE	4	2JDR	4	8DR	15DR	4DR	14	19DR	17DR	10DR	7DR

ORIGINA
(red)

TABLE B

VOLATILE ORGANIC RESULTS FROM CLP ANALYSIS OF GROUNDWATER, SURFACE WATER, AND RESIDENTIAL SUMP SAMPLES
DECEMBER 9-10, 1986
MILLCREEK SITE
(ug/l).

SAMPLE No.: LOCATION: PARAMETER	MI-MW-201 MW-11	MI-MW-116 MW-23B	MI-MW-104 MW-2	MI-MW-104A MW-2 (Duplicate)	MI-MW-134 MW-21B	MI-MW-000 Field Blank	MI-RW-000 Field Blank	MI-RW-001 Sump Sample 1326 Harper Drive	MI-RW-001A (Duplicate)	MI-SW South Corner
Vinyl Chloride	38	220*	ND	ND	ND	ND	ND	94J	190J	ND
Chloroethane	ND	ND	97	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	1200	1200	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene	140	460*	ND	23	ND	ND	ND	74	90	N
1,1,1-Trichloroethane	ND	ND	2300J	2700J	ND	ND	ND	ND	ND	5J
Trichloroethene	ND	73J	ND	ND	ND	ND	ND	ND	ND	ND
Carbon Disulfide	ND	ND	ND	ND	ND	ND	6J	ND	ND	ND

NOTES:
ND - Not detected.
J - Estimated; data can be used as reported.
* - Results from diluted sample analyses (dilution of 1:5).

Section 2

Soil and Hydrogeologic Characteristics

1. Soil and Rock Characteristics

The Millcreek Site covers a 75 acre area and was developed in an existing marshy area. The site area though had been mapped by the Soil Conservation Service prior to the placement of fill. Figure 1(A) (Soils Map) illustrates the soils that existed in the area prior to landfilling.

The surface of the site is covered with foundry sand from local ferrous and non-ferrous foundaries. The fill is well drained with rapid permeability. The average depth of fill is about 7 feet.

The natural soils represent an interface between the waste and nature subsoils. The following is a description of soil types illustrated in figure one:

- **Halsey Series** -
  - deep, poorly drained
  - slowly to moderately permeable (0.2 to 6.3 inches per hr)
  - pH 5.8 to 7.0
  - high concentrations of organic matter
- **Freedon/Rexford Series**
  - deep (>72 inches), poor drained
  - pH 5.8 to 6.2
  - permeability is 0.2 to 6.3 inches per hour
- **Conotton**
  - deep, moderately well drained
  - permeability 2 to 20 inches per hour
  - pH 5.6 to 6.0

Generally, surficial and near-surface natural deposits consist of alternating layers of fine sands and silts, with occasional clayey or gravely zones. These are glaciolacustrine deposits, deposited by glacial lakes that were forerunners to Lake Erie. The sandy deposits were visually classified during drilling operations as poorly graded (SW or SP soils). Silty deposits were classified as silt or sandy silt (Ml or SM soils), using the Unified Soil Classification System. The thickness of these deposits onsite ranges from 15 feet to 28 feet. Offsite borings, especially downgradient show a greater thickness. Geologic cross section show that the sediments dip from east to west but the surface slopes to the north. The surface of the sediment controls ground water flow. See Figures 2(A) and 3(A).

A continuous layer of till deposits underlies the glaciolacustrine deposits ranging from 12 to 43 feet in thickness and lies directly on top of bedrock. The till is very dense, fine grained soil consisting primarily of silt, with minor amounts of sand and gravel. Till samples were visually classified for the most part as ML or SM soils. Physical Testing Results of till samples

FIGURE 1(A)

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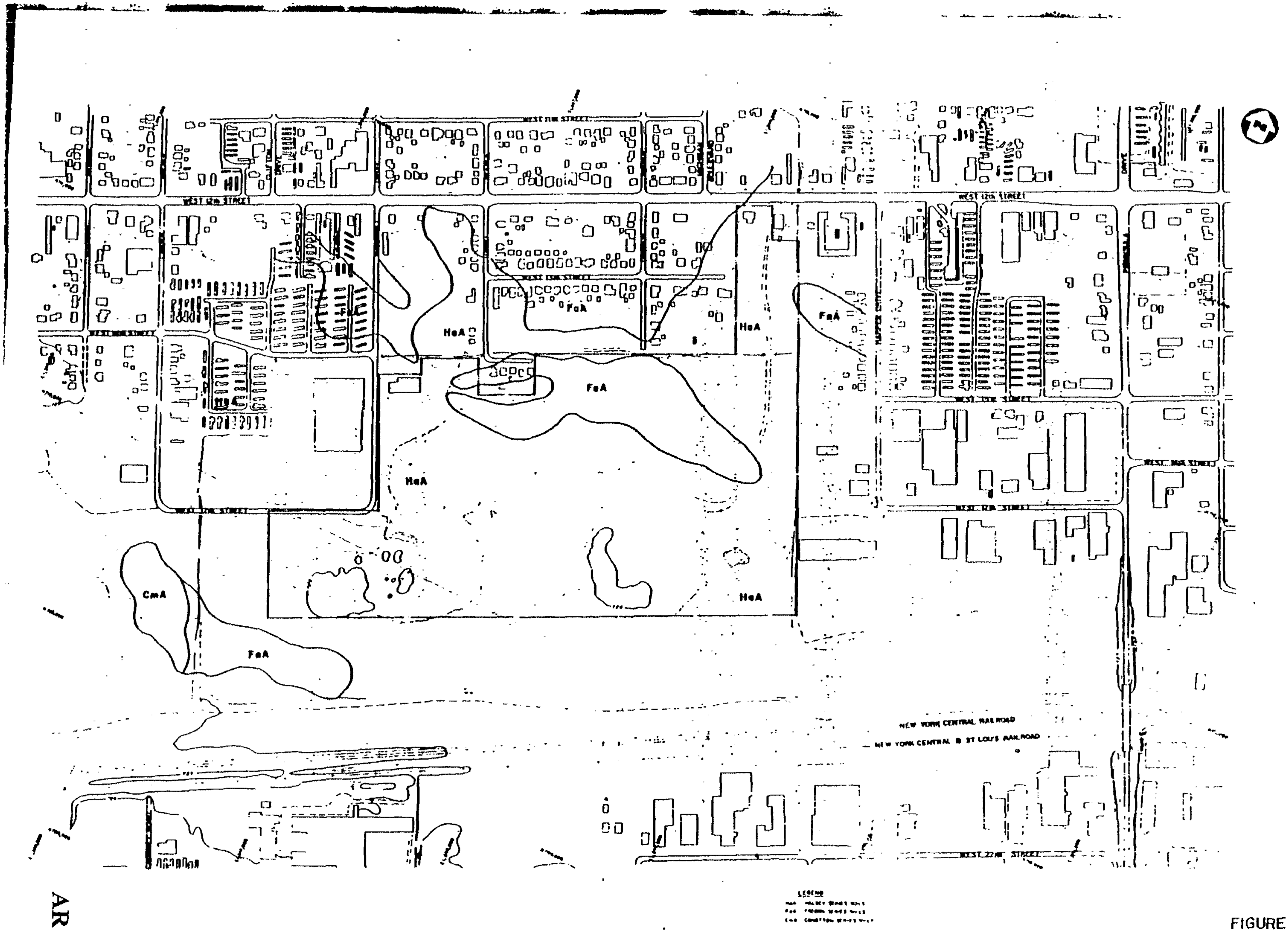
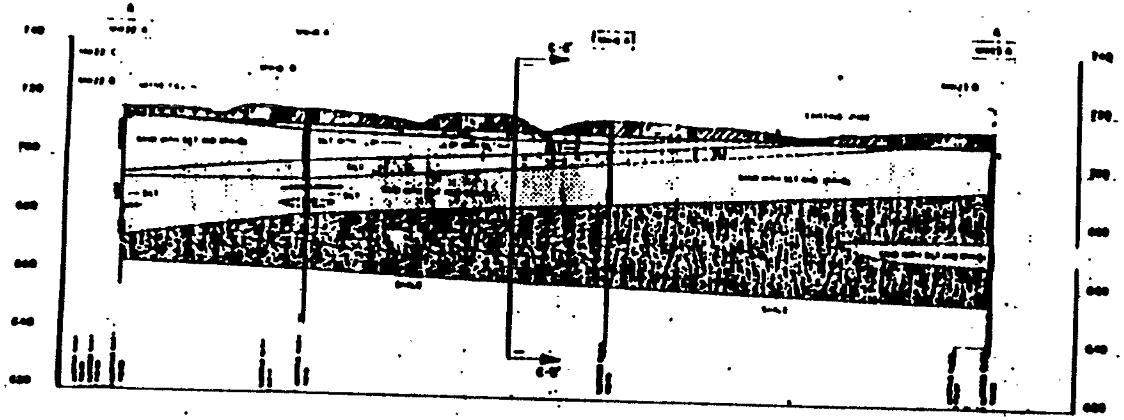
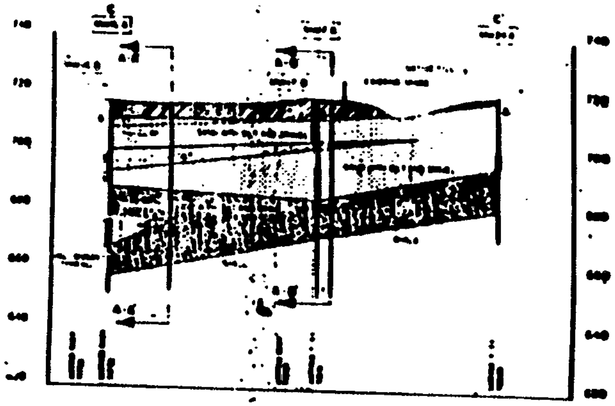
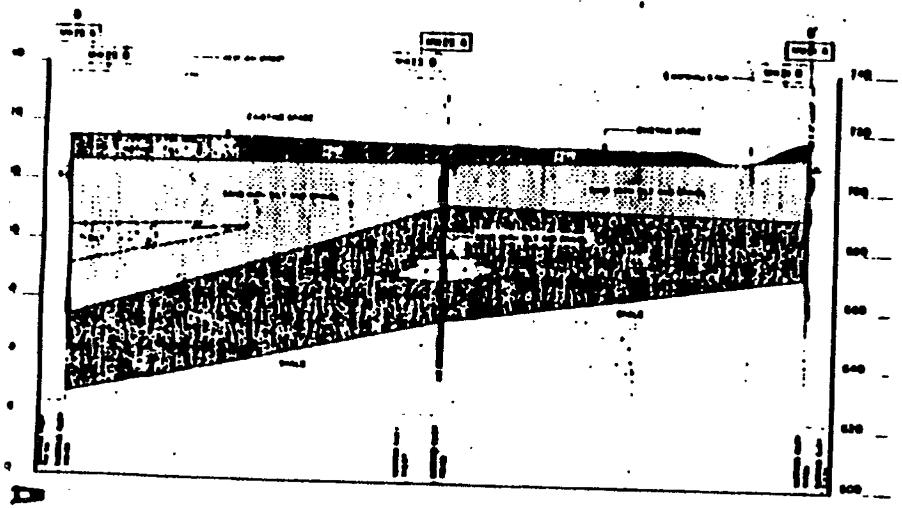
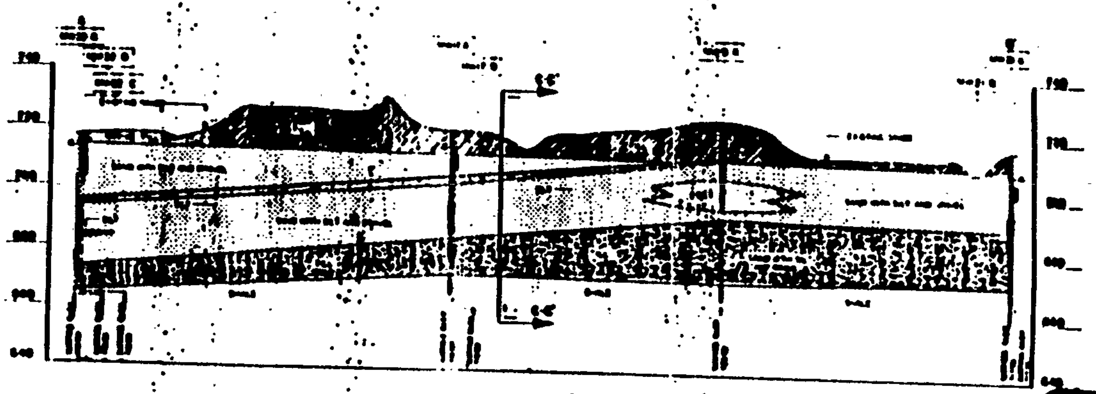


SOILS MAP
MILLCREEK SITE, MILLCREEK TWP.
SCALE: 1"=500'


CROSS SECTION A-A'


CROSS SECTION C-C'


CROSS SECTION B-B'


CROSS SECTION A-B'

ORIGINAL
(red)

GEOLOGIC CROSS SECTIONS
MILLCREEK SITE, MILLCREEK 1 PA

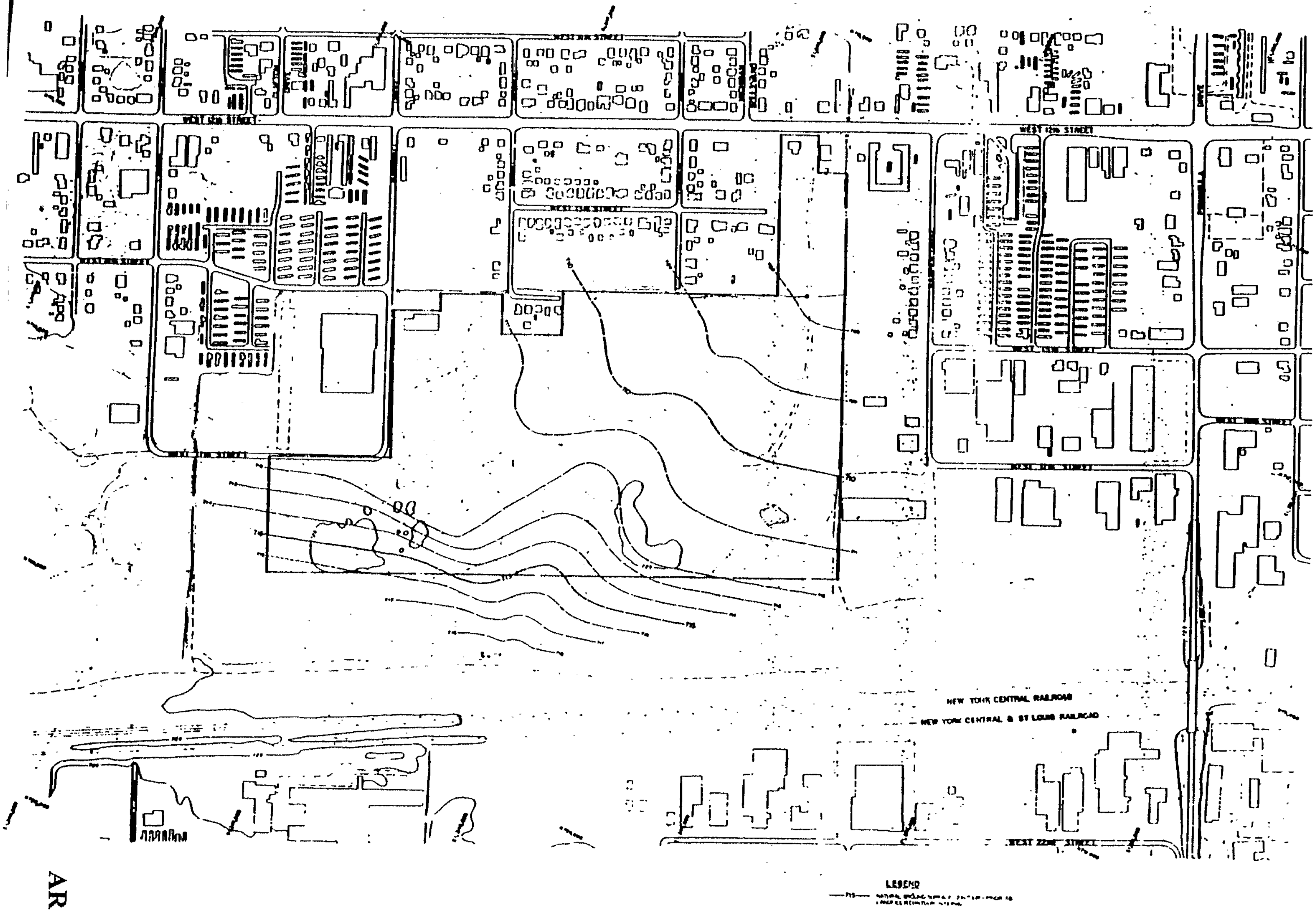


FIGURE 3(A)

CONTOUR MAP OF NATURAL GROUND SURFACE
MILLCREEK SITE, MILLCREEK TWP. PA
SCALE: 1" = 500'

NUS CORPORATION

are presented in Table 2(A).

Soil characteristics such as Total Organic Carbon (TOC) and Cation Exchange Capacity (CEC) are tabulated in Tables 3(A) and 4(A).

Longtudinal and Transverse dispersivity values of 21 and 4 meters respectively were chosen from Long Island glacial deposit on Table 4(A) because it most closely approximated the subsurface conditions at the Millcreek Site.

Other soil properties such as the saturated thickness and hydraulic conductivity are presented in Tables 6(A) and 7(A) respectively. Effective porosity was estimated at 15%.

DRAFT

2oc

TABLE 2(A)

PHYSICAL TESTING RESULTS, TILL SAMPLES
MILLCREEK SITE

Sample No.	Percent Gravel	Percent Sand	Percent Silt & Clay	Natural Moisture Content	Liquid Limit	Plastic Limit	Plasticity Index	Unified Soil Classification	Hydraulic Conductivity
DT-1, B-23B	14%	20%	66%	15.4%	18.3	16.7	1.6	ML	7.7×10^{-7} cm/sec
DT-3, B-24A	3%	10%	87%	19.9%	24.6	19.7	4.9	ML-CL	4.6×10^{-7} cm/sec
B-23A, 21.0-22.5'	4%	18%	78%	-	19.8	17.5	2.3	ML	-
B-23A, 48.0-52.0'	21%	51%	28%	-	NL	NP	-	SM	-

NL - Non Liquid
NP - Non Plastic
ML - Silt with Sand
ML-CL - Silt to Silt/Lean Clay
SM - Silty Sand with Gravel

Table 3(A)

Total Organic Carbon (TOC) Content of Soils and Sediments

Sample No.	Description	TOC in % (Wet basis)
SD-101	Sediment sample near MW-18 taken to determine TOC of residual sediment.	1.050
SD-102	Sediment sample at culvert in west Branch of Marshalls Run near West 17th street.	0.636
SD-103	Sediment sample at SW-101 in East Branch of Marshalls Run.	1.740
SD-104	Sediment Sample at Presque Isle (background)	0.797
SD-105	Sediment Sample at Presque Isle (background)	
SO-106	Soil Sample in PCB pit A_t 1-1.5 ft.	1.360
SO-107	Soil Sample in PCB pit A_t 2-3 ft.	1.170
SO-108	Soil Sample in PCB pit A_t 4.5-5 ft.	1.660
SO-109	Soil Sample in PCB pit at 6 ft. (surface of clay layer)	0.741
SO-110	Soil Sample in PCB pit at 8-9 ft. (ground water zone)	0.476
SO-111	Soil Sample near drum disposal area	2.790
SO-111A	Duplicate of SO-11	3.460
SO-112	Soil Sample in Southwestern portion of site near high NMA area	1.780
SO-113	?	1.190
SO-128	?	0.791

- Mean sediment TOC of Marshalls Run = (SO-102 + SO-103)/2 = 1.188%.
- Mean residaul soil or sediment at base of fill = (SO-101 + SO-109)/2 = 0.8955%
- Mean fill TOC = (SO-106 + SO-107 + SO-108 + SO-111 + SO-111A + SO-112 + SO-113 + SO-128)/8 = 1.775%.

Table 4(A)

Cation Exchange Capacity of Sediment and Soil

Sample No.	CEC in meg/100g
SD-101	9.7
SD-102	3.6
SD-103	10.6
SD-104	3.2
SD-105	7.5
SO-106	18.8
SO-107	3.9
SO-108	8.5
SO-109	3.9
SO-110	3.5
SO-111	9.4
SO-111A	7.8
SO-112	9.4
SO-113	11.9
SO-128	5.9

For sample description, see Table 3(A).

° Mean sediment CEC of Marshalls Run = (SO-102 + SO-103)/2 = 7.1 meg/100g

° Mean residual soil or sediment CEC at base of fill = (SD-101 + SO-109)/2 = 6.8 meg/100g

° Mean fill CEC = (SO-106 + SO-107 + SO-108 + SO-111 + SO-111A + SO-112 + SO-113 + SO-128)/8 = 5.55 meg/100g

(From Isherwood, 1981).

ORIGIN (red)

Reference	Setting	a_L, m	
Konikow, 1977	Rocky Mtn. Arsenal alluvial sediments	30.5	30.5
Konikow and Bredehoeft, 1974	Arkansas River valley, Colo., alluvial sediments	30.5	9.1
Helweg and Labadie, 1977	California	30.5	9.1
Gupta et al., 1975	Sutter Basin, California alluvial sediments	80-200	8-20
Pinder, 1973	Long Island glacial deposits	21.3	4.3
Bredehoeft and Pinder, 1973	Brunswick, Georgia limestone	61	20
Robertson, 1974	Snake River, Idaho fractured basalt	91	136.5
Grove, 1977	Idaho fractured basalt	91	91
Ahlstrom et al., 1977	Hanford site, Washington fractured basalt	30.5	18
Robson, 1978	Barstow, California alluvial sediments	61	0.18
Fried, 1975	Alsace, France alluvial sediments	15	1
Schwartz, 1977	Alberta glacial till	3.0-6.1	0.6-1.2
Segol and Pinder, 1976	Florida (SE)	6.7	0.7
Robson, 1974	Barstow, California alluvial deposits	61	18
Fried, 1975	Lyons, France alluvial aquifer	12	4
Rabinowitz and Gross, 1972	Roswell Basin, New Mexico limestone	21.3	--[a]
Robertson and Barraclough, 1973	Idaho Falls, Idaho lava flows and sediments	91	137

Table 6(a)

Estimation of Saturated Thickness in Upper and Lower Ground Water Zones of Aquifer (feet)

	Ground Elem.	Residual Soil Elem.	Till Elem.	Water Table Element	Screened Internal	Saturated thickness
1	716.58	?	?	708.93 - 711.39	?	?
2	714.96	?	?	708.44 - 709.85	?	?
3	713.00	?	?	708.85 -	?	?
4	713.94	?	?	709.78 - 711.39	?	?
5	716.32	?	?	708.40 - 711.10	?	?
6	713.52	?	?	708.07 - 709.36	707.52 - 697.52	?
7	710.64	?	?	706.57 - 708.14	704.64 - 694.64	?
8	720.09	?	?	717.06 - 718.78	714.59 - 704.59	?
9	713.41	?	?	707.98 - 710.12	707.41 - 697.41	?
10	713.45	?	?	706.79 - 709.27	706.45 - 696.45	?
11	713.42	?	?	705.03 - 707.42	706.42 - 696.42	?
12	712.59	?	?	705.75 - 709.26	706.59 - 696.59	?
13	713.05	?	?	711.50 - 713.01	708.05 - 698.05	?
14	715.95	?	?	713.11 - 714.39	710.96 - 700.96	?
15A	725.59	711.59	693.59	712.74 - 714.19	716.59 - 706.59	6' in upper area
16A	717.55	711.55	667.55	708.60 - 710.82	674.55 - 669.55	4.3 in lower zone - 11 in till
16B	717.66	711.66	667.55	710.42 - 712.17	699.66 - 689.66	10.64 in upper zone
17A	719.90	711.90	683.6	713.82 - 715.13	695.9 - 685.9	18.3 in lower zone
17B	719.88	711.88	683.6	714.32 - 715.81	710.88 - 705.88	10.19 in upper zone
18A	717.14	711.64	680.64	711.50 - 713.21	686.14 - 681.14	12.5 in lower zone
18B	717.17	711.67	680.64	712.74 - 715.01	709.17 - 699.17	14.71 in upper zone
19A	715.76	710.26	691.23	709.78 - 711.83	692.51 - 687.56	6.05 in upper zone - 14.5 in lower zone
20A	719.13	712.53	691.23	711.40 - 713.34	695.88 - 691.13	9.9 in lower zone
20B	718.99	712.39	690.48	711.85 - 713.92	709.99 - 703.99	8.9 in upper zone
21A	716.98	711.48	690.48	709.56 - 711.30	695.93 - 690.68	19.95
21B	717.02	711.52	672.93	709.49 - 710.83	705.77 - 701.52	19.67
22A	716.98	713.58	672.93	713.76 - 715.33	677.98 - 672.98	20' in upper zone
22B	716.85	713.25	672.98	713.49 - 715.19	689.85 - 684.85	"
22C	716.85	713.45	693.02	713.34 - 714.41	711.85 - 701.85	22.6 in lower zone
23A	714.02	708.02	693.02	707.24 - 710.05	672.97 - 668.02	15.63 in upper zone
23B	713.59	707.57	696.4	706.49 - 709.99	702.47 - 692.57	9.5 in till
24A	720.40	718.90	652.9	717.13 - 718.77	701.55 - 696.6	21.55
25A	714.49	714.49	652.9	701.84 - 704.[illegible]	658.49 - 653.41	18.2 in lower zone 35.8
[illegible]B	714.53	711.53	652.9	701.99 - 704.2[illegible]	704.78 - 674.78	17.6 in upper zone > Total

Section 3

Ground Water Flow Direction and Quantity

TABLE 7A

HYDRAULIC CONDUCTIVITY VALUES
MILLCREEK SITE

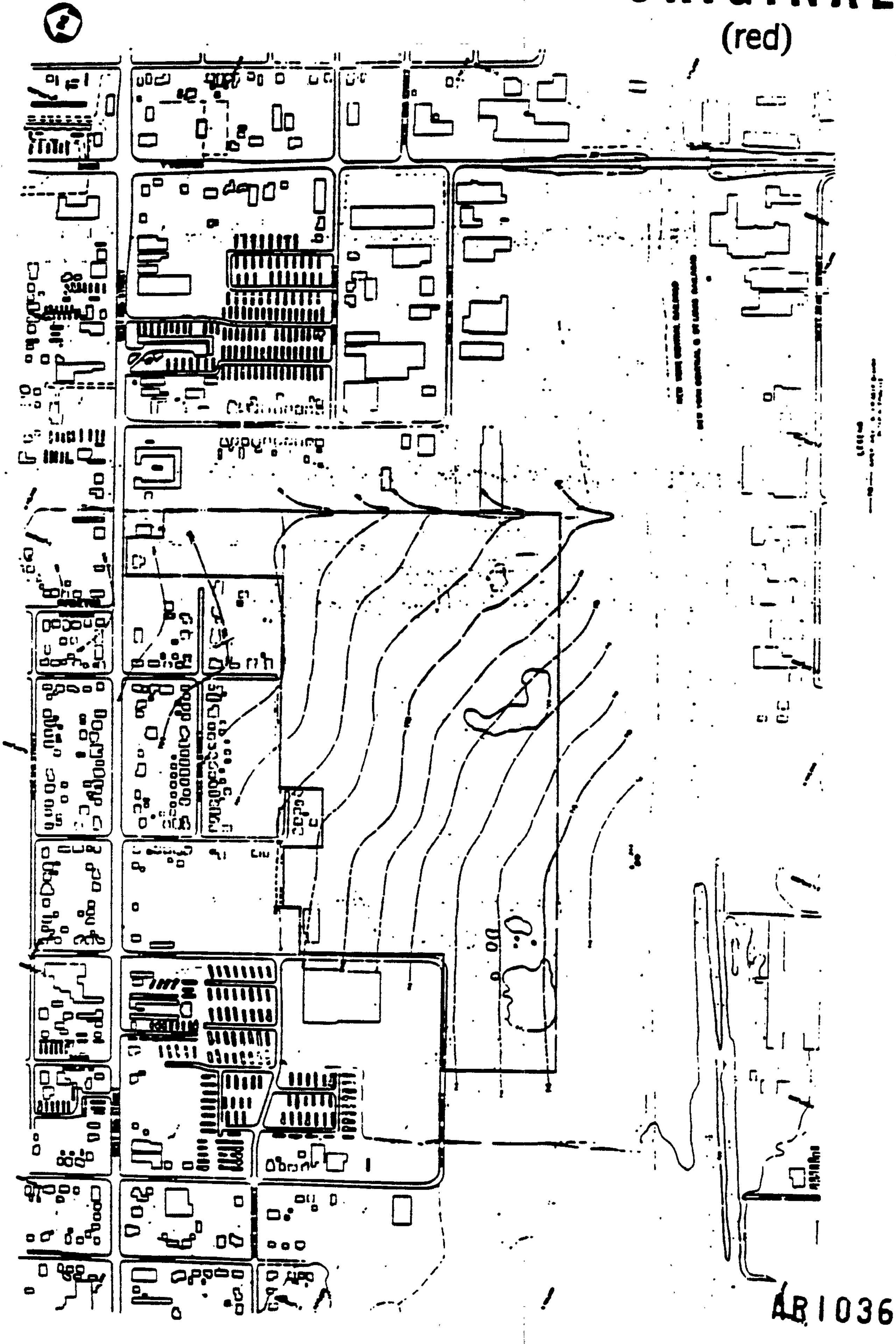
Well No.	Hydraulic Conductivity (cm/sec)	Screened Formation
15A	2.7×10^{-4}	Sand, w/silt
16A	1.1×10^{-3}	Sand, w/silt and gravel
16B	6.2×10^{-3}	Sand and silt
17A	4.0×10^{-3}	Sand, w/silt
17B	3.7×10^{-3}	Sand, w/silt
18A	2.7×10^{-3}	Sand, silt and gravel
18B	3.1×10^{-3}	Sand, w/silt
19A	7.0×10^{-5}	Sand, w/silt and gravel
0A	1.6×10^{-3}	Sand, w/silt and gravel
20B	1.5×10^{-4}	Sand, w/silt
21A	5.4×10^{-4}	Sand, w/gravel and silt
21B	3.9×10^{-4}	Gravel, w/sand
22A	3.3×10^{-3}	Sand, w/silt
22B	4.3×10^{-4}	Sand, w/gravel and silt
22C	6.9×10^{-4}	Sand, w/gravel and silt
23A	1.3×10^{-3}	Sand, w/silt
23B	7.0×10^{-5}	Sand, w/silt and gravel
24A	1.5×10^{-4}	Sand, w/silt
25A	1.1×10^{-3}	Sand, w/silt
25B	2.1×10^{-3}	Sand, w/silt and gravel

Denison Tube Samples (Till)	Hydraulic Conductivity (cm/sec)	Material Classification
DT-1, B-23B	7.7×10^{-7}	Silt, w/sand
T-3, B-24A	4.6×10^{-7}	Silt to silt-lean clay

ORIGINAL

(red)

FIGURE 4(A



CONTOUR MAP OF WATER TABLE

MILLCREEK SITE, MILLCREEK TWP., PA

SCALE: 1"=500'

following asumptions:

- The aquifer is homogeneous and isotropic.
- The aquifer is of infinite areal extent.
- The well penetrates the entire aquifer.
- Water removed from storae is discharged instantly with a corresponding change in head.
- The wells are of infinitesimal diameter.

In reality, these conditions are not met, and illustrate the limitations of the data presented.

Using the Theis nonequilibrium formula, the time for a cone of depression to reach the edge of the site from Yoder Well No. 1, pumped continually at the maximum pumping rate with no recharge to the aquifer, was calculated to take slightly less than 2 months. The cone depression of Yoder well no. 2, pumping continously at maximum capacity with no recharge to the aquifer, would take about 2 months to reach the landfill.

Under normal pumping and recharge conditions, the cone of depression of Yoder Well No. 1 may extend as far as 1,600 feet from the well. The cone of depression of Yoder Well No. 2 may extend as far as 1,200 feet from the well. Using these figures, the cones of influence of the Yoder Wells do not reach the landfill under normal pumping conditions.

The calculations performed did not take into account the presence of relatively highly permeable beach ridge deposits about 1,000 feet upgradient of the wellfield.

Recharge to the wells from these deposits would be expected to decrease the cone of influence of the pumping wells to some degree.

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ORIGINAL
(red)

Section 4

Patterns of Rainfall

Rainfall and other climatalogy information was obtained from Erie International Airport. The climate of the region is influenced by the lake, which serves to moderate temperatures throughout the year. Precipitation is evenly distributed throughout the year, as seen in Table 9(A). The Millcreek area receives less precipitation and less severe storms than inland areas of the county Table 9(A) presents precipitation, temparature, and wind data during the RI. The site climate can generally be defined from the following statistics.

Average annual precipitation	37.81 inches
Mean avearage annual temperature	49.0°F
Maximum average annual temperature	56.3°F
Minimum average annual temperature	41.6°F

DRAF

TABLE : 8(1)

METEOROLOGICAL DATA FOR 1942-1981
RECORD STATION; ERIE INTERNATIONAL AIRPORT
MILLCREEK SITE

Average Monthly Temperature (°F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	27.0	26.4	34.4	46.3	56.6	66.4	71.2	69.8	63.9	53.2	41.8	31.6	49.0
Max	33.6	33.6	41.9	53.3	64.8	74.4	78.9	77.4	71.6	60.6	48.0	37.3	56.3
Min	20.4	18.2	26.9	37.3	48.1	58.3	63.6	62.2	56.2	45.8	35.6	25.8	41.6

Average Monthly Precipitation (in.)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2.68	2.41	2.78	3.13	3.34	3.44	3.27	3.30	3.62	3.53	3.45	2.86	37.81

Source: National Oceanic and Atmospheric Administration
Annual Summary with Comparative Data, 1981 - Erie, Pennsylvania

ORIGIN
(red)

TABLE 9(A)

PRECIPITATION, TEMPERATURE, AND WIND DATA COLLECTED DURING THE REMEDIAL INVESTIGATION FIELD STUDY PERIOD
MILLCREEK SITE

Precipitation

	Total Precipitation	Deviation from 40-year Average
May 1984	5.83*	+2.49
June 1984	4.49	+1.05
July 1984	1.94	(-1.33)
August 1984	2.09	(-1.21)
September 1984	5.29	+1.67

*Values given in water equivalent inches.

Temperature

	Month Average	Deviation from 40-year Average
May 1984	53.8°F	(-2.7°F)
June 1984	68.6°F	2.2°F
July 1984	69.6°F	(-1.6°F)
August 1984	72.0°F	2.2°F
September 1984	61.8°F	(-2.1°F)

Wind

	Average Wind Direction Origination	Average Speed	Maximum Speed	Maximum Speed Direction
May 1984	West-Southwest	11.0 mph	30 mph	West-Southwest
June 1984	West-Southwest	10.2 mph	23 mph	West-Southwest
July 1984	West-Southwest	8.9 mph	23 mph	South
August 1984	West-Southwest	8.5 mph	29 mph	West-Southwest
September 1984	West-Southwest	9.6 mph	23 mph	North-Northwest

ORIGINAL
(red)

Section 5

Proximity of Surface Water

Ground water occurs in significant quantities within the glaciolacustrine deposits. Recharge is principally through precipitation and infiltration. The till deposits act as a confining layer to retard the downward migration of ground water. Ground water at the Millcreek site occurs both under water table and semiconfined condition. The water table extends into the fill throughout wet portions of the year.

Silty layers within the deposits can act as local, confining layers to ground water flow. The silt layers are believed to be local confining layers of limited aereal extent, and do not separate the lake deposits into separate aquifers. The east and west branches of Marshalls Run act as limited discharge points for some of the ground water migrating from the site. Ground water flow accross the site is generally north but in the eastern point of the flow is locally northeast because of discharge into Marshalls Run. This effect does not continue beyond Marshalls Run. Figure 4(A) illustrates the direction of ground water flow.

As illustrated on Table 7(A), values of hydraulic conductivity (k) in the screened intervals ranged from 10^{-3} cm/s to 10^{-5} cm/s. Two values of hydraulic conductivity will be used in ground water velocity equations. One value, 3.9×10^{-4} cm/s, was obtained by averaging the 10 lowest calculated hydraulic conductivities; and the other value, 2.9×10^{-3} cm/s, was obtained by averaging the 10 highest hydraulic conductivities. The ground water gradient (i) across the site ranged from 0.004 ft/ft to 0.006 ft/ft, with an average value of 0.0053 ft/ft.

Using the low value for hydraulic conductivity and low value for the hydrualic gradient, the ground water velocity using Darcy's Law ($V = KI/N$) with effective porosity (n) = 0.15 equals 10.8 ft/yr. Using the high value for hydraulic conductivity, and the high value for the hydraulic gradient, the ground water velocity is calcuated to be 120 ft/yr. Actual ground water velocity is probably somewhere between the two values.

The only ground water use in the area are the Yoder municipal wells located 1200 to 2100 south of the site (upgradient). The wellfield consists of 3 hand dug wells, each approximately 24 feet deep. The closest well (1200 feet) has been disconnected from the system. The two other wells though are used regularly. Yoder well No. 1 is located approximately 2,100 feet south of the site and is currently pumped at a rate of 150,000 gallons per day. Yoder well No. 2 is located 1,600 feet south of the site and is pumped at a rate of 80,000 gallons per day. The maximum reported yields for wells one and two are 288,000 gpd and 144,000 gpd respectively. Water obtained from these wells are mixed with lake water at a ratio of 1 part well water to 3 parts lake water. The wells serve approximately 8,000 people in the area.

An attempt was made to deterime how long it would take for the cone of influence of the Yoder Wells to reach the landfill if the wells were pumped continuously at maximum rates and there was no recharge to the aquifer (severe drought conditions). Using the known information about the well depths, diameters, and maximum yields, and the estimated distances from the wells to the edge of the landfill, a projection was made, using the

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Section 6

Current and Future Uses of Ground Water and Surface Water in the Area

Surface Water

A wetland or swamp of about 8 acres exists in the southern portion of the site. Apparently, ground water discharges from the wetland since it is located in the southern portion of the site. The water elevation is lower than the surrounding topography though so the wetland acts as a drainage area in the southern portion of the site. The mean depth of the wetland is probably about 2 feet. During the Remedial Investigation a strong hydrogen sulfide odor was noticed around the wetland indicating anaeorobic conditions. A macroinvertebrate survey was attempted but was unsuccessful because of a thick layer of organic deposits.

The west branch of Marshall's Run flows to the north, west of the Millcreek Township Park which is adjacent to the site. This tributary was found to be flowing during the August 1984 sampling. The west branch flows into a culvert as it reaches West 14th Street, then runs parallel West 14th Street until it reaches Marshall Drive. Here it feeds into another culvert that appears to be diverted parallel to Idaho Avenue.

Marshall's Run borders the site to the east. The low gradient stream flows ultimately into Lake Erie, approximately 1.5 miles downstream. Tributaries to Marshall's Run include a stream that orginates near the location of the now removed greenhouses along West 26th Street and a stream that collects flow from urban drainage south of the railroad tracks. Ground water also discharges to Marshall's Run.

The RI did not contain specific physical characteristics of Marshalls Run, but generally it is an intermittent stream with width varying from about 5 feet onsite to about 15 feet at the mouth at Lake Erie. During flowing condition, the stream probably flows at about 0.25 ft/s at a depth ranging from 2 inches to 1 foot. Flow rates for the stream were not measured during the RI but if it is assumed that at the site. stream width is 3 feet, depth is 6 inches, and velocity is 0.25 ft/s, flow rate would be about 0.375 ft^3/s. This flow could approach zero during dry conditions and be greatly exceeded during the flood conditions.

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Section 7

Existing Quality of Ground Water and Surface Water

Ground Water Uses

Ground water in the Millcreek Area fall into a Class II category under EPA's Ground Water Protection Strategy. That is: current and potential sources of drinking water and waters with other beneficial uses. Ground water is currently used for drinking only upgradient at the Yoder Wells. Some wells downgradient of the site may be used for lawn watering but is not currently being used for drinking water purposes.

Some factors that must be considered in determining future potential use are:

1) Restrictions on ground water use - none are in place although the township has indicated a willigness to place restrictions on future ground water use.

2) Demography of surrounding area - Millcreek area is a suburban area downgradient which should not experience a significant increase in population.

3) Zoning patterns and projected changes in zoning - area is industrial to the south, west, and directly east. A trailer park exists directly offsite to the northwest. Residential development exists north and north east.

Projecting future ground water use is difficult. EPA's ACL guidance states that "the potential point of exposure to the ground water contaminants is assumed to be at the facility waste management boundary unless use restrictions have been implemented". The ACL's though may take future ground water use into account. Generally, EPA has accepted a 10^{-6} cancer risk level as acceptable at a receptor. This issue will be examined more closely in Section 8.

Surface Water Uses

The only body of water presently impacted 6x detectable ground water contaminants is the east branch of Marshalls Run. The east branch eventually drains into Lake Erie 1.5 stream miles from the site. The stream is not used as a drinking, receational, industrial, or agricultural water source. At the mouth of the river though at Lake Erie the river is used as a fish propagation area for species such as rainbow and brook trout.

EPA's ACL guidance states that the "the point of exposure for surface water bodies is assumed to be the water body closest to the facility in the pathway of contaminant migration".

Ground Water

The Yoder Wells are probably the best indicators of upgradient or background water quality. The Erie County Dept. of Health (ECDH) conducted the most recent Yoder Well sampling for metals in July 1984. The results are indicated below:

Metal	Concentration (ug/l)
As, total	<10
Cd, total	<1
Ci, total	<10
Cr, total	10
Pb, total	<10
Ni, total	30
Ag, total	10
Zn, total	50
Sb, total	<10
Se, total	<10

ECDH also conducted the most recent sampling in Yoder Wells 1 and 2 in August 1983 for pesticides. None were detected. In July 1983 Yoder Wells 1 and 2 were sampled for volatiles. Only chloroform was detected in Yoder Well #2 at 5 ug/l but this compound was believed to be caused by blank contamination.

Background ground water is therefore of high quality.

Surface Water

Since the east branch of Marshalls Run is the only current surface water body considered in this ACL demonstration (since the existing wetland is hydraulically upgradient) only corresponding sample results will be considered. Tables through contain past surface water data in Marshalls Run. Surface water data is not considered from the RI because there were dry conditions. at the time of sampling. Upstream surface water quality of Marshalls Run is summarized below. Upstream samples considered are SWMC10, 12, and 17.

Parameter	Values	Mean
pH	7.5, 7.7	7.59
Specific conductance	650, 650	650
Alkalinity (mg/l) (umho/cm)	220,224	222
Hardness (mg/l Ca CO_3)	312	312
COD (mg/l)	10,30	20
DO (mg/l)	N/A	N/A
T (°C)	N/A	N/A
Sulfate (mg/l)	50, 56	53
Chloride (mg/l)	50, 81	65.5
Nitrate as N (mg/l)	0.20	0.20
Ammonia as N (mg/l)	0.13	0.13
Phosphate as P (mg/l)	0.05	0.05
Total dissolved solids	0.8	0.8

Parameter	Values	Mean
Sb (ug/l)	N/A	N/A
As (ug/l)	<10, <10	<10
Be (ug/l)	< N/A	N/A
Cd (ug/l)	<1, <1	<1
Cr (ug/l)	<10, <10	<10
Cu (ug/l)	10, 10	10
Pb (ug/l)	<10, <10	<10
Hg (ug/l)	<1	<1
Ni (ug/l)	<10, 10	<10
Se (ug/l)	<10, <10	<10
Ag (ug/l)	<10	<10
Tl (ug/l)	N/A	N/A
Zn (ug/l)	10, 20	15
Al (ug/l)	50, 100	75
Ba (ug/l)	700	700
Fe (ug/l)	2220, 850	1535
Mn (ug/l)	510, 930	720
Te (ug/l)	N/A	N/A
Cyanide (ug/l)	<10, <10	<10

Upstream organic surface water data is presented as follows:

Parameters	Values
Diethyl phthalate	0.5
1.2 dichloroethene	4

Section 8

Potential Health Risks

From a technical perspective, it appears that onsite ground water contamination from some VOCs such as TCE and its biodegradation products; 1,2-DCE, and VCM, are steadily decreasing with time. Other VOCs such as 1,1,1-trichloroethane are decreasing also but not as rapidly.

A recent (December 1985) sample from a monitoring well adjacent to the site detected greater than 7,000 ug/l of 1,2-DCE. EPA does not recommend consumption of water with greater than 70 ug/l of 1,2-DCE. This same monitoring well along with other monitoring wells on or adjacent to the site show unit cancer risks approaching or higher than 10^{-2}. Therefore, there is little doubt that the ground water would present a significant health risk if it were presently being ingested.

The decision whether to pursue active remedial ground water measures involves not only a technical risk assessment, but a policy decision on EPA's part to protect currently unused aquifers. EPA is currently uncertain about the long term effectiveness of institutional controls as a means of restricting ground water use. As a result, the Superfund program generally does not encourage ground water remediation with long term time frames. EPA's preference is for rapid restoration as may be achieved by pumping of ground water (e.g. 2 years as estimated in the FS) as opposed to long term natural restoration which may take in excess of 100 years as calculated with the AT123D Ground Water Model.

The AT123D Model was used to determine the ground water concentrations of 1,2-DCE and VCM over a 120 year period using extrapolated best case and worst case scenarios from figure one. Figure one illustrates three possible source terms from previous sample data at ground water flow rates of 60 and 120 feet per year. The worst case scenario is represented with an unsteady state original source concentration of 470 umoles/l at a ground water flow velocity of 60 feet per year; and the best case scenario is represented with an unsteay state original source of 140 umoles/l with a ground water flow rate at 120 feet per year.

The results of the model are presented on the following pages and are printed out as ppm of 1,2-DCE over 20 year intervals. Most of the input data was obtained from the RI. Data that was not available such as longitudinal, transverse, and vertical dispersitivities were estimated from the geological materials of the aquifer (sand and gravel). Hydraulic conductivities were adjusted using Darcy's Law to represent appropriate ground water flow rates.

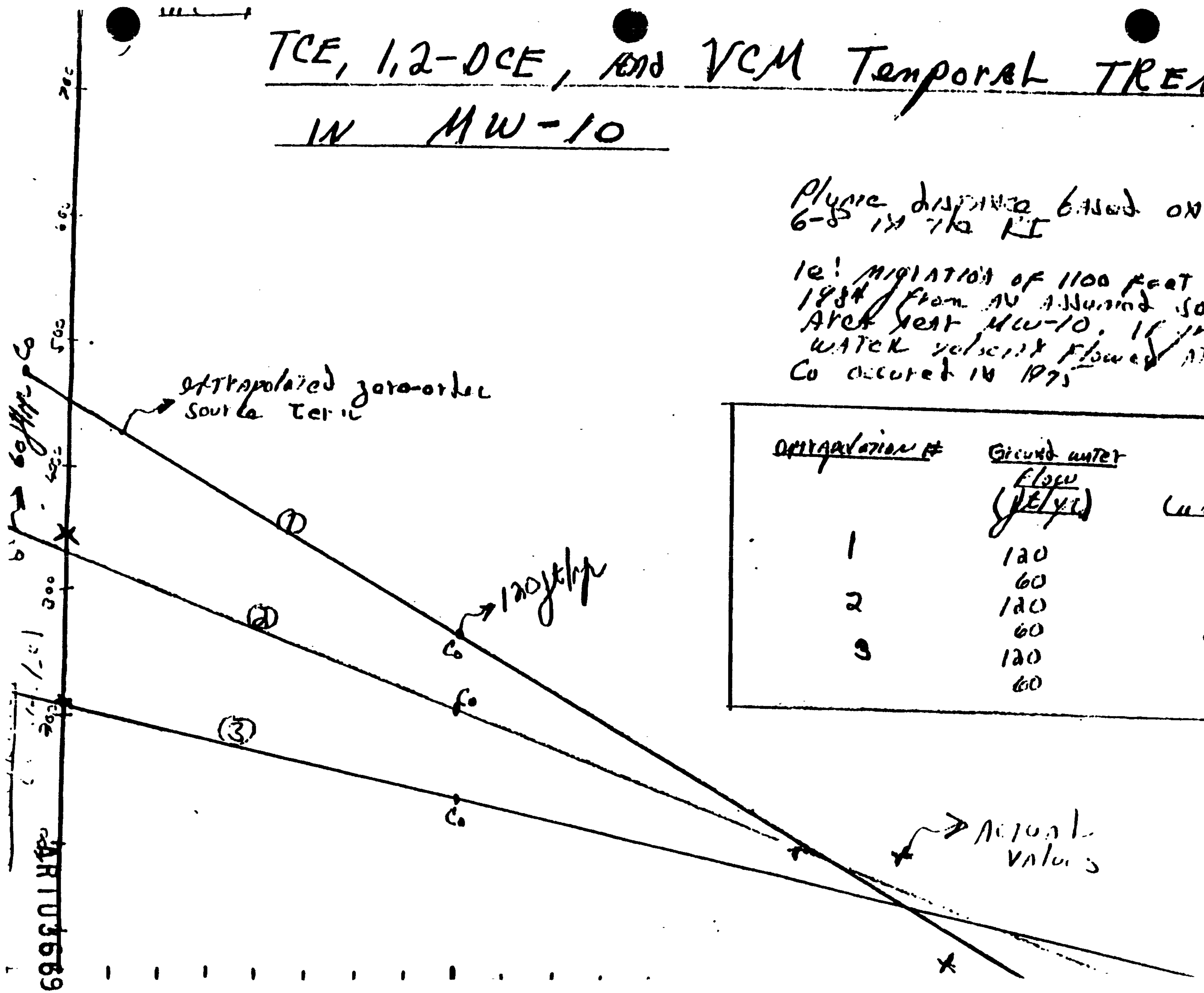
The calculations reveal that 1,2-DCE will reduce over time in both scenarios but not to levels considered safe by EPA (70 ug/l), even after a 120 year period. As presented in section 8a, TCE is expected to either hydrolyze or biodegrade to 1,2-DCE which the degrades into VCM. This is of significance because the 10(-6) UCR for VCM is two orders of magnitude less than TCE (0.015 ug/l vs. 1.8 ug/l). TCE quickly degrades into 1,2-DCE and then slowly degrades into VCM. At a ground water flow rate of 120 feet per year, the combined TCE-1,2-DCE degradation rate was estimated to be 6.264E-04 per year. Even under the best case scenario when the concentration os 1,2-DCE is expected to be 150 ug/l at 30 meters in 120 years, VCM would still be present at unsafe levels. Converting 150 ug/l into umoles/l and using first order kinetics with the degradation rate previously given the concentration of VCM can also be estimated. The calculations reveal that even in the best case scenario, VCM would be present at 7 ug/l or greater than a 10(-4) UCR.

TCE, 1,2-DCE, and VCM Temporal TRENDS IN MW-10

Plume distance based on Figure 6-8 in the RI

ie: migration of 1100 feet as of 1984 from an assumed source area near MW-10. If ground water velocity flowed at 120/ Co occurred in 1975

Extrapolation #	Ground water Flow (ft/yr)	Co Calculated
1	120	270
	60	470
2	120	210
	60	350
3	120	140
	60	210



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MILLIREEM

NO. OF POINTS IN X-DIRECTION .......................     7
NO. OF POINTS IN Y-DIRECTION .......................     9
NO. OF POINTS IN Z-DIRECTION .......................     1
NO. OF APPROX. NO. OF SERIES TERMS .................   400
NO. OF BEGINNING TIME STEP .........................    21
NO. OF ENDING TIME STEP ............................   140
NO. OF TIME INTERVALS FOR PRINTED OUT SOLUTION ....    20
INSTANTANEOUS SOURCE CONTROL = 0 FOR INSTANT SOURCE      1
SOURCE CONDITION CONTROL = 0 FOR STEADY SOURCE ....    22
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT ....     1
THIS CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD      2


AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ...  0.5000E+02
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ...  0.0000E+00
BEGIN POINT OF X-SOURCE LOCATION (METERS) ......... -0.1500E+02
END POINT OF X-SOURCE LOCATION (METERS) ...........  0.1500E+02
BEGIN POINT OF Y-SOURCE LOCATION (METERS) ......... -0.1500E+02
END POINT OF Y-SOURCE LOCATION (METERS) ...........  0.1500E+02
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .........  0.0000E+00
END POINT OF Z-SOURCE LOCATION (METERS) ...........  0.0000E+00


POROSITY ..........................................  0.1500E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) ...............  0.5920E-01
HYDRAULIC GRADIENT ................................  0.5300E-02
LONGITIDUNAL DESPERSIVITY (METER) .................  0.5000E+02
LATERAL DISPERSIVITY (METER) ......................  0.5000E+01
VERTICAL DISPERSIVITY (METER) .....................  0.5000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG) ............  0.1820E-02
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C)..  0.0000E+00


MOLECULAR DIFFUSION MULTIPLY BY TOROSITY (M**2/HR)   0.0000E+00
DECAY CONSTANT (PER HOUR) .........................  0.0000E+00
BULK DENSITY OF THE SOIL (GRAM/CM**3) .............  0.1320E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE ......  0.3000E-02
DENSITY OF WATER (KG/M**3) ........................  0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) ..  0.8760E+04
DISCHARGE TIME (HR) ...............................  0.1927E+06
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) .  0.0000E+00


LIST OF TRANSIENT SOURCE RELEASE RATE
   0.137E-02   0.131E-02   0.124E-02   0.117E-02   0.111E-02
   0.104E-02   0.980E-03   0.912E-03   0.848E-03   0.781E-03
   0.716E-03   0.653E-03   0.590E-03   0.521E-03   0.454E-03
   0.390E-03   0.326E-03   0.259E-03   0.195E-03   0.128E-03
   0.128E-03   0.640E-04
RETARDATION FACTOR ................................
RETARDED DARCY VELOCITY (M/HR) ....................  0.1702E+02
RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) ..  0.1229E-03
RETARDED LATERAL DISPERSION COEFFICIENT (M**2/HR) ..  0.6146E-02
RETARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR)   0.6146E-03
                                                      0.6146E-03
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1840E+06 HRS (Present)
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                 Z =         0.00
                                                                X
            0.          30.         90.         150.           300.         600.

0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
0.    0.903E-07   0.984E-07   0.347E-07   0.245E-08   0.309E-14   0.000E+00   0.0
0.    0.964E-03   0.103E-02   0.326E-03   0.198E-04   0.144E-10   0.000E+00   0.0
0.    0.311E+00   0.313E+00   0.739E-01   0.353E-02   0.164E-08   0.000E+00   0.0
0.    0.278E+01   0.338E+01   0.421E+00   0.177E-01   0.707E-08   0.000E+00   0.0
0.    0.311E+00   0.313E+00   0.739E-01   0.353E-02   0.164E-08   0.000E+00   0.0
0.    0.903E-07   0.984E-07   0.347E-07   0.245E-08   0.309E-14   0.000E+00   0.0
0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.3592E+06 HRS (20 years)
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                 Z =         0.00
                                                                X
            0.          30.         90.         150.           300.         600.

0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
0.    0.118E-06   0.142E-06   0.112E-06   0.389E-07   0.753E-10   0.000E+00   0.0
      0.812E-03   0.980E-03   0.751E-03   0.247E-03   0.401E-06   0.000E+00   0.0
      0.198E+00   0.237E+00   0.168E+00   0.489E-01   0.586E-04   0.000E+00   0.0
0.    0.144E+01   0.170E+01   0.111E+01   0.288E+00   0.281E-03   0.000E+00   0.0
0.    0.198E+00   0.237E+00   0.168E+00   0.489E-01   0.586E-04   0.000E+00   0.0
0.    0.118E-06   0.142E-06   0.112E-06   0.389E-07   0.753E-10   0.000E+00   0.0
0.    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
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DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.5344E+06 HRS (40 years)
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                 Z =         0.00
                                                                X
            0.          30.         90.         150.           300.         600.

30.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
20.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
30.   0.864E-07   0.108E-06   0.113E-06   0.676E-07   0.168E-08   0.000E+00   0.0
0.    0.593E-03   0.743E-03   0.764E-03   0.447E-03   0.101E-04   0.000E+00   0.0
30.   0.143E+00   0.178E+00   0.177E+00   0.979E-01   0.180E-02   0.000E+00   0.0
0.    0.102E+01   0.126E+01   0.122E+01   0.637E+00   0.984E-02   0.000E+00   0.0
30.   0.143E+00   0.178E+00   0.177E+00   0.979E-01   0.180E-02   0.000E+00   0.0
90.   0.864E-07   0.108E-06   0.113E-06   0.676E-07   0.168E-08   0.000E+00   0.0
20.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.0
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DISTRIBUTION OF DISSOLVED CHEM[illegible] IN PPM AT [illegible] HRS    (60 year
 (ADSORBED CHEMICAL CONC. =   [illegible] * DISSOLVED CHEMICAL CONC.)

                     Z =          0.00
                                                                  X
           0.           30.           90.          150.          300.          600.

        0.000E-00    0.000E+00    0.000E+00    0.000E-00    0.000E+00    0.000E+00    0.
        0.000E-00    0.000E+00    0.000E+00    0.000E-00    0.000E-00    0.000E+00    0.
 0.     0.672E-07    0.860E-07    0.103E-06    0.812E-07    0.732E-08    0.294E-13    0.
 0.     [illegible]  [illegible]  0.699E-03    0.544E-03    0.462E-04    0.151E-09    0.
        [illegible]  0.140E+00    0.164E+00    0.128E+00    0.921E-02    0.201E-07    0.
        [illegible]  [illegible]  0.114E+01    0.832E+00    0.331E-01    0.911E-07    0.
 0.     [illegible]  0.140E+00    0.164E+00    0.128E+00    0.921E-02    0.201E-07    0.
 0.     0.672E-07    0.860E-07    0.103E-06    0.812E-07    0.732E-08    0.294E-13    0.
 0.     0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.0

 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.8848E+06 HRS   (80 years)
 (ADSORBED CHEMICAL CONC. =   0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                     Z =          0.00
                                                                  X
 I         0.           30.           90.          150.          300.          600.

 50.    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.
 20.    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.
 90.    0.541E-07    0.699E-07    0.909E-07    0.848E-07    0.166E-07    0.126E-11    0.
 60.    0.369E-03    0.477E-03    0.619E-03    0.571E-03    0.108E-03    0.719E-08    0.
 30.    0.878E-01    0.113E+00    0.145E+00    0.131E+00    0.227E-01    0.119E-05    0.
  0     0.620E+00    0.799E+00    0.101E+01    0.900E+00    0.143E+00    0.618E-05    0.
        0.878E-01    0.113E+00    0.145E+00    0.131E+00    0.227E-01    0.119E-05    0.
 3      0.541E-07    0.699E-07    0.909E-07    0.848E-07    0.166E-07    0.126E-11    0.
 20.    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.

 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.1060E+07 HRS   (100 years)
 (ADSORBED CHEMICAL CONC. =   0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                     Z =          0.00
                                                                  X
           0.           30.           90.          150.          300.          600.

 0.     0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.0
 0.     0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.0
 0.     0.443E-07    0.577E-07    0.794E-07    0.827E-07    0.273E-07    0.164E-10    0.0
 0.     0.303E-03    0.394E-03    0.540E-03    0.559E-03    0.179E-03    0.979E-07    0.0
 0.     0.717E-01    0.933E-01    0.127E+00    0.130E+00    0.391E-01    0.176E-04    0.0
 .      0.505E+00    0.656E+00    0.887E+00    0.894E+00    0.255E+00    0.974E-04    0.0
 0.     0.717E-01    0.933E-01    0.127E+00    0.130E+00    0.391E-01    0.176E-04    0.0
 0.     0.443E-07    0.577E-07    0.794E-07    0.827E-07    0.273E-07    0.164E-10    0.0
 0.     0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.0
ADY STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME
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ORIGINAL (RED)

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 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT [illegible] HRS
   ADSORBED CHEMICAL CONC. =    0.1822E+01 * DISSOLVED CHEMICAL CONC.

                  Z =         0.00

              0.          30.          90.         150.         300.         600.

 150.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.
 120.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.
  90.   0.369E-07   0.482E-07   0.691E-07   0.779E-07   0.372E-07   0.984E-10   0.
  60.   0.251E-03   0.329E-03   0.470E-03   0.528E-03   0.247E-03   0.607E-06   0.
  30.   0.595E-01   0.778E-01   0.111E+00   0.123E+00   0.550E-01   0.116E-03   0.
   0.   0.418E+00   0.546E+00   0.779E+00   0.951E+00   0.365E+00   0.673E-03   0.
 -30.   0.595E-01   0.778E-01   0.111E+00   0.123E+00   0.550E-01   0.116E-03   0.
 -90.   0.369E-07   0.482E-07   0.691E-07   0.779E-07   0.372E-07   0.984E-10   0.
-120.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.
```

<120 years

```
[illegible]

[illegible] POINTS IN X-DIRECTION .......................
[illegible] POINTS IN Y-DIRECTION .......................
[illegible] POINTS IN Z-DIRECTION .......................
[illegible] .................................   430
[illegible] .....................................
[illegible] TIME STEP ...............................   131
[illegible] FOR DESIRED OUTPUT SOLUTION ....    20
[illegible] = 1 FOR INSTANT SOURCE     1
[illegible] CONTROL = 0 FOR STEADY SOURCE ....    17
INTERMITTENT OUTPUT CONTROL = 0 NO SUCH OUTPUT ....     1
[illegible] CONTROL =1 THERMAL, = 2 FOR CHEMICAL, = 3 RAD       2


AQUIFER DEPTH, = 0.0 FOR INFINITE DEEP (METERS) ...  0.5000E+01
AQUIFER WIDTH, = 0.0 FOR INFINITE WIDE (METERS) ...  0.0000E+00
BEGIN POINT OF X-SOURCE LOCATION (METERS) ......... -0.1500E+02
END POINT OF X-SOURCE LOCATION (METERS) ...........  0.1500E+02
BEGIN POINT OF Y-SOURCE LOCATION (METERS) ......... -0.1500E+02
END POINT OF Y-SOURCE LOCATION (METERS) ...........  0.1500E+02
BEGIN POINT OF Z-SOURCE LOCATION (METERS) .........  0.0000E+00
END POINT OF Z-SOURCE LOCATION (METERS ...........  0.0000E+00


POROSITY ..........................................  0.1500E+00
HYDRAULIC CONDUCTIVITY (METER/HOUR) ...............  0.5920E-01
HYDRAULIC GRADIENT ................................  0.5300E-02
LONGITIDUNAL DESPERSIVITY (METER) .................  0.5000E+02
I   TRAL DISPERSIVITY (METER) .....................  0.5000E+01
    ICAL DISPERSIVITY (METER) .....................  0.5000E+01
DISTRIBUTION COEFFICIENT, KD (M**3/KG) ............  0.1820E-02
HEAT EXCHANGE COEFFICIENT (KCAL/HR-M**2-DEGREE C)..  0.0000E+00


MOLECULAR DIFFUSION MULTIPLY BY TOROSITY (M**2/HR)   0.0000E+00
DECAY CONSTANT (PER HOUR) .........................  0.0000E+00
BULK DENSITY OF THE SOIL (GRAM/CM**3) .............  0.1320E+04
ACCURACY TOLERANCE FOR REACHING STEADY STATE ......  0.5000E-02
DENSITY OF WATER (KG/M**3) ........................  0.1000E+04
TIME INTERVAL SIZE FOR THE DESIRED SOLUTION (HR) ..  0.8760E+04
DISCHARGE TIME (HR) ...............................  0.1489E+06
WASTE RELEASE RATE (KCAL/HR), (KG/HR), OR (CI/HR) .  0.0000E+00

 LIST OF TRANSIENT SOURCE RELEASE RATE
    0.400E-03    0.380E-03    0.353E-03    .329E-03   0.306E-03    0.284E-03
                                                      0.165E-03    0.141E-03
 0.259E-03    0.235E-03    0.214E-03    0.188E-03
  .118E-03    0.940E-04    0.710E-04    0.470E-04    0.230E-04


  RETARDATION FACTOR ................................  0.1702E+02
  ~~RETARDED DARCY VELOCITY (M/HR) ....................  0.1229E-03~~
  RETARDED LONGITUDINAL DISPERSION COEF. (M**2/HR) ..  0.6146E-02
     ARDED LATERAL DISPERSION COEFFICIENT (M**2/HR)   0.6146E-03
    ARDED VERTICAL DISPERSION COEFFICIENT (M**2/HR).  0.6146E-03
```

(present) ORIGIN. (RED)

```
 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  [illegible] HRS
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                  Z =        0.00

          0.           30.          90.          150.         300.          600.

 150.  [illegible]   [illegible]  [illegible]  [illegible]  [illegible]  [illegible]
 120.  0.000E+00    0.000E+00    0.000E+00    0.0[illegible]E+00    0.000E+00    0.000E+[illegible]
  90.  0.000E-0[illegible]    0.0[illegible]E+00    0.000E+00    [illegible]    0.000E+00    0.000E+[illegible]
  60.  0.303E-06    0.381E-06    0.142E-07    0.517E-10    0.000E+00    0.000E+00
  30.  0.267E-01    0.209E-01    0.819E-02    0.1[illegible]E-0[illegible]    0.000E+00    0.000E+[illegible]
   0.  0.101E+01    0.335E+00    0.125E-01    0.179E-04    0.000E+00    0.000E+00
 -30.  0.267E-01    0.209E-01    0.819E-02    0.137E-05    0.000E+00    0.000E+00
 -90.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
-120.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
```

(20 year)

```
 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.2628E+06 HRS
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                  Z =        0.00
                                                                  X
 Y        0.           30.          90.          150.         300.          600.

 150.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
 120.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
  90.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
  60.  0.491E-04    0.569E-04    0.322E-04    0.582E-05    0.598E-09    0.000E+00
  30.  0.430E-01    0.491E-01    0.250E-01    0.383E-02    0.276E-06    0.000E+00
   0.  0.449E+00    0.503E+00    0.226E+00    0.296E-01    0.173E-05    0.000E+00
 -30.  0.430E-01    0.491E-01    0.250E-01    0.383E-02    0.276E-06    0.000E+00
 -90.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
-120.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
```

(40 year)

```
 DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.4380E+06 HRS
 (ADSORBED CHEMICAL CONC. =    0.1820E+01 * DISSOLVED CHEMICAL CONC.)

                  Z =        0.00
                                                                  X
 Y        0.           30.          90.          150.         300.          600.

 150.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
 120.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
  90.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
  60.  0.339E-04    0.418E-04    0.382E-04    0.176E-04    0.132E-06    0.000E+00
  30.  0.291E-01    0.357E-01    0.315E-01    0.136E-01    0.809E-04    0.000E+00
   0.  0.297E+00    0.363E+00    0.307E+00    0.124E+00    0.600E-03    0.000E+00
 -30.  0.291E-01    0.357E-01    0.315E-01    0.136E-01    0.809E-04    0.000E+00
 -90.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
-120.  0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00
```

ORIGINAL (RED)

```
[illegible] DISSOL[illegible] CHEM[illegible] [illegible]E+[illegible] HRS (60 years)
 [illegible] CHEMICAL CONC. =   0.[illegible]E+[illegible] * DISSOLVED CHEMICAL CONC.)

              Z =       0.00

          [illegible]      30.        [illegible]       [illegible]       300.       [illegible]

[illegible]   [illegible]E-02  0.0[illegible]E+00  0.000[illegible]  0.000E+00  [illegible].000E+0[illegible]  0.300[illegible]
[illegible]   0.000E-00  0.000E-00  0.000E-00  0.000E+00  0.000E-00  0.000E-[illegible]
[illegible]   [illegible]E-0[illegible]  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E-00
[illegible]   [illegible]E-04  0.[illegible]E-04  0.362E-04  0.249E-04  0.118E-05  0.000E-00
 30.  0.218E-01  0.270E-01  0.303E-01  0.201E-01  0.830E-03  0.000E-00
[illegible]   0.221E+00  0.279E+00  0.300E+00  0.193E+00  0.695E-02  0.000E-00
-30.  0.218E-01  0.278E-01  0.303E-01  0.201E-01  0.830E-03  0.000E+00
-90.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.0[illegible]E+00  0.00[illegible]E+00
[illegible]   [illegible]E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.0[illegible]E+00

DIS[illegible] [illegible] DISSOLVED CHEMICALS IN PPm AT  0.7884E+06 HRS (80 years)
 [illegible] CHEMICAL CONC. =   0.1820E+01 * DISSOLVED CHEMICAL CONC.)

              Z =       0.00
                                                          X
 I        0.        30.        90.        150.       300.       600.

 150.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
 120.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  90.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
       0.203E-04  0.260E-04  0.324E-04  0.278E-04  0.364E-05  0.565E-10
    .  0.172E-01  0.221E-01  0.272E-01  0.228E-01  0.275E-02  0.329E-07
   0.  0.173E+00  0.222E+00  0.271E+00  0.223E+00  0.246E-01  0.241E-06
 -30.  0.172E-01  0.221E-01  0.272E-01  0.228E-01  0.275E-02  0.329E-07
 -90.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
-120.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00

DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT  0.9636E+06 HRS (100 years)
(ADSORBED CHEMICAL CONC. =   0.1820E+01 * DISSOLVED CHEMICAL CONC.)

              Z =       0.00
                                                          X
 I        0.        30.        90.        150.       300.       600.

  50.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  20.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  90.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  60.  0.164E-04  0.213E-04  0.285E-04  0.280E-04  0.702E-05  0.142E-08
  30.  0.139E-01  0.180E-01  0.239E-01  0.232E-01  0.548E-02  0.917E-06
   0.  0.140E+00  0.181E+00  0.239E+00  0.228E+00  0.508E-01  0.715E-05
  30.  0.139E-01  0.180E-01  0.239E-01  0.232E-01  0.548E-02  0.917E-06
 -90.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
  20.  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00

[illegible] STATE SOLUTION HAS NOT BEEN REACHED BEFORE FINAL SIMULATING TIME
```

C120

ORIGINAL (RED)

```
DISTRIBUTION OF DISSOLVED CHEMICALS IN PPM AT [illegible]
 (ADSORBED CHEMICAL CONC. = [illegible]E+01 * DISSOLVED CHEMICAL CONC.)

                    Z =        0.00

            0.          25.          50.         100.         200.         400.

  150.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
  120.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
   90.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
   60.   0.135E-04   0.177E-04   0.248E-04   0.269E-04   0.105E-04   0.126E-07
   30.   0.115E-01   0.150E-01   0.209E-01   0.224E-01   0.839E-02   0.870E-05
    0.   0.115E+00   0.150E+00   0.208E+00   0.221E+00   0.795E-01   0.717E-04
  -30.   0.115E-01   0.150E-01   0.209E-01   0.224E-01   0.839E-02   0.870E-05
  -90.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
 -150.   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
```

ORIG (RED)

Section 8a

Determination of Present and Future Ground Water Contamination at the Millcreek Site

Table 11(A) presents concentrations of Volatile Organic Chemical (VOC) compounds detected in ground water during the RI Ground Water was sampled on 8/17/84. The table summarizes currently accepted associated Unit Cancer Risks (UCR) present at each monitoring well. UCR values for vinyl chloride (VCM), 1,1dichloroethene (1,1-DCE), 1,2dichloroethane (EDC) and trichloroethene (TCE) were obtained from Draft Health Advisories from the Office of Drinking Water dated September 30, 1985. The UCR values for VCM; 1,1-DCE, EDC, and TCE for 10^{-6} cancer risk are 0.015, 0.24, 0.95, and 2.8 ug/l respectively. These risk values assume lifetime exposure for a 70 kg male consuming 2 liters of water daily. Figure 5(A) illustrates the present UCR values for each monitoring well and uses isocentration contour lines to describe the current extent and magnitude of ground water contamination as of August 1984.

In order to better understand the temporal trends of ground water VOC contamination, EPA collected another round of samples on December 9, 1985. Samples were analyzed by NUS's mobile laboratory. Table 11(A)-1 summarizes these results along with other past analytical results. Table 11(A)-2 summarizes associated UCR values present at each monitoring well for the December 1985 sampling. Figure 5(A)-1 uses UCR isocentiation contour lines to describe the potential risk posed by ingesting ground water in December 1985.

Table 11(A)

Potential Cancer Risk at Millcreek From Ground Water Ingestion Data Obtained From RI Sampling. Concentrations in (ug/l)

Monitoring Well	Compound	Concentration	UCR
MW-1	TCE	14	5×10^{-6}
MW-2	1,1-DCE TCE VCM	84 14 6.1	3×10^{-5} 5×10^{-6} 4.1×10^{-4} [= 4.5×10^{-4}]
MW-3	VCM	13	8.7×10^{-4}
MW-4	VCM	32	[= 2.1×10^{-3}]
MW-5	TCE VCM	6.4 33	2.3×10^{-6} 2.2×10^{-3} [= 2.3×10^{-3}]
MW-6	EDC VCM	6 110	6.3×10^{-6} 7.3×10^{-3} [= 7.3×10^{-3}]
MW-7	1,1-DCE TCE VCM	6.4 5 220	2.7×10^{-5} 1.8×10^{-6} 1.5×10^{-3} [= 1.5×10^{-3}]
MW-9	1,1-DCE VCM	11 91	4.6×10^{-5} 6.1×10^{-3} [= 6.1×10^{-3}]
MW-10	1,1-DCE TCE VCM	8.5 300 120	3.5×10^{-5} 1.1×10^{-4} 8.0×10^{-3} [= 8.1×10^{-3}]

G 564

MW-11	VCM	6.4	4.3×10^{-4}
MW-23B	1,1-DCE	16	6.7×10^{-5}
	TCE	140	5×10^{-5}
	VCM	200	1.3×10^{-2}
			[= 1.3×10^{-2}]

Total UCR converted to Exponential Values

Monitoring Wells	UCR	UCR Exponential
MW1	5×10^{-6}	$10^{-5.3}$
MW2	4.9×10^{-4}	$10^{-3.3}$
MW3	8.7×10^{-4}	$10^{-3.1}$
MW4	2.1×10^{-3}	$10^{-2.7}$
MW5	2.3×10^{-3}	$10^{-2.6}$
MW6	7.3×10^{-3}	$10^{-2.1}$
MW7	1.5×10^{-3}	$10^{-2.8}$
MW9	6.1×10^{-3}	$10^{-2.2}$
MW10	8.1×10^{-3}	$10^{-2.1}$
MW11	4.3×10^{-4}	$10^{-3.4}$
MW23B	1.3×10^{-2}	$10^{-1.9}$

Probably the greatest difficulty encountered in estimating downgradient concentrations of VCM is determining the rate of TCE and 1,2-dichloroethene (1,2-EDC) biodegradation to VCM. It is readily apparent that TCE is rapidly degrading to 1,2-DCE which is degrading to VCM at a slower rate. Evidence of TCE and 1,2-DCE biodegradation is provided in Table 12(A) and Figure 6(A) Concentrations of TCE in ground water were compared with its biodegradation break down products (1,2-DCE, VCM) and are presented in Table 12(A) and Figure 6(A) in ratios. Biodegradation has been documented at other sites and occurs under reducing and anaerobic conditions. The fact that ground water at the site is reducing is borne out by the high concentrations of dissolved iron and manganese present in the ground water. There has been some scientific discussion as to whether microbes use TCE and 1,2-DCE as a sole carbon source or as secondary source being degraded as another substitute is consumed. It may be significant to note that hydrocarbons are also present with VOC contamination in the eastern part of the site and may be acting as a primary carbon source. Hydrocarbons exceed 1 mg/l is some monitoring wells.

TCE biodegradation is important because the breakdown product of 1,2-DCE is more carcinogenic than the original compound.

Molar Ratio of 1,2-DCE and VCM to TCE

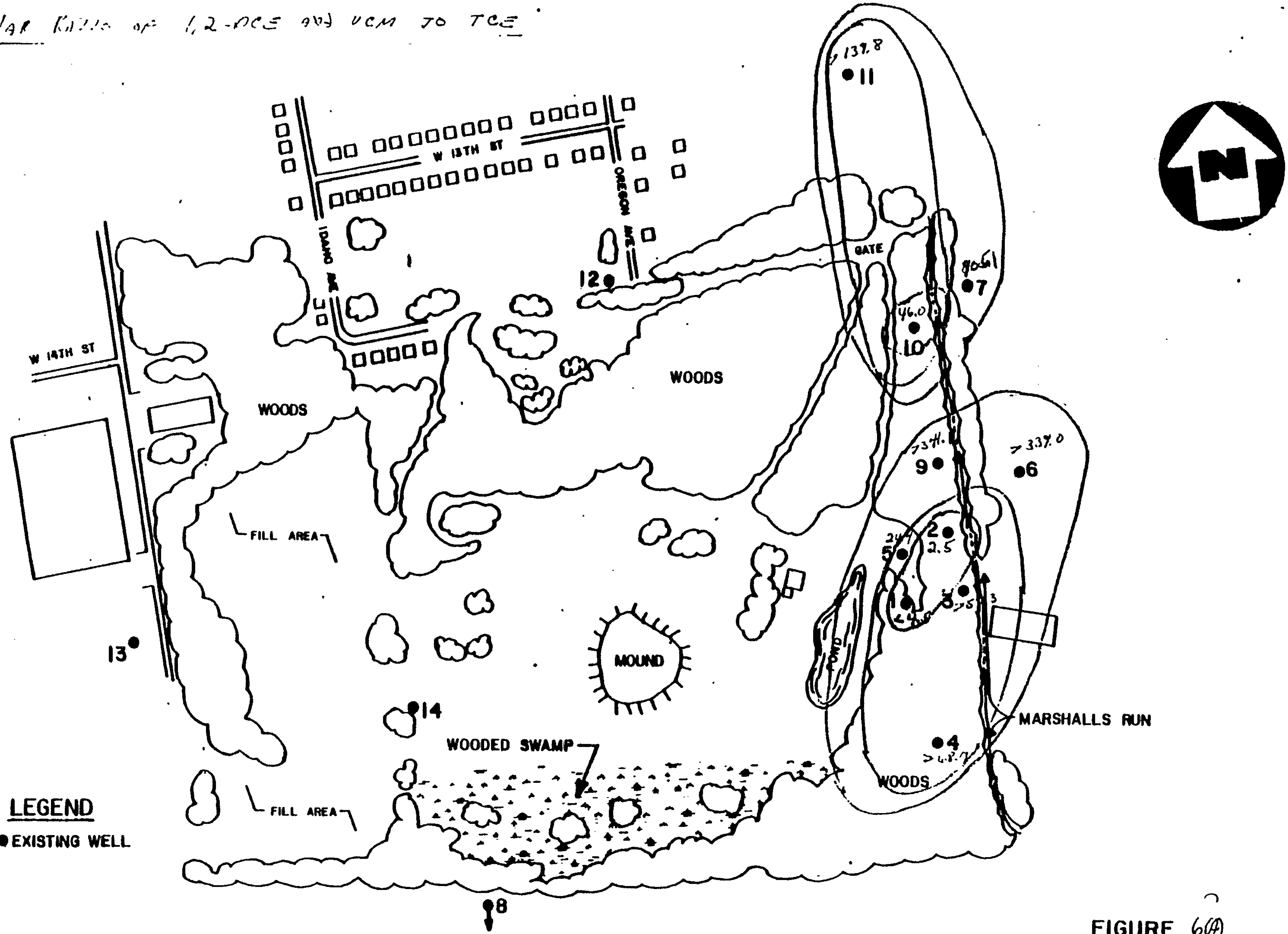

FIGURE 6A

EXISTING MONITORING WELL LOCATION MAP

MILLCREEK SITE, MILLCREEK TWP, PA

TABLE 11(A)-1

TEMPORAL TRENDS OF VOC GROUNDWATER CONTAMINATION AT Millcreek

VOC	MW-1				MW-2				MW-3				
	7/82 PADER	12/82 BET	8/84 KI	12/85 KI	7/82 PADER	1/83 PADER	8/84 KI	12/85 KI	7/82 PADER	12/82 BET	1/83 PADER	8/84 KI	12/85 KI
chloroethane						350	32	70/23					
1,1-dichloroethane	99	29	25	6	1000	2000	210	1090/1170	41	40	21	12	
1,2-dichloroethane	10				20	14		3/08	0				
1,1,1-trichloroethane	700	100	160		5000	4000	960	2120/2190	27	47	24	6.9	
1,1,2-trichloroethane					12	3							
vinyl chloride	200	110		4	200	18	61	15/10	20	67	73	13	NA
1,1-dichloroethene					40	10	44	5/5					
1,2-dichloroethene	400	180	47	4	200	41	16	12/11	47	93	47	22	
trichloroethene		27	14				14						
ethyl benzene		12											
total xylenes			45										
toluene					80	2							
	MW-4			MW-5				MW-6				MW-7	
	7/82 PADER	8/84 KI	12/85 KI	7/82 PADER	12/82 BET	8/84 KI	12/85 KI	12/82 BET	8/84 KI	12/85 KI	12/82 BET	8/84 KI	12/85 KI
chloroethane									44				
1,1-dichloroethane				200		27				50			
1,2-dichloroethane									6	40			
1,1,1-trichloroethane			NA	500		46			26	30			
vinyl chloride	13	12		500		33	2		110	34			
1,1-dichloroethene												220	110
1,2-dichloroethene	37	32							77	38	36,000	300	7,000
chloroform													
	MW-9			MW-10			MW-13		MW-11				
	12/82 BET	8/84 KI	12/85 KI	12/82 BET	8/84 KI	12/85 KI	8/84 KI	12/85 KI	12/82 BET	8/84 KI	12/85 KI		
chloroethane		7	7										
1,1-dichloroethane	40	400	200			6					2		
1,2-dichloroethane		46	6					6					
1,1,1-trichloroethane	36	570	900										
vinyl chloride	10	11	130		120	10	200	7		44	10		
1,1-dichloroethene			4		2.5	10	16						
1,2-dichloroethene	60	10	40	11,000	10,000	8/15	27,000	[illegible]	210	93	50		
trichloroethene					300	205	140						
toluene	54												
isophorone		73											
diethyl phthalate										24			
di-n-butyl phthalate										21			

ORIGINA

(red)

Table 11(A)-2

Potential Cancer Risk at Millcreek From Ground Water Ingestion Data Obtained December, 1985.

Monitoring Well	Compound	Concentration	UCR
MW-1	1,1-DCE	6	2.5×10^{-5}
	VCM	4	2.67×10^{-4}
			$2.92 \times 10^{-4} = 10^{-3.53}$
MW-2	EDC	3	3.2×10^{-6}
	VCM	15	1.10^{-3}
	1,1-DCE	5	2.1×10^{-5}
			$1.02 \times 10^{-3} = 10^{-3.0}$
MW-3	-	-	-
MW-4	-	-	-
MW-5	VCM	2	$1.33 \times 10^{-4} = 10^{-3.9}$
MW-6	VCM	54	3.6×10^{-3}
	EDC	20	2.11×10^{-5}
			$3.62 \times 10^{-3} = 10^{-2.4}$
MW-7	VCM	110	7.33×10^{-3}
	1,1-DCE	7	2.92×10^{-5}
			$7.36 \times 10^{-3} = 10^{-2.1}$
MW-9	VCM	130	8.7×10^{-3}
	EDC	6	6.3×10^{-6}
	1,1-DCE	5	2.1×10^{-5}
			$8.7 \times 10^{-3} = 10^{-2.1}$
MW-10	VCM	10	6.7×10^{-4}
	1,1-DCE	10	4.2×10^{-5}
	TCE	205	7.32×10^{-5}
			$7.8 \times 10^{-4} = 10^{-3.1}$
MW-23B	VCM	57	3.8×10^{-3}
	EDC	6	6.3×10^{-6}
			$3.8 \times 10^{-3} = 10^{-2.4}$
MW-11	VCM	10	$6.7 \times 10^{-4} = 10^{-3.2}$

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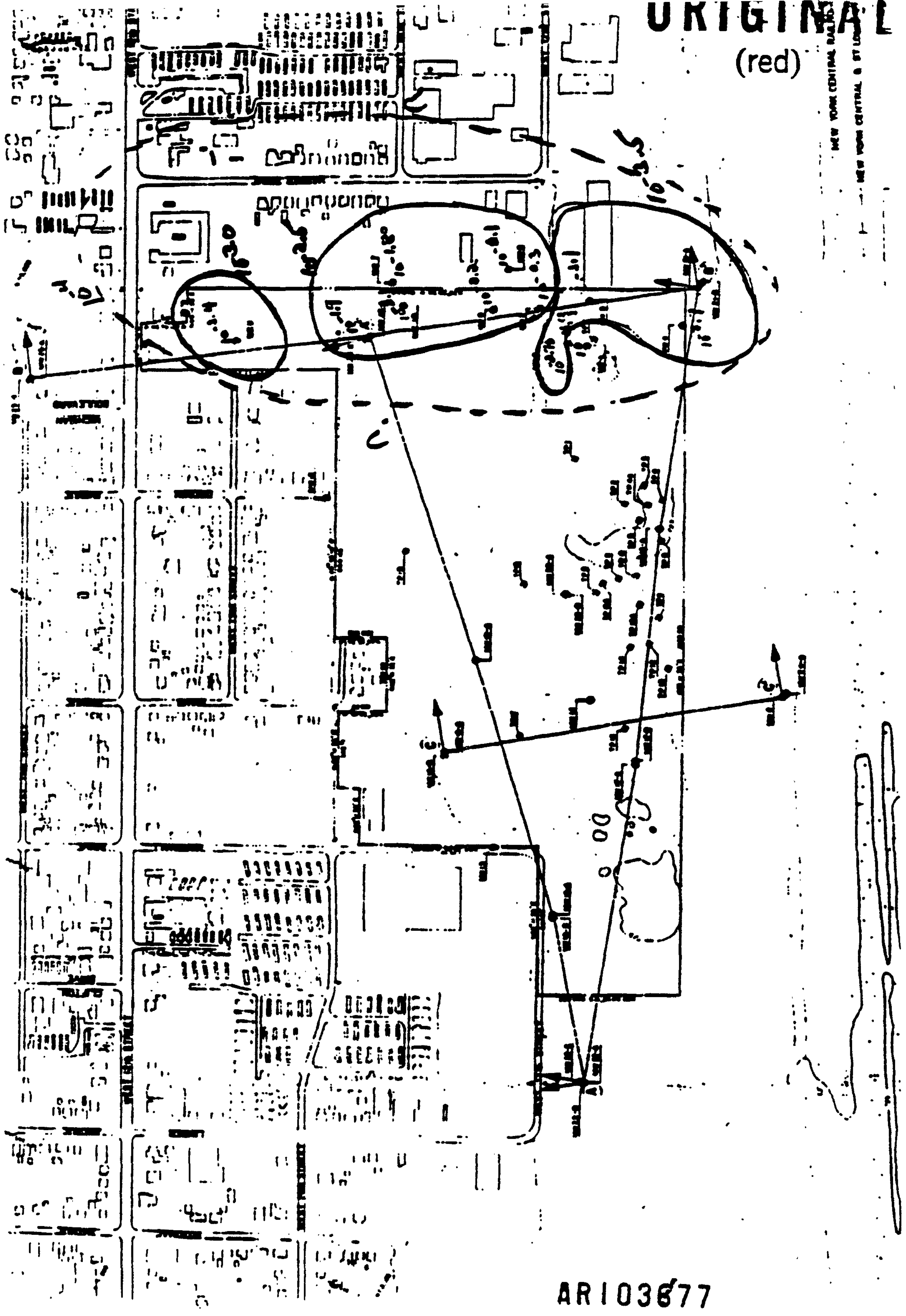


Fig. 5(A): Millcreek UCR - 8pt

Figure 5(A)-1: Millcreek UCR - 1'05

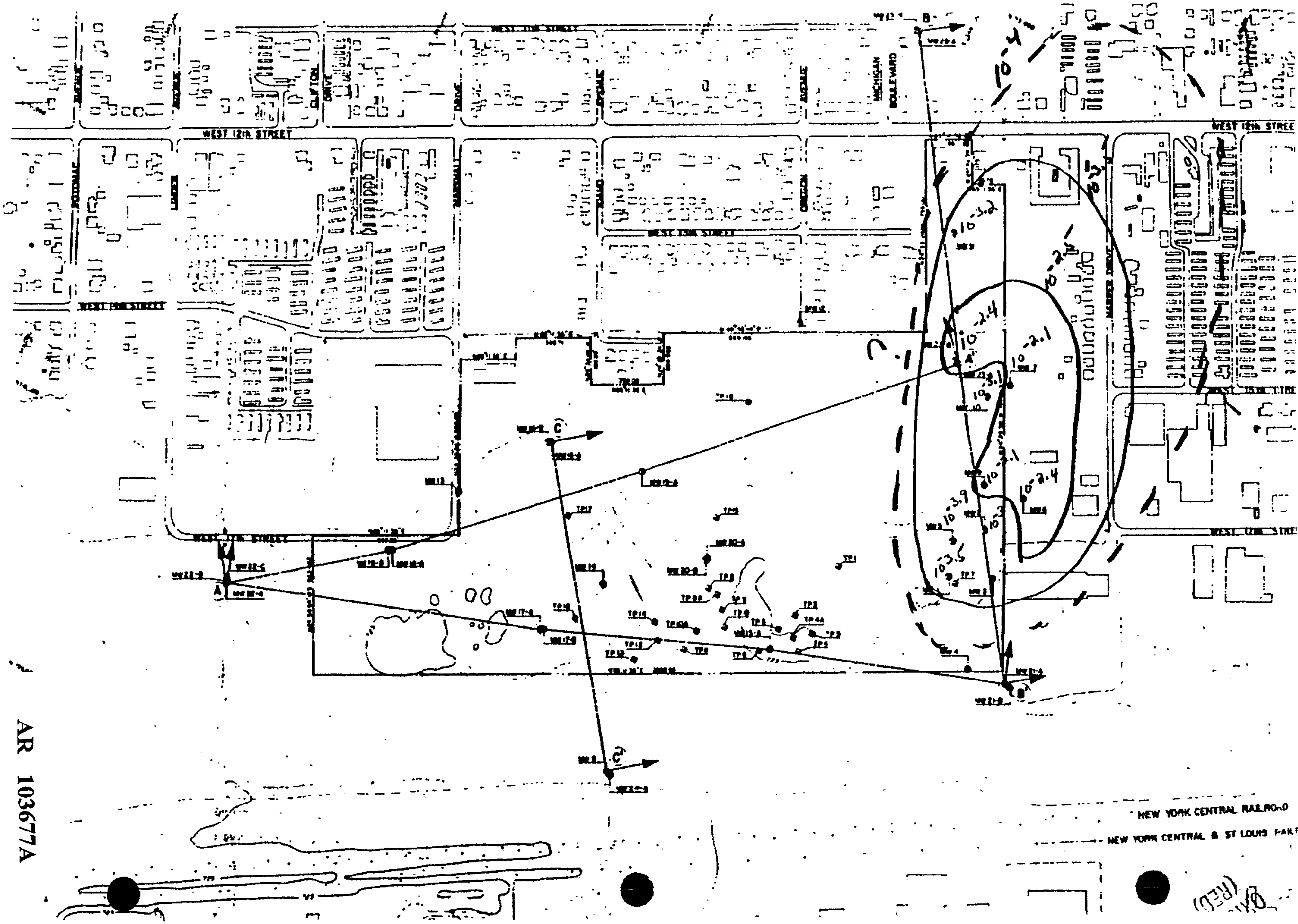


Table 12(A)

Molar Concentration of TCE, 1,2-DCE, and VCM in the Eastern Portion of Millcreek Site (u moles/l)

MW	TCE	1,2-DCE	VCM	(1,2-DCE + VCM)/TCE	1,2-DCE/VCM
1	106.6	485.0	<16.0	<4.5	>30.3
2	106.6	165.1	97.7	2.5	1.7
3	<7.6	227.0	208.2	>57.3	1.1
4	<7.6	330.2	192.2	>68.7	1.7
5	48.7	660.0	528.4	24.4	1.2
6	<7.6	815.3	1761.4	>339.0	0.5
7	38.1	30,959.8	3522.8	905.11	8.8
9	<7.6	1135.2	1457.2	>341.1	0.8
10	2284.0	103,199.2	1921.5	46.0	55.7
11	<7.6	959.8	102.5	>139.8	9.4
12	<7.6	<10.3	<16.0		
21A	<7.6	<10.3	<16.0		
21B	<7.6	<10.3	<16.0		
25A	<7.6	<10.3	<16.0		
25B	<7.6	52.6	<16.0		>3.3

The offsite risk level are above levels considered acceptable for an ACL demonstration (10^{-4} to 10^{-8}) Figure 5(A) leaves no doubt that an unacceptable cancer risk exists offsite for potential ground water users.

To estimate the downgradient 1,2-DCE and VCM concentration at Lake Erie and thus provide an the biodegradation rate constant of TCE and 1,2-DCE must be determined. This was done by developing mass balance equations to determine the total mass of TCE, 1,2-DCE, and VCM in ground water and aquifer soil. These calculations are extensive and thus are not presented here. Refer to section 8b for specific details. The equations do not consider volatilization of VCM or other volatiles from ground water. Table 13(A) illustrates the total mass of TCE, 1,2-DCE, and VCM present in ground water and in aquifer soil.

Table 13(A)

Mass Balance of TCE, 1,2-DCE, and VCM in Ground Water and Aquifer Soil

Compound	Amount Present in Ground Water (K mole)	Amount Present in Aquifer Soil (K mole)	Total (K mole)
TCE	11	138	149
1,2-DCE	926	158	1089
VCM	57	9	66

Total TCE, 1,2-DCE, and VCM mass equals about 1300 K mole. This is equivalent to 170,560 kg or 113 55-gallon drums of pure TCE.

Since current research indicates that biodegradation occurs mostly in the aqueous phase, it would appear that 138 K mole of TCE and 158 K mole of 1,2-DCE are currently not available for biodegradation into VCM. However, the estimated KOC values for TCE, and 1,2-DCE are low, 123 and 182 respectively, and thus these contaminants would be expected to eventually migrate to the aqueous phase.

To estimate biodegradation rates of TCE, the molar mass of break down products of TCE should be compared to the remaining molar mass of TCE over a specified time period. The same process would be followed in determining the biodegradation rate of 1,2-DCE to VCM.

To estimate the flow rate component of the calculation, Figure 7(A) may be useful. From the biodegradation pattern illustrated in Figure 6(A), it is hypothesized that the most significant original source of TCE contamination is near MW-10. The RI states that the direction of ground water flow is generally directly north. If the outer extent of the plume is at West 12th as illustrated on Figure 7(A), the plume would have traveled about 1125 feet in a certain time period. Data identifying the original disposal date are sparse, but it is generally believed that disposal occured less than 20 years ago. If 20 years is used as a time marker, the plume would be traveling at about 56 feet per year. The remedial investigation estimated that ground water flow velocity varied from 10.8 to 120 feet per year. For the purposes of estimating biodegradation rates then, 60 feet per year will be used.

First order kinetics will be used to estimate the biodegration rates. A first order kinetic equation is:

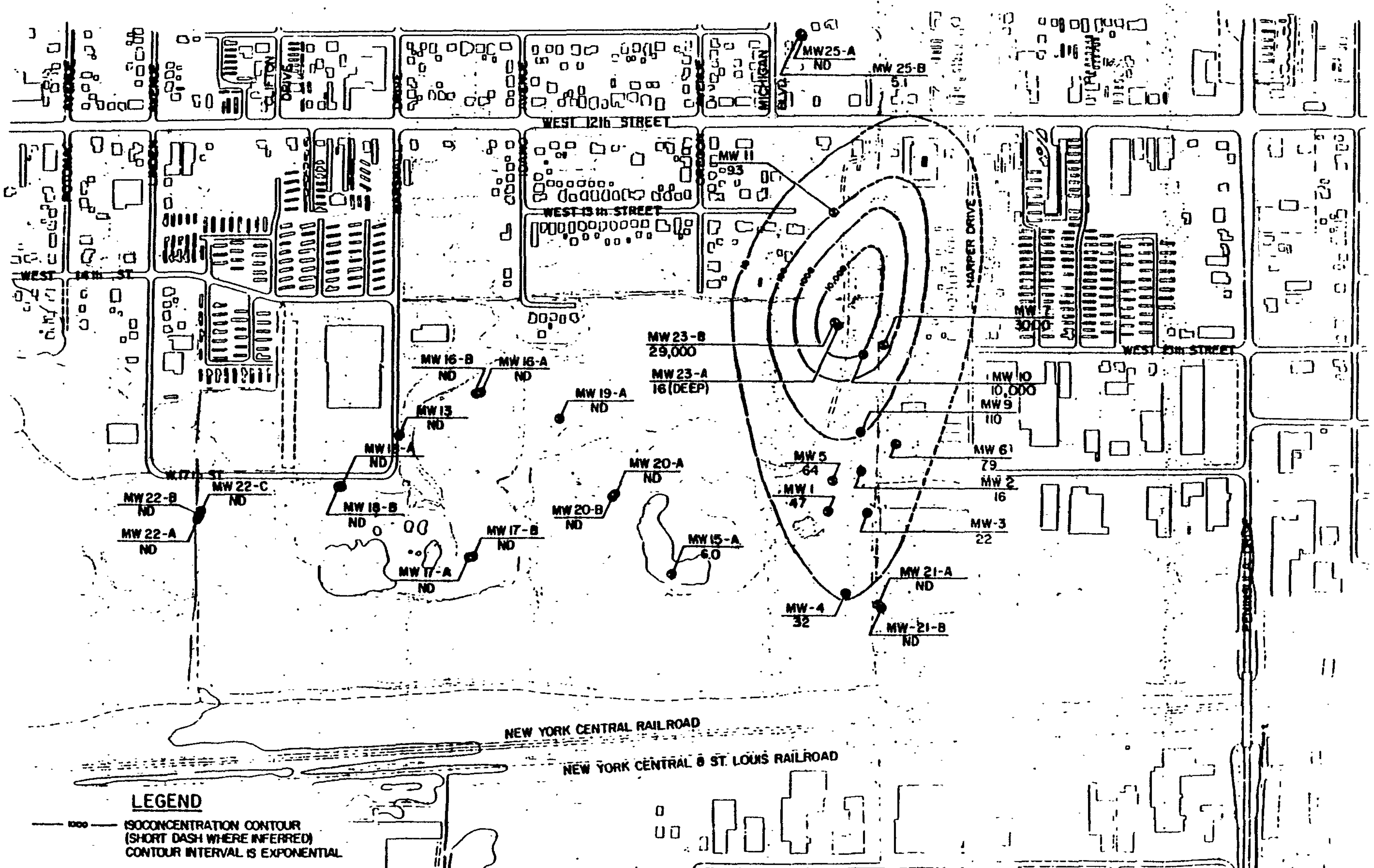
$$\frac{d(C)}{dt} = -K(C)$$

which is integrated to:

$$K = \frac{\ln(Co) - \ln(C)}{t}$$

where:

K = biodegradation constant
Co = concentration at time = 0
C = concentration after some specified time period
t = time under consideration



NOTE: CONCENTRATIONS AT INDIVIDUAL WELLS EXPRESSED IN MICROGRAMS PER LITER (ug/l); ND INDICATES NOT DETECTED. DATA REPRESENTED BASED ON NUS GROUNDWATER SAMPLING RESULTS OF 8/14-17/84.

FIGURE

ISOCONCENTRATION MAP FOR 1,2-DICHLOROETHENE
MILLCREEK SITE, MILLCREEK TWP., PA

SCALE: 1" = 500'

500 0 500

SCALE IN FEET

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Appendix 1a

Mass Balance Calculations for TCE, 1,2 - DCE, and VCM

Mass of 1,2 - DCE in Ground Water and Soil

1. Mass of 1,2 DCE in Ground Water

Refer to Figure 9(A) in RI. Use area of ellipse = (3.14)(a)(h)

A1 = 3.14(250)(125) = 98125ft.^{2}
A2 = 3.14(500)(250) - 98125ft.^{2} = 294,375ft.^{2}
A3 = 3.14(375)(625) - 294,375 - 98125 = 343,438ft.^{2}
A4 = 3.14(625)(1000) - 343,438 - 294,375 - 98124 = 1,226,563ft.^{2}

Depth of saturated zone = 16 feet for source estimate, assume whole saturate zone contains concentration of 1,2-DCE. Therefore Volume x Effective porosity =

V1 = 1,570,000ft.^{3} x 0.15 = 235,500ft.^{3}
V2 = 4,710,000ft.^{3} x 0.15 = 706,500ft.^{3}
V3 = 5,495,008ft.^{3} x 0.15 = 824,251ft.^{3}
V4 = 19,625,008ft.^{3} x 0.15 = 2,943,751ft.^{3}

Converting volumes to liters (28.32 l=ft.^{3}) and total mass

V1 = 6,668,617 l x 10mg/l = 6,6686kg
V2 = 20,008,080 l x 1mg/l = 20,008kg
V3 = 23,342,788 l x 0.1mg/l = 2334kg
V4 = 83,366,972 l x 0.01/mg/l = 834kg
89862kg

Which equals $\frac{89862kg}{97kg/Kmole}$ = 926 Kmole

2. Mass of 1.2 DCE in Soil

V1 = 1,570,000ft.^{3} - 235,500ft.^{3} = 1,334,500ft.^{3}
V2 = 4,710,000ft.^{3} - 706,500ft.^{3} = 4,003,500ft.^{3}
V3 = 5,495,008ft.^{3} - 824,251ft.^{3} = 4,670,757ft.^{3}
V4 = 19,624,992ft.^{3} - 2,943,749ft.^{3} = 16,681,243ft.^{3}

Ft.^{3} converted to M^3 (1ft.^{3} = 0.0283M^3) x Dry Bulk Density (1200 kg/M^3)

V1 = 37766M^3 x 1200kg/M^3 = 45,319,620kg
V2 = 113299M^3 x 1200kg/M^3 = 135,958,860kg
V3 = 132182M^{3}x 1200kg/M^3 = 158,618,908kg
V4 = 472,079M^3 x 1200kg/M^3 = 566,495,010kg

Using the Freundlich equation and concentrations of 1,2 DCE in ground water within volumes 1,2,3, and 4, and estimate can be made of concentration and mass of 1,2 DCE in soil.

$$Qe = Koc\ foc\ Ce$$

Assume N=1, thus a linear isotherm. Assume completely reversible, instantaneous equilibrium.

qe = concentration is dry soil (mg/kg)
Ce = dissolved concentration in ground water (mg/l)
Koc = organic carbon partition coefficients
foc = fraction of organic carbon in fill and underlying sediment.(See table 3(A))
(1.188% = 0.8955% + 1.775%)/3 = 1.29% or 0.013

	Ce(mg/l)	qe(mg/kg)
V1	10.0	0.26
V2	1.0	0.026
V3	0.10	0.0026
V4	0.01	0.00026

$$V1 = 43{,}319{,}620\text{kg} \times \frac{0.26\text{mg}}{\text{kg}} = 11{,}263\text{kg}$$

$$V2 = 135{,}958{,}860\text{kg} \times \frac{0.026\text{mg}}{\text{kg}} = 3535\text{kg}$$

$$V3 = 158{,}618{,}908\text{kg} \times \frac{0.00026\text{mg}}{\text{kg}} = 412\text{kg}$$

$$V4 = 566{,}495{,}010\text{kg} \times \frac{0.00026\text{mg}}{\text{kg}} = \underline{147\text{kg}}$$

$$15{,}347\text{kg}$$

$$\text{Which equals } \frac{15357\text{kg}}{97\ \text{kg/Kmole}} = 158\ \text{Kmoles}$$

Therefore, Total 1,2-DCE which has escaped from the unsaturated zone = 158 + 926 = 1084 Kmole

Mass of TCE in Ground Water and Soil

1. Mass of TCE in Ground Water

Refer to Figure 8(A) for aerial measurements. Area of ellipse was used

A1 = 3.14(125)(125) = 49,063ft.^{2}
A2 = 3.14(250)(125) - 49,063ft.^{2} = 49,062ft.^{2}
A3 = 3.14(625)(250) - 49,063 - 49,063 = 392,500ft.^{2}

Volume of ground water equals areas multiplied by effective porosity (0.15) and saturated thickness (16ft.)

V1 = 49,063ft.^{2} x 16ft. x 0.15 = 117,751ft.^{3}
V2 = 49,062ft.^{2} x 16ft. x 0.15 = 117,751ft.^{3}
V3 = 392,500ft.^{2} x 16ft. x 0.15 = 942,000ft.^{3}

Convert ft.^{3} to liters and multiply by concentrations of TCE to determine mass (28.32 = 1ft.^{3})

M1 = 117,751ft.^{3} x 28.32 l/ft.^{3} x 0.3mg/l x 1kg/1000mg = 1000kg
M2 = 117,751ft.^{3} x 28.32 l/ft.^{3} x 0.1mg/l x 1kg/1000mg = 333kg
M3 = 942,000ft.^{3} x 28.32 l/ft.^{3} x 0.005mg/l x 1kg/1000mg = 133kg

Total mass converted to Kmole

(1000+333+133)kg/131.2kg/Kmole = 11 Kmole

2. Mass of TCE is Soil

V1 = 117751/0.15 - 117751 = 667,256ft.^{3}
V2 = 117751/0.15 - 117751 = 667,256ft.^{3}
V3 = 942,000/0.15 - 942,000 = 5,338,000ft.^{3}

ft.^{3} converted to M^3 and multiplied by Dry Bulk Density (1200 kg/m^3) (1ft.^{3}=0.0283M^3)

M1 = 667,256ft.^{3} x 0.0283 M^3/ft.^{3} x 1200 kg/M^3 = 22,660,014kg
M2 = M1 = 22,660,014kg
M3 = 5,338,000ft.^{3} x 0.0283 M^3/ft.^{3} x 1200 kg/M^3 = 181,278,480kg

Using the freundlich equation when koc=140 and foc=0.013 equals
qe=kocfoc Ce

	Ce	qe
M1	0.3	0.546
M2	0.1	0.182
M3	0.0005	0.009

Mass x Soil Case = TCE Mass is Soil

$$M1 = 22{,}660{,}014kg \times 0.546 \frac{mg}{kg} \times \frac{kg}{1000mg} = 12372kg$$

$$M2 = 22{,}660{,}014kg \times 0.182 \frac{mg}{kg} \times \frac{kg}{1000mg} = 4124kg$$

$$M3 = 181278480kg \times 0.009 \frac{mg}{kg} \times \frac{kg}{1000mg} = 1632kg$$

Total mass converted to Kmole
(12372 + 4124 + 1632) kg/131.2kg/Kmole = 138 Kmole

Therefore, total TCE Mass in Soil and Ground Water = 149 Kmole

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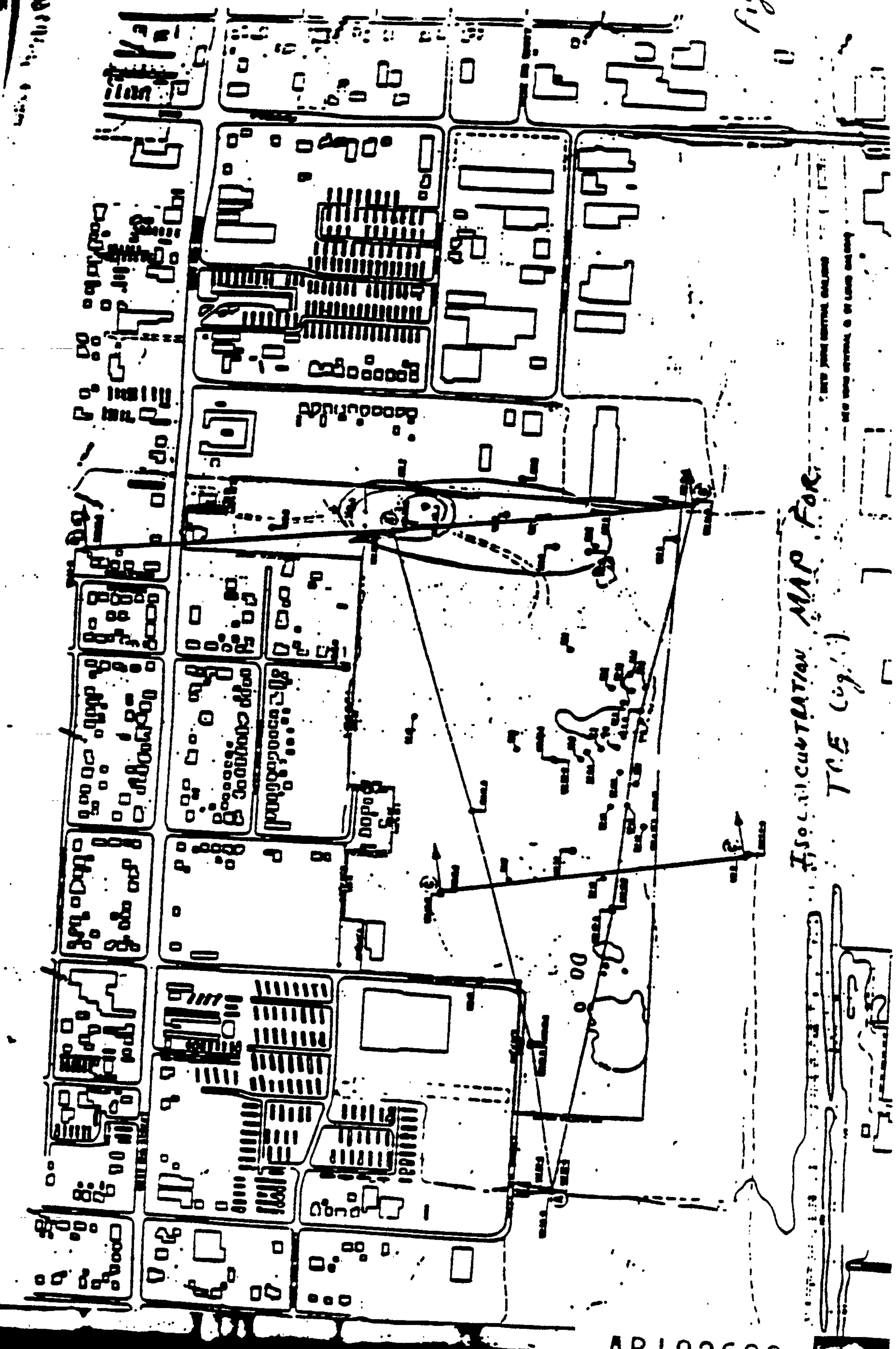

figure 5(1)

ISOCONCENTRATION MAP FOR TCE (ug/l)

Mass of VCM in Ground Water and Soil

1. Mass of VCM in Ground Water

Refer to Figure 10(A) for aerial measurements area of ellipse was used

A1 = 3.14(250)(125) = 98125ft.^{2}
A2 = 3.14(500)(250) - 98125 = 294,375ft.
A3 = 3.14(1000)(500) - 98125 - 294,375 = 1,177,500ft.^{2}

Volume of ground water equals areas multiplied by the effective porosity (0.15) and saturated thickness (16ft.)

V1 = 98125 ft.^{2} x 16ft. x 0.15 = 235,500ft.^{3}
V2 = 294,375ft^2 x 16ft. x 0.15 = 706,500ft.^{3}
V3 = 1,177,500 ft.^{2} x 16ft. x 0.15 - 2,826,000ft.^{3}

Convert ft.^{3} to liters (28.32 1 = 1ft.^{3}) and multiply by VCM concentrations to determine mass in ground water.

M1 = 235,000ft.^{3} x 28.32 1/ft.^{3} x 0.200mg/1 x kg/1000mg = 1334kg
M2 = 706,500ft.^{3} x 28.32 1/ft.^{3} x 0.090 mg/1 x kg/1000mg = 1801kg
M3 = 2,826,000ft^3 x 28.32 1/ft.^{3} x 0.005 mg/1 x kg/1000mg = 400kg

Total Mass converted to Kmole (1334 + 1801 + 400)kg/61.5 kg/Kmole = 57 Kmole.

2. Mass of VCM is Soil

V1 = 235,500/0.15 - 235,500 = 1,334,500ft.^{3}
V2 = 706,500/0.15 - 706,500 = 4,003,500ft.^{3}
V3 = 2,826,000/0.15 - 2,826,000 = 16,014,000ft.^{3}

Converting ft.^{3} to M^3 and multiplying by Dry Bulk Density (1200kg/M^3) glues soil mass.

M1 = 1,334,500ft.^{3} x 0.0283M^3/ft.^{3} x 1200kg/M^3 = 45,319,620g
M2 = 4,003,500ft.^{3} x 0.0283M^3/ft.^{3} x 1200kg/M^3 = 135,958,860kg
M3 = 16,014,000ft.^{3} x 0.0283M^3/ft.^{3} x 1200kg/M^3 = 543,835,440kg

Using the Freundich equation with Koc = 2 and Foc = 0.013

qe=KocFocCe

	Ce(Mg/1)	qe(Mg/kg)
M1	0.200	0.005
M2	0.090	0.002
M3	0.005	0.0001

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(red)

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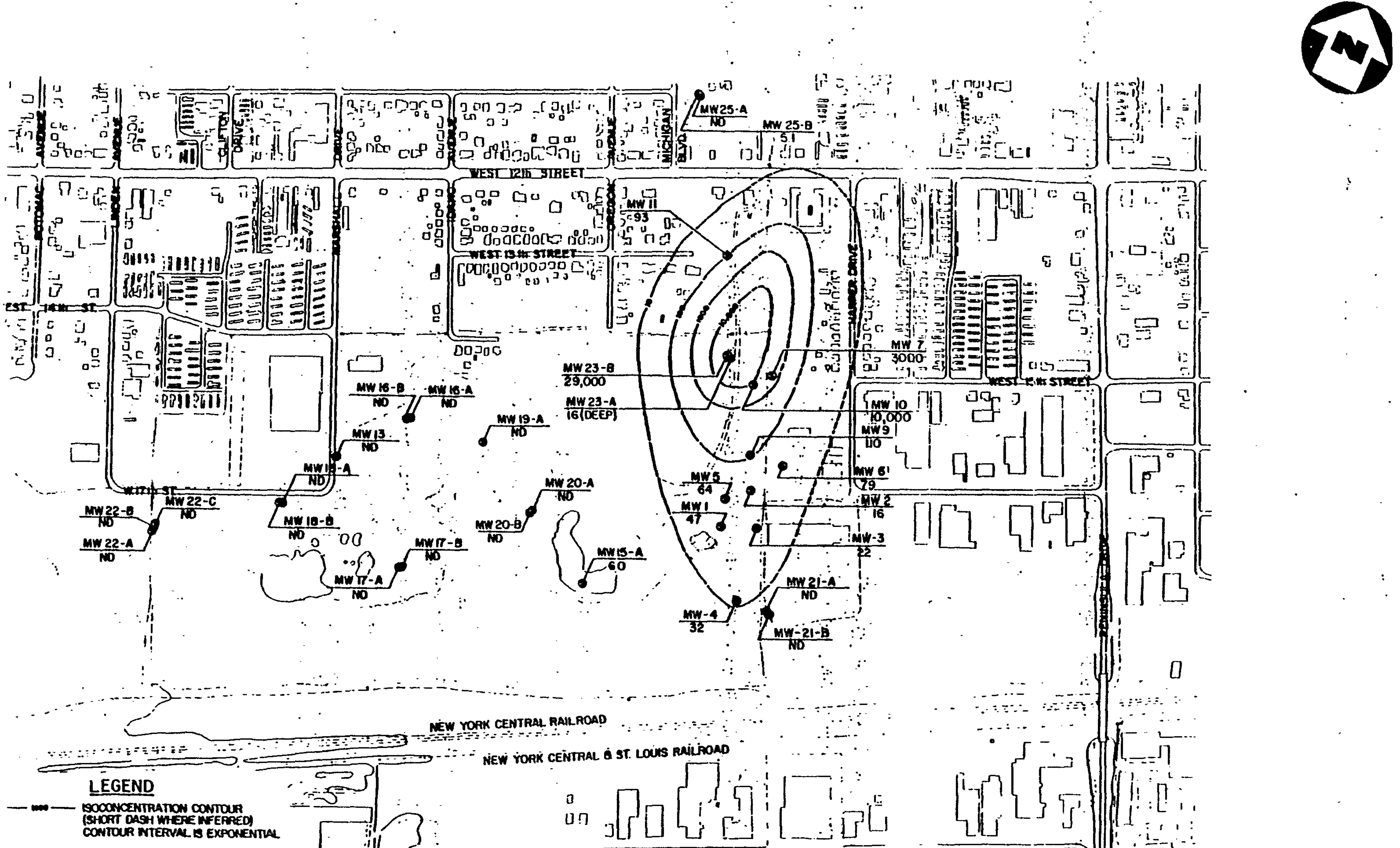
Mass V Soil Canc = VCM Mass in Soil.

M1 = 45,319,620kg x 0.005mg/kg x kg/1000mg = 227kg
M2 = 135,958,860kg x 0.002mg/kg x kg/1000mg = 272kg
M3 = 543,835,440kg x 0.0001mg/kg x kg/1000mg = 54kg

Total soil mass converted to Kmole.
(227 + 272 + 54)kg/61.5kg/Kmole = 9 Kmole

Therefore, total VCM mass = 9 + 57
66 Kmole



NOTE: CONCENTRATIONS AT INDIVIDUAL WELLS EXPRESSED IN MICROGRAMS PER LITER (ug/l); ND INDICATES NOT DETECTED. DATA REPRESENTED BASED ON NUS GROUNDWATER SAMPLING RESULTS OF 8/14-17/84.

FIGURE 9(A)

ISOCONCENTRATION MAP FOR 1,2-DICHLOROETHENE MILLCREEK SITE, MILLCREEK TWP., PA

SCALE: 1" = 500'

500 0 500
SCALE IN FEET

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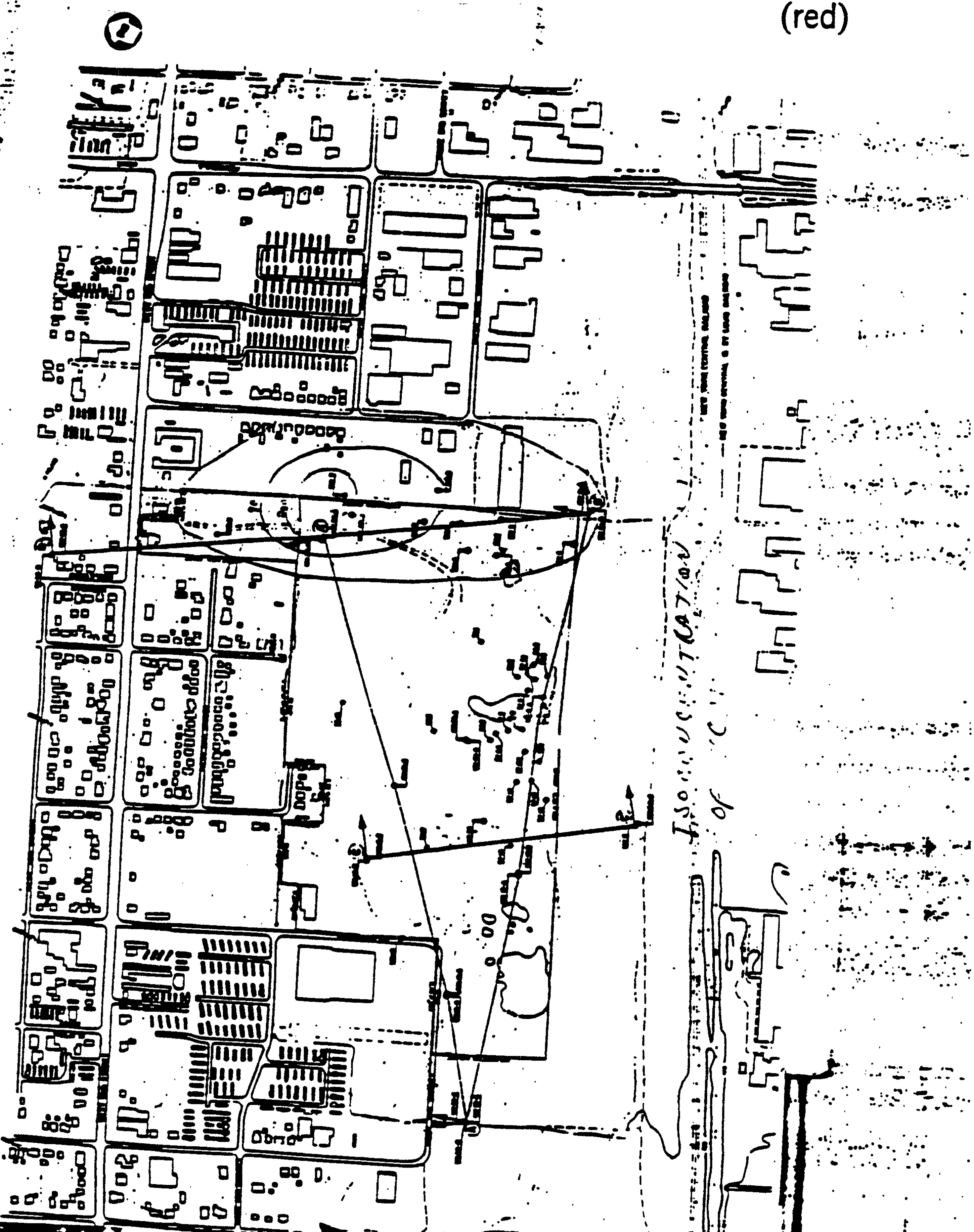

Section 9

Potential Damage to Wildlife, Vegetation, Agriculture, and Physical Structures

At the Millcreek Site, damage to agriculture and physical structures are not relevant concerns. Only potential adverse effects from ground water contaminants on aquatic life and wildlife will be considered since this is a more likely pathway of contamination. EPA has initiated a biological assessment of the site through an Interagency Agreement (IAG) with the U.S. Fish and Wildlife Service. Fish, rabbit, and rodent samples were collected from the site to determine possible biocentration and bioaccumulation trends. A macroinvertebrate diversity index was also completed. Results from the diversity index and sample analysis are not yet available so field data are not available to assist in determining safe ground water discharge levels to protect aquatic life and wildlife which may ingest aquatic life. Literature data will be used to propose safe ground water discharge levels. Table 14(A) represents data gathered from ambient water quality documents and illustrates contaminant levels necessary to protect aquatic and wildlife. The level for iron is not based on criteria but a regional estimate of levels which could endanger aquatic life.

The selected compliance point will be ground water levels in the eastern portion of the site since it is assumed that ground water discharges to the surface water flow during most times of the year. Criteria are proposed to protect aquatic life adjacent to the site in Marshalls Run.

Safe levels of TIC compounds detected in ground water were not estimated because of inadequate data. Region III is currently researching available data and will propose compliance limits during design or predesign.

Compliance for carcinogens and non carcinogens should be determined in an additive fashion as previously described.

Table 14(A)

Suggested Ground Water Goals to Protect Aquatic Life and Wildlife Ingesting Aquatic Life

Compound	Goals
Organics	
volatiles	1000
phenols	500
phthalates	3
Inorganics	
lead	10.8
copper	26.8
arsenic	190
cadmium	2.4
chromium III	341
chromium VI	11
mercury	0.012
zinc	710
nickel	295
iron	1000
cyanide	5.2
ammonia (Total)	1500

T - assume 260 ug/l $CaCO_3$ hardness, pH = 7.5, and T = 15°C

Section 10

Summary of Ground Water Goals For Present Ground Water Contamination

Table 15(A) summarizes the Ground Water Goals to protect human health through direct consumption of ground water, human health through ingestion of aquatic life, wildlife through the ingestion of aquatic life and aquatic life. Compliance will be established separately in an additive manner for carcinogens and non-carcinogens as previously explained. For carcinogens for direct human ingestion, a 10^{-6} UCR is deemed acceptable for presently contaminated ground water.

Table 15(A)

Recommended Ground Water Goals for Present Groundwater Contamination

Compound	Goals (ug/l)
Volatiles	
1,2-dichloroethane	95 (direct ingestion)
1,1,1-trichloroethone	22 (direct ingestion)
vinyl chloride	0.015 (direct ingestion)
1,1-dichloroethene	0.24 (direct ingestion)
1,2-dichloroethene	70 (direct ingestion)
trichloroethene	1.8 (direct ingestion)
chloroform	0.19 (direct ingestion)
toluene	2000 (direct ingestion)
benzene	0.70 (direct ingestion)
ethyl benzene	680 (direct ingestion)
xylene	440 (direct ingestion)
phenols	300 (direct ingestion)
Base/Neutrals	
phthalates	3 (aquatic life)
Inorganics	
lead	10.8 (aquatic life)
copper	26.8 (aquatic life)
arsenic	50 (MCL)
cadmium	2.4 (aquatic life)
chromium III	341 (aquatic life)
chromium VI	11 (aquatic life)
mercury	0.012 (aquatic life)
zinc	710 (aquatic life)
nickel	295 (aquatic life)
iron	1000 (aquatic life)
cyanide	5.2 (aquatic life)
ammonia	1500 (aquatic life)

Appendix B

Establishment of Proposed Soil Criteria

Soil Contamination

Perhaps the way to approach remediating soils at this site is to establish saf soil criteria for each contaminant and conducting appropriate action on soils which exceed these criteria. A less stringent approach could be taken on soil which are below criteria but above background. The following proposal is presented:

1. Establish safe levels in unsaturated soils for each contaminant base on future potential effect on groundwater only.
   - Contaminants in saturated soils should be addressed during groundwater remediation.
   - Air and surface water runoff pathways need not be considered since it is assumed that all soils containing above background levels of contaminants will at least be covered with soil capable of supporting vegetation. At least a soil cover over these areas is necessary to prevent the inhalation of contaminants adsorbed to particulates via wind dispersal.
   - Ground water receptors considered will be the same listed on the previous page.
   - Mathematical models will be necessary to develop criteria i.e. RCRA delisting model or SESOIL.
   - Batch or column testing may be needed to check empirically deraive equations used.
2. Use soil criteria and additional soil sampling to compartmentilize site soils. Sampling costs could be kept down by selective analysis: i.e. anaylze only ABNs or PCBs in certain areas of the site. The site could be broken down into numerous compartments and separted into compartments which exceed criteria or don't exceed criteria.
3. Excavate compartments which exceed criteria and move soils to an area on site which will be capped or covered with relatively impermeable soils.

1. Appendix VIII Compounds Detected in Soil During the RI and ERT Investigation

Sustance	Concentration Range (ug/kg)
Volatiles	
Methylene chloride	2 - 650*
fluorotrichloromethane	3 - 12*
1,1,1-trichloroethane	3 - 27
acetone	19 - 1,670*
chloroform	73 - 88
trichloroethene	13 - 1,670
1,1-dichloroethane	5
vinyl chloride	733
1,2-dichloroethene	7 - 5,300
toluene	3 - 1,610
benzene	3 - 16
ethyl benzene	9 - 94
xylenes	23 - 144
2-hexanone	5 - 126
chloroethane	ND
1,2-dichloroethane	ND
1,1-dichloroethene	ND
Acid Compounds	
phenol	130 - 6800
4-methylphenol	200 - 4430
2-methylphenol	210 - 240
2,4-dimethylphenol	190 - 917
Base/Neutral Compounds	
bis (2-ethylbexyl) phthalate	400 - 480
di-n-butylphthalate	93 - 72,000
di-noctylphlhalate	69 - 9,100
butylbenzlphthalate	120 - 2,100
naphthalene	116 - 15,700
anthracene	659 - 15,700
2-methylnapthalene	66 - 1950
benzo (b) fluoranthene	320 - 350,000
benzo (k) fluoranthene	560 - 350,000
fluoranthene	150 - 115,000
chrysene	230 - 40,500
pyrzene	180 - 43,400
phenanthrene	100 - 26,000
benzo (a) pyrene	690 - 85,000
Indeno (1,2,3-cd) pyrene	480 - 44,600
benzo (g,h,i) perylene	450 - 55,200
benzo (a) anthracene	140 - 46,000

acenaphthylene	90 - 450
dibenz (a,h) anthracene	544 - 3400
acenaphthene	68 - 697
fluorene	52 - 15,700
dibenzofuran	55 - 360
PCBs	
PCB - 1248	98 - 6300
PCB - 1260	3000 - 31,000
PCB - 1254	12 - 400
Pesticides	
dieldrin	181
Inorganics	(mg/kg)
lead	7.2 - 2,375
chromium	8 - 820
cadmium	0.4 - 10
iron	13,335 - 74,355
manganese	209 - 14,260
copper	18 - 20,500
vandium	4.7 - 312
mercury	0.1 - 3
zinc	69 - 7450
arsenic	16 - 25

* - will not be considered further because of suspected Laboratory Contamination.

ND - Not detected in soil but detected in Ground Water, thus will be considered in soil criteria.

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2. Background Levels of Metals in the Eastern United States

Metal	Mean	Range
Arsenic	4.8	<0.1 - 73
Chromium	33	1 - 1000
Copper	13	<1 - 700
Iron	14,000	100 - 100,000
Mercury	0.081	0.01 - 3.4
Manganese	260	<2 - 7,000
Nickel	11	<5 - 700
Lead	14	<10 - 300
Tin	0.86	<0.1 - 10
Thallium	7.7	2.2 - 23
Zinc	40	<5 - 2900

FROM: Element Concentrations in Soils and other Surficial Materials of the Conterminous United States, U.S.G.S. Professional Paper 1270, 1984.

3. Log Kow and Log Koc values for Appendix VIII Compounds in Soil

Compound	Log Kow	Log Koc eqn 1	Log Koc eqn 2	Avg. Log Koc
Volatiles				
Chloroethane	1.54			1.51+
1,1-dichloroethane	1.79			1.63+
1,2-dichloroethane				1.51+
1,1,1-trichloroethane	2.17			2.74+
vinyl chloride	0.60			0.39+
1,1-dichloroethene	0.73			2.26+
1,2-dichloroethene	1.48			2.26+
trichloroethene	2.29			2.09+
Chloroform	1.97			1.58+
toluene	1.46	1.36	1.25	1.31
benzene	2.01	1.88	1.80	1.84
ethyl benzene	3.15	2.95	2.94	2.94
xylene	3.55*	3.32	3.34	3.33
2-hexanone	0.66			0.39+
Acids				
Phenol	1.46	1.36	1.26	1.32
2-methylphenol	1.94	1.81	1.73	1.78
4-methylphenol	1.94	1.81	1.73	1.78
2,4-dimethylphenol	2.42	2.26	2.21	2.24
Base/Neutral				
Diethyl phthlate	3.22	3.01	3.01	3.01
Bis(2-ethylhexyl) phthalate	5.3	4.96	5.09	5.03
Di-n-butylphthalate	5.20	4.87	5.00	4.93
Di-n-octylphthalate	9.2	8.61	8.99	8.84
Butylbenzl phthalate	5.8	5.43	5.59	5.52
Naphthalene	3.36	3.14	3.15	3.15
2-methylnapthalene	4.02	3.76	3.81	3.79
Anthracene	4.45	4.16	4.24	4.20
Benzo(a)anthracene	5.60	5.24	5.39	5.32
Dibenz(a,h)anthracene	5.97	5.59	5.76	5.68
Flouranthene	5.53	5.18	5.32	5.26
Benzo(b)fluoranthene	6.60	6.18	6.39	6.30
Benzo(k)fluoranthene	6.85	6.41	6.64	6.54
Pyrene	5.30	4.96	5.09	5.03
Benzo(a)pyrene	6.04	5.65	5.83	5.75
Indeno(1,2,3-cd) pyrene	7.66	7.17	7.45	7.33
Chrysene	5.60	5.24	5.39	5.32
Phenanthrene	4.46	4.18	4.25	4.22
Benzo(g,h,i) perylene	7.23	6.77	7.02	6.91
Acenaphthene	4.33	4.05	4.12	4.09
Acenaphthylene	3.94	3.69	3.73	3.71
Fluorene	4.18	3.91	3.97	3.94
Dibenzofuran	4.12	3.85	3.91	3.88
Isophorone	1.70	1.59	1.49	1.54

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Compound	Log Kow	Log Koc egn 1	Log Koc egn 2	Avg. Log Koc
PCBs				
PCB-1248	6.11	5.72	5.90	5.82
PCB-1254	6.03	5.64	5.82	5.74
PCB-1260	7.14	6.68	5.93	6.82
Pesticides				
Dieldrin	5.48	5.13	5.27	5.51

Equation 1: derived from Brown *et al*; equals log Koc = 0.937 log Kow - 0.006, has an R2 value of 0.95 and was derived from aromatics, polynuclear aromatics, triazines, and dinitroaniline herbicides.

Equation 2: was derived from Karickhoff; equals log Koc - log Kow - 0.21, has an R2 value of 1.00 and was derived from mostly aromatic or polynuclear aromatics.

* = estimated from ortho, meta and para values.

\+ = derived from Chiou *et al* for chlorinated hydrocarbons equals; Log Koc = - 0.557 log S + 4.277 where S = solubility in umoles/l.

4. Toxicological Properties of Organic Appendix VIII Compounds Detected in Soil

Compound	Protection of Human Health thru Ingestion (ug/1)	Protection of Aquatic Life (ug/1)	Protection of Human Health thru Ingestion of Aquatic Life (ug/1)
Volatiles		1000*	
Chloroethane	N/A	N/A	N/A
1,1-dichloroethane	400(ADI)	N/A	N/A
1,2-dichloroethane	0.95(UCR)	N/A	N/A
1,1,1-trichloroethane	22(HA)	18,000	N/A
vinyl chloride	0.015(UCR)	50,000	N/A
1,1-dichloroethene	0.24(UCR)	N/A	N/A
1,2-dichloroethene	70(HA)	N/A	N/A
trichloroethene	2.8(UCR)	45,000	N/A
Chloroform	0.19(UCR)	28,900	N/A
toluene	2000(HA)	17,500	N/A
benzene	0.7(UCR)	5,300	N/A
ethyl benzene	680(HA)	32,000	N/A
xylene	440(HA)	N/A	N/A
			N/A
Acids			N/A
Phenol			N/A
2-methylphenol	300(taste)	2560	N/A
4-methylphenol			N/A
2,4-dimethylphenol			N/A
Base/Neutral			
Diethyl phthate	N/A		1,800,000
Bis(2-ethylhexyl) phthalate	N/A		50,000
Di-n-butylphthalate	N/A	3.0	154,000
Di-n-octylphthalate	N/A		N/A
Butylbenzl phthalate	N/A		N/A
Naphthalene	N/A	620	N/A
2-methylnapthalene		N/A	N/A
Anthracene		N/A	
Benzo(a)anthracene		N/A	
Dibenz(a,h)anthracene		N/A	
Flouranthene	0.0029(UCR)	N/A	0.031(UCR)
Benzo(b)fluoranthene		N/A	
Benzo(k)fluoranthene		N/A	
Pyrene		N/A	
Benzo(a)pyrene		N/A	

HA = Health Advisory, Office of Drinking Water September, 1985

N/A = Not Applicable

* = levels of volatiles protective of aquatic life are variable; 1000 ug/1 will be considered a safe concentration for total volatiles.

UCR = 10_{-6} unit cancer risk factor

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Compound	Protection of Human Health thru Ingestion (ug/1)	Protection of Aquatic Life (ug/1)	Human Health thru Ingestion of Aquatic Life (ug/1)
Indeno(1,2,3-cd)pyrene			
Chrysene			
Phenoanthrene			
Benzo(g,h,i) perylene	0.0029(UCR)	N/A	0.031(UCR)
Acenaphthene			
Acenaphthylene			
Fluorene			
Dibenzo furan	N/A		N/A
Isophorone	N/A	117,000	N/A
PCBs			
PCB-1248			0.005 (back-ground)*
PCB-1254	0.081(UCR)	0.014	
PCB-1260			
Pesticides			
Dieldrin	0.000071	0.0019	
Inorganics			
Lead	20(HA)	10.8	N/A
Copper	1000(SMCL)	26.8	N/A
Arsenic	50(MCL)	190	N/A
Cadmium	5(HA)	2.4	N/A
Chromium III	170,000(MCL)	341	N/A
Chromium VI	50(MCL)	11	N/A
Mercury	3(HA)	0.012	N/A
Zinc	5000(SMCL)	710	N/A
Nickel	150(HA)	197	N/A
Iron	300(SMCL)	1000	N/A
Manganese	50(SMCL)	N/A	N/A
Tin	N/A	N/A	N/A
Aluminum	N/A	N/A	N/A
Cyanide	750(HA)	5.2	N/A
Ammonia(unionized)	N/A	128	N/A

For inorganics established to protect aquatic life assumed hardness of 260 mg/l as Ca CO_3 pH = 7.5, and temperature = 15°C.

Note: UCR values represent 10^{-6} risk factors. UCR values for PNAs and PCBs represent values as a class of compounds not individual compounds. For example, the 10^{-6} VCR for PNAs = 0.0029 ug/l for direct human ingestion, therefore all PNAs in drinking water should not additively exceed 0.0029 ug/l.

* The 10^{-6} UCR for PCBs to protect human health thru ingestion of aquatic life is actually 0.000079 ug/l but PCBs are found in concentrations exceeding 0.005 ug/l in Lake Erie.

5. Establishment of Safe Soil Organic Contaminant Levels

To establish safe soil levels to prevent the future contamination of ground water, the following steps were followed:

1) determine receptor location;
2) determine acceptable contaminant concentration at receptor location;
3) determine source location;
4) determine ground water contaminant concentration at source which could cause contaminant concentration above acceptable limits at the receptor;
5) determine soil concentration which would cause a ground water contaminant level at the source which would eventually cause concentration above acceptable limits at the receptor.

Step one is established by examining each possible receptor location, associated toxicological effects of contaminants, and distance of receptor from source. The most sensitive receptor is chosen. Three primary receptor pathways were established while reviewing site data.

1) Direct future downgradient human ingestion of contaminated ground water.

2) Chronic effects on aquatic life in surface water resulting from contaminated ground water discharge.

3) Human and wildlife ingestion of aquatic life in stream adjacent to site and wetlands within site.

Step two is determined by examining most current EPA criteria and appropriate toxicological literature. Step three is determined by examining soil contamination patterns. In this case, Figure 1 was used.

Step four involves the use of an appropriate ground water model. In this case, the RAPID assessment model was used. Step five is probably the most difficult and entails establishing an unsaturated zone contaminant flow model. In this case, a model for organics was developed utilizing:

- the Freundich equation isotherm
- annual percolation
- area of contamination
- ground water flow velocity
- thickness of the saturated zone
- total organic carbon content of fill

The Freudich equation is presented below:

$$Qe = Koc\ Foc\ Ce^{1/n}$$

Where:

Qe = the dry weight concentration of an nonionic organic compound in soil (mg/kg).

Ce = the equilbrium pore space aqueous concentration in (mg/l).

Foc = the fraction of organic carbon in soil (unitless).

Koc = The organic carbon partition coefficient which equals:

$$\left[\frac{\text{Mg cont.}}{\text{Kg soil}} \times \frac{\text{L soln}}{\text{Mg cont.}} \right]$$

The partition coefficient is a physical property unique to each nonionic organic compound. Page 4 lists values determined for each contaminant detected in ground water or soil.

n = an exponential adjustment factor to the adsorption isotherm. The values are experimentally derived and difficult to obtain. For the purposes of calculations at Millcreek, n will be assumed to equal unity, thus making the isotherm linear.

Use of the Freundich isotherm assumes:

- completely reversible adsorption
- instantaneous equilbrium
- and in this case, a linear isotherm

There has been extensive debate in the scientific community as to whether adsoption is completely reversible, especially for hydrophobic contaminants. The rates of adsorption and desorption are also under investigation. Since a clearly definable consensus has not been reached, Region III will assumed completely reversible adsorption and instantaneous rates since this represents the more conservative approach.

Annual percolation was determined from the RI to be 11.15 inches year. Ground water velocity is assumed to be 60 feet year as explained in Appendix A. The thickness of the saturated zone is assumed to be 16 feet as also explained in Appendix A. Total organic carbon of the fill was determined to be 0.018 or 1.8 percent during the RI.

The Rapid assessment ground water model is illustrated as follows:

$$Co = \frac{C}{\text{erf}\left[\frac{Z}{2(A_t \cdot X)\ 1/2}\right] \text{erf}\left[\frac{Y}{4(A_t \cdot X)\ 1/2}\right]}.$$

Before doing this though, a medium Koc value must be determined for PNAs detected in soil since the ACL compliance is being considered as a class instead of individually. Page 4 contains Log Koc values. The medium Koc equals:

$$\frac{181,970 + 107,152}{2}$$

Determination of a Kocby averaging was not considered since it would skew the value toward the few very high Koc levels. Perhaps the best method for determining a representative Koc value would be weighing values by the frequency and concentration of the individual contaminants found in soil. This method though would be very time consuming and may not result in a Koc value much different that 144,561.

Also before using the Freundlich equation an average Foc value must be determined for the fill. Table 2 in section 2 of the ACL demonstration shows that 1.775% or 0.018 is an appropriate value.

Thus using the Freundlich equation with a Koc value of 144,561 and an Foc value of 0.018 yields a safe PNA soil level of:

$$Qe = (144,561)(0.018)(1.13)$$

$$Qe = 2.94 \text{ mg/kg for a } 10^{-6} \text{ risk level.}$$

For PCBs, similar calculations will be carried out.

1. The receptor or compliance area will be the eastern portion of the site adjacent to Marshalls Run, since the risk level to protect human health through ingestion of aquatic life is lower (0.000079 ug/l) than the risk level to protect human health through the ingestion of ground water (0.08) or protection aquatic life (0.014 ug/l). This level though is too low when considering averaging background concentrations of PCB in water (0.08). The level to protect human health will also be considered protective of wildlife.

2. The total area of contamination as illustrated on Figure 1 is about 652,500 $ft.^2$.

3. The health based compliance concentration will be (0.005 ug/l since this represents of background concentration). To represent a conservative estimate of exposure, assumed that all flowing surface water results from ground water discharge onsite.

4. Since the source area lies adjacent to the compliance point, Co = 0.005 ug/l.

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$$\frac{0.0029}{(0.079)(1)}$$

Co = 0.037 ug/l

5. Percolation through the unsaturated zone equals:

(percolation) x (area)

$$11.15\ \frac{\text{inches}}{\text{yr.}} \times \frac{1\text{ft}}{12\text{ in.}} \times 1{,}215{,}000\ \text{ft.}^2$$

= 1,128,938 ft.^{3}/year

1,128,938 ft.^{3}/year equals:

1,128,938 ft.^{3}/year x 8.631 liters/ft.^{3}

= 9,743,864 liters/year

Lateral ground water flow equals:

(saturated thickness) x (ground water velocity) x (lateral source length)

16 feet x 60 feet/year x 2400 feet = 2,304,000 ft.^{3}/year or 19,885,824 liters/year

Total flow equals

(9,743,864 + 19,885,824) liters/year = 29,629,602 liters/year.

To cause a PNA contaminant level of 0.37 ug/l in the saturated zone underlying the contaminated area.

$$\frac{x}{29{,}629{,}602\ \text{liters}} = \frac{0.037\ \text{ug}}{\text{liter}}$$

x = 1.1 grams/year

The next step it to determine the average unsaturated pore space aqueous concentration which would cause the Co in the saturated zone to exceed 0.37 ug/l. This is done by dividing the annual mass of PNA escaping from the unsaturated zone by the unsaturated annual flow.

$$\frac{1.1\ \text{grams/year}}{9{,}743{,}864\ \text{liters/year}} = 01.13\ \text{ug/l}$$

The Freudich equation can now be utilized to determine the dry soil concentration which will result in an aqueous concentration of 1.13 ug/l.

Where:

Co = original concentration at the source area
C = concentration at receptor or compliance area
Z = plume thickness
X = distance of compliance point from source
Y = width or lateral extent of source
A_t = transverse dispersitivity

As in the ACL demonstration in Appendix A,

° Z = 16 feet
° A_t = 13 feet

The first class of compounds for which soil criteria will be developed are polynuclear aromatic hydrocarbons (PNAs).

1. The receptor location chosen will be future ground water use on west 14th street, directly north of the site because the predominant area of PNA contamination is in the south western and south central portions of the site and PNA ground water contamination would be expected to impact ground water users on west 14th street before aquatic life in Marshalls Run or humans or wildlife ingesting aquatic life.

2. The 10^{-6} UCR direct ingestions levels are 0.029,

3. Figure 1 illustrates that the total PNA contaminated area is about 1,215,000 ft.^{2}.

4. The saturated source concentration causing 0.029 ug/l at the receptor is determined from the Rapid Assessment model when

   X = 1000 feet if the predominate source area is considered in the southern portion of the site.

   Y = 2400 feet, which is the lateral extent of the south source area.

Solving for Co yields:

$$Co = \frac{0.0029}{\mathrm{erf}\left[\frac{16}{2(13 \times 1000)1/2}\right] \mathrm{erf}\left[\frac{2400}{4(13 \times 1000)1/2}\right]}$$

$$= \frac{0.0029}{\mathrm{erf}\left[0.070\right] \mathrm{erf}\left[5.26\right]}$$

5. The percolation through the unsaturated zone equals:

$$11.15\ \frac{\text{in.}}{\text{yr.}} \times \frac{\text{ft}}{12\ \text{in.}} \times 652{,}500\text{ft.}^2 = 606{,}281\ \text{ft.}^3/\text{year}$$

The amount of lateral ground water per year equals:

$$16\ \text{feet} \times 60\ \frac{\text{feet}}{\text{year}} \times 600\ \text{feet (length adjacent to stream)} = 576{,}000\text{ft.}^3$$

Total water flow equals:

$$576{,}000\text{ft.}^3 + 606{,}281\text{ft.}^3 = 1{,}182{,}281\text{ft.}^3$$

Which equals:

$$1{,}182{,}281\text{ft.}^3 \times \frac{8.631 \times 10^{-3}\ M^3}{\text{ft.}^3} \times \frac{\text{liter}}{M^{-3}\ M^3} = 10{,}204{,}627\ \text{liters/year.}$$

To produce a PCB contaminant level of 0.005 ug/l in ground water.

$$\frac{x}{10{,}204{,}267} = \frac{0.005}{\text{liter}}\ \text{ug/l} \qquad x = 51.02\ \text{mg/year}$$

The aqueous PCB concentration in the unsaturated zone to produce 51.02 mg/year equals:

$$\frac{51.02\ \text{mg/year}}{606{,}281\ \frac{\text{ft.}^3}{\text{yr.}} \times \frac{8.631 \times 10^{-3}\ M^3}{\text{ft.}^3} \times \frac{\text{liter}}{10^{-3}\ M^3}} = 0.0098\ \text{ug/l}$$

The medium PCB Koc from table equals log 5.82 or 660,693. Therefore, the calculated safe soil level equals:

$$Qe = (660{,}693)(0.018)(0.0098) = 116\ \text{ug/kg}$$

The next class of compounds to be considered are phthalates.

1. Phthalates are considered relatively non toxic to humans, but moderately toxic to aquatic life. Therefore, soil criteria will be based on levels to protect aquatic life in Marshalls Run. Since bis(2-ethyl hexyl)phthalate is the most toxic phthalate to aquatic life, and has been shown to affect fish at concentrations as low as 3 ug/l, it will be considered the maximum safe level in Marshalls Run.

2. The total area of phthalate contamination from figure 1 is about 1,260,000 ft.^{2}.

3. To represent a conservative estimate of exposure, assume that all the flowing surface water results from ground water discharge. Thus a concentration of 3 ug/l is acceptable at the compliance point.

4. Since most of the phthalates in soil are located in the south central portion of the site assume a travel distance of about 1000 feet. The predominate phthalate source is about 1800 feet long. Using the Rapid Assessment Model this results in a Co concentration of:

$$Co = \frac{3.0}{\text{erf}\left[\frac{16}{2(13 \times 1000)1/2}\right] \text{erf}\left[\frac{1800}{4(13 \times 1000)1/2}\right]}$$

$$Co = \frac{3.0}{\text{erf}\left[0.070\right] \text{erf}\left[3.95\right]}$$

$$Co = \frac{3.0}{(0.079)(1)}$$

Co = 38.0 ug/1

5. The percolation through the unsaturated zone per year equals:

$$11.15 \frac{\text{in.}}{\text{yr.}} \times \frac{\text{ft}}{12 \text{ in.}} \times 1,260,000\text{ft.}^2 = 1,170,750\text{ft.}^3$$

The amount of ground water flow per year equals:

16 feet x 60 feet/year x 1800 feet = 1,728,000 ft.^3

Total water flow equals:

$1,170,750\text{ft.}^3 + 1,728,000\text{ft.}^3 = 2,893,750\text{ft.}^3$.

Which equals:

$$2,898,750\text{ft.}^3 \times \frac{8.631 \times 10^{-3} \text{ M}^3}{\text{ft.}^3} \times \frac{\text{liter}}{\text{M}^{-3} \text{ M}^3} = 25,019,111 \text{ liters/year.}$$

To produce a phthalate concentration of 380 ug/1 in ground water.

$$\frac{x}{25,019,111 \text{ liter/yr.}} = \frac{38.0 \text{ ug}}{\text{liter}} \quad x = 0.9507 \text{ kg/year}$$

The aqueous phthalate concentration in the unsaturated zone to produce to produce 0.9507 kg/year equals:

$$\frac{0.9507 \text{ mg/year}}{\frac{1,170,750\text{ft.}^3}{\text{yr.}} \times \frac{8.631 \times 10^{-3} \text{ M}^3}{\text{ft.}^3} \times \frac{\text{liter}}{10^{-3} \text{ M}^3}} = .0941\text{mg/1 or } 94 \text{ ug/1}$$

The medium phthalate Koc from Table equals log 5.3 or 199,526. Therefore, the calculated safe soil level equals:

Qe = (199,526)(0.018)(0.0941) = 338.0mg/kg

1: The next class of compounds to consider are phenols. Phenols are not particulary toxic to human. Health or aquatic life. Since most sources of phenols at the site are located nearer to residential areas, the level to protect human health will be used to establish soil criteria. The suggested level to protect human health is 300 ug/l which is a taste threshold.

2. The total area of phenol contamination from figure 1 is about 362,000 ft.^{2}.

3. Travel distance to west 14th street is about 750 feet. The predominate phenol source is about 450 feet wide. Using the Rapid Assessment Model, this yeilds a Co concentration of:

$$Co = \frac{300}{\text{erf}\left[\frac{16}{2(13 \times 750)1/2}\right] \text{erf}\left[\frac{1800}{4(13 \times 750)1/2}\right]}$$

$$Co = \frac{300}{\text{erf}\left[0.08\right] \text{erf}\left[1.14\right]}$$

$$Co = \frac{300}{(0.09)(0.88)}$$

Co = 3.788 mg/l

4. The percolation through the unsaturated zone per year equals:

$$11.15 \frac{\text{in.}}{\text{yr.}} \times \frac{\text{ft}}{12 \text{ in.}} \times 360{,}000\text{ft.}^2 = 334{,}500\text{ft.}^3$$

The amount of ground water flow per year equals:

16 feet x 60 feet/year x 450 feet = 432,000ft.^{3}

Total water flow equals:

766,500ft.^{3}.

Which equals:

$$766{,}500\text{ft.}^3 \times \frac{8.631 \times 10^{-3} \text{ M}^3}{\text{ft.}^3} \times \frac{\text{liter}}{\text{M}^{-3} \text{ M}^3} = 6{,}615{,}662 \text{ liters/year.}$$

To produce a phenol concentration of 3.788 mg/l in ground water.

$$\frac{x}{6{,}615{,}662} = \frac{3.788}{\text{liter}} \quad x = 25 \text{ kg/year}$$

Where:

Co = original concentration at the source area
C = concentration at receptor or compliance area
Z = plume thickness
X = distance of compliance point from source
Y = width or lateral extent of source
A_t = transverse dispersitivity

As in the ACL demonstration in Appendix A,

° Z = 16 feet
° A_t = 13 feet

The first class of compounds for which soil criteria will be developed are polynuclear aromatic hydrocarbons (PNAs).

1. The receptor location chosen will be future ground water use on west 14th street, directly north of the site because the predominate area of PNA contamination is in the south western and south central portions of the site and PNA ground water contamination would be expected to impact ground water users on west 14th street before aquatic life in Marshalls Run or humans or wildlife ingesting aquatic life.

2. The 10^{-6} UCR direct ingestions levels are 0.029,

3. Figure 1 illustrates that the total PNA contaminated area is about 1,215,000 ft.^{2}.

4. The saturated source concentration causing 0.029 ug/l at the receptor is determined from the Rapid Assessment model when

   X = 1000 feet if the predominate source area is considered in the southern portion of the site.

   Y = 2400 feet, which is the lateral extent of the south source area.

Solving for Co yields:

$$Co = \frac{0.0029}{erf\left[\frac{16}{2(13 \times 1000)1/2}\right] \; erf\left[\frac{2400}{4(13 \times 1000)1/2}\right]}$$

$$= \frac{0.0029}{erf\left[0.070\right] \; erf\left[5.26\right]}$$

The aqueous VCM concentration in the unsaturated zone to produce the unsaturated zone to produce mass equals:

$$\frac{146 \text{ mg/yr.}}{3,929,622} = 0.037 \text{ ug/l}$$

The Koc for VCM, which is 3 will be used to estimate migration patterns.
Qe = (123)(0.018)(0.037) = 0.082 ug/kg

Carrying out the same calculation for TCE (10^{-6} UCR = 2.8 ug/l) and 1,2 - DCE (HA = 70 ug/l) yields soils levels of 2 ug/kg and 594 ug/kg respectively.

Calculation of safe 1,1,1-TCA concentration:

1. Receptor area same as VCM. HA = 22 ug/l

2. Area of contamination = 490,000

3. Co = 22 ug/l

4. Seepage concentration equals:

$$\frac{x}{9{,}729{,}654} = \frac{22 \text{ ug}}{1}$$

$$x = 214 \text{ grams/yr.}$$

$$\frac{214 \text{ grams/yr.}}{3{,}929{,}625} = 54 \text{ ug/l}$$

5. Soil concentration equals:

$$Qe = (54)(0.018)(550) = 540 \text{ ug/kg}$$

For 1,1 - DCA with an AIC or 400 ug/l, the soil criteria using the same source area equals 760 ug/kg.

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Calculation of safe EDC soil level:

1. Receptor area same as VCM. UCR 10^{-6} risk = 0.95 ug/l

2. Area of contamination = 490,000 (Same as VCM, 1,2-DCE, and TCE)

3. Co = 0.95 ug/l

4. Percolation = 5614 liters/yr. Ground water flow = 4,971,456 liters/year. Total flow = 4,977,070 liters/year. Seepage concentration equals:

$$\frac{x}{9,729,654} = \frac{22 \text{ ug}}{1}$$

$$x = 9.2 \text{ grams/yr.}$$

$$\frac{9.2 \text{ grams/yr.}}{2,929,625} = 2.4 \text{ ug/l}$$

5. Soil concentration equals:

Qe = (2.4)(0.018)(32) = 1.4 ug/kg for a 10^{-6} risk level.

Calculation of safe 1,1-DCE soil level:

1. Receptor area same as VCM. UCR 10^{-6} = 0.24 ug/1

2. Area of contamination = 490,000ft.^{2}.

3. Co = 0.24 ug/1

4. Seepage concentration equals:

$$\frac{x}{9{,}729{,}654} = \frac{0.24 \text{ ug}}{1}$$

$$x = 2.3 \text{ grams/yr.}$$

$$\frac{2.3 \text{ grams/yr.}}{3{,}929{,}625} = 0.6 \text{ ug/1}$$

5. Soil concentration equals:

$$Qe = (0.6)(0.018)(182) = 1.95\text{ug/kg for } 10^{-6} \text{ risk level.}$$

Calculation of safe chloroform concentration:

1. Receptor area same as VCM. UCR 10^{-6} = 0.19 ug/l

2. Area of contamination = 490,000ft.^{2}.

3. Co = 0.19 ug/l

4. Seepage concentration equals:

$$\frac{x}{9.729,654} = \frac{0.19\ \text{ug}}{1}$$

$$x = 1.85\ \text{grams/yr.}$$

$$\frac{1.85\ \text{grams/yr.}}{3,929,625} = 0.47\ \text{ug/l}$$

5. Soil concentration equals:

Qe = (0.49) (0.018)(38) = 0.32 ug/kg for a 10^{-6} risk level.

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Summary of Soil Criteria (ug/kg)

Compound	
PHAs	2940
PCBs +	116
VCM	<10
TCE	<10
1,2-DCE	594
1,1,1-TCA	540
1,1-DCA	760
EDC	<10
1,1-DCE	<10
Chloroform	<10
Benzene	<10
Xylene	41,926
Toluene	1783
Ethyl benzene	26,396
Phthalates	338,000
Phenols	9,000

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Appendix C

Determination of Sediment Criteria

Sediment Contamination

Sediment contamination includes soils present in the east and west branches of Marshall's Run and in the marsh in the southern part of the site. As with soils, safe sediment contaminant levels should be established to protect receptors. Remedial action would only be taken on sediment presenting a risk. Sediments exceeding established criteria would be dredged and removed to the capping area on site. The criteria for sediment will differ from soils and probably be more stringent because there is no soil attenuating capacity in sediments. Contaminants can react directly with surface water instead of percolating through a layer of soil prior to reaching groundwater.

Receptors to be considered in remediating sediment are as follows:

- Aquatic life and humans who ingest aquatic life.
- Wildlife ingesting surface water on site.
- Ingestion of sediment by children
- Dermal contact with sediment.

Further sampling will be necessary.

G 418

Sediment criteria for the freshwater weltand in the southern portion of the site will be determined using the Freundlich equation and coefficients directly. The Freundlich equation will yield an average sediment level which is protective of aquatic life and humans or wildlife ingesting aquatic life. Further sediment sampling in Marshalls Run and the existing wetland in the southern portion of the site is necessary to determine appropriate levles of excavation. Sediment contaminant levels may exceed the average concentration level as long as all sediment areas averaged equal the average criteria. One exception to this rule though due to possible incomplete mixing is the excavation of some areas, containing substantialy higher contaminant levels than the acceptable average. in this demonstration, only average acceptable sediment levels will be established. Table 1(c) illustrates water quality criteria used for organics.

Table 1(c)

Compound	10^{-6}
PCBs	0.005
PNAs	1
Phthalates	3
Phenols	2560

Volatiles contaminant criteria were not established since these compounds have low Koc values and high henry's constants as illustrated in Section 1 of Appendix A and thus would not be expected to concentrate in sediment. The Koc values used in establishing sediment criteria are illustrated in Table 2(c) which were established in Appendix B.

Table 2(c)

Compound	Koc
PCBs	660,693
PNAs	144,561
Phthalates	199,526
Phenols	60

Using the Freundlich and assuming a sediment TOC content of 0.012 is establishing in Appendix A, sediment criteria are illustrated in Table 3(c).

Table 3(c)

Compound	Sediment Criteria (ug/kg) (dry weight)
PCBs	40
PNAs	1730
Phthalates	7183
Phenols	1843

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APPENDIX RS-1

MILLCREEK SITE
PUBLIC MEETING SUMMARY

MILLCREEK TOWNSHIP, ERIE COUNTY, PENNSYLVANIA
SEPTEMBER 11, 1985

A public meeting was held at 7:00 p.m., September 11, 1985, in the West Lake High School auditorium, Millcreek Township, Erie County, Pennsylvania. The purpose of the meeting was to discuss the remedial investigation and feasibility study (RI/FS) report with local residents and other parties interested in the Millcreek Site and to explain to them the preferred remedial action alternative of the U. S. Environmental Protection Agency (EPA).

Representing the EPA were Ann Cardinal, Community Relations Coordinator; Dominic DiGiulio, Remedial Project Manager; Richard Brunker, Toxicologist; and Gregg Crystall, CERCLA Enforcement Officer. Art Detisch and Paul Martin, Supervisors, and Charles Moffat, Solicitor, represented Millcreek Township. The Pennsylvania Department of Environmental Resources (DER) spokesperson was Eric Tartler, and the Erie County Health Department was represented by Joseph Trzybinski, Manager of the county's Environmental Control Program. Attending from NUS Corporation were Catherine Chambers, NUS Project Manager; Michele Mrozek, Project Engineer; David MacIntyre, Regional Manager; and Carrie Deitzel, Community Relations Specialist. Approximately 130 citizens and interested parties attended the meeting. The local media were also represented.

Mr. Detisch welcomed the public. Before turning the meeting over to Ms. Cardinal, he pointed out that microphones had been provided on either side of the auditorium to enable interested parties to address the speakers following the formal presentations. For those who did not wish to approach the microphones but who still wished to have their concerns acknowledged, he distributed blank cards and instructed those in attendance to fill them out and pass them to the speaker's table.

When Ms. Cardinal spoke, she reviewed the basic Superfund process and emphasized that the Millcreek Site was a long-term project that was approaching the remedial action alternative selection-and-design phase. She stressed the EPA's desire to hear from interested citizens regarding remediation of the site and also announced that the comment period would remain open until October 4, 1985. The address of the EPA Region III office was provided, and Ms. Cardinal assured everyone that all comments would be acknowledged.

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Ms. Cardinal then turned the meeting over to Mr. DiGiulio who used several overhead projections made from figures in the RI/FS report to explain the RI/FS discoveries, conclusions, and recommendations. EPA representatives underscored the importance of public comments and their significance to the record of decision (ROD). The floor was then opened to the public, and a very orderly discussion period ensued.

The following is a summary of citizen concerns and EPA responses.

MILLCREEK SITE
RESPONSIVENESS SUMMARY

A SUMMARY OF
CITIZEN AND INTERESTED-PARTY COMMENTS AND CONCERNS AND OF U. S. ENVIRONMENTAL PROTECTION AGENCY RESPONSES

PUBLIC MEETING
MILLCREEK TOWNSHIP, ERIE COUNTY, PENNSYLVANIA
SEPTEMBER 11, 1985

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Public and Environmental Health

Issue: **Is there a current risk from the site to area residents?**

Response: There seems to be little present risk, except to people who use the site. EPA does not believe that the site is presently affecting people who live in the vicinity. Most volatile organic compounds volatilized already or have gone into the groundwater. The greatest risk appears to be direct dermal contact with onsite soils or wastes and inhalation of contaminated particulates.

Issue: **Many gas wells are being installed around the site. Is this cause for worry?**

Response: The greatest worry from gas wells would be related to explosions rather than to the site. When a gas company wanted to dig wells on site, EPA required the firm to take special precautions to protect themselves and the surrounding public. EPA required the gas company to put its wells around the site border. The agency did not want a road put through the site or wells put where they would interfere with EPA activities.

Issue: **What will you do about air pollution during construction?**

Response: As far as volatile organic chemicals go, we are considering pumping and treating the groundwater which shouldn't affect air quality. With air stripping, it's pump and filter. The only air problem likely to develop will occur when we remove soils or install a cap. We will probably put up dust screens to prevent the offsite migration of as many dust particles as possible. We will also be doing some mathematical modelling to estimate the concentrations of contaminants in this dust. If it appears to present a hazard, we may ask people to leave their homes or to keep their windows shut. We will make every effort to minimize risk.

Issue: **Is drainage from the site affecting the fish in Marshall's Run?**

Response: EPA, in cooperation with the U.S. Fish and Wildlike Service and Pennsylvania State University, is currently studying the impact of site drainage on aquatic life in Marshall's Run.

Property Values

Issue: **Is there a recourse for loss of property value? The EPA should keep in mind that we did not buy contaminated properties and we are not the ones who polluted them.**

Response: Few of us live in pristine areas any more, and this is a problem many of us are faced with. The best we can say is that we share your concern. It is the subject of much discussion, but we do not have a solution.

Issue: Even after the site is cleaned up, will it still be considered a hazardous waste site?

Response: There will be various levels of organic chemicals and various levels of metals that will remain on site indefinitely, but we believe they will not pose a problem as long as there is not a receptor pathway.

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Issue: Since it will always be a site, what will homeowners have to do, in terms of the required disclosure or other legal restrictions, to sell their property?

Response: When the EPA sampled several private properties contamination was not found on anyone's property. These findings would be ~~you~~ proof that your property is not contaminated. Groundwater contamination maybe a problem for some properties; however, when we pump and treat, we will hopefully eliminate that problem too.

Issue: Isn't there an act coming that will require the parties responsible for the pollution of private properties to reimburse the property owners?

Response: Prior to the passage of the Superfund law there were several discussions in congress, and various committees of congress attempted to develop a liability clause in the law, but they were unable to come to any agreement. It is an issue that continues to be discussed, but it has not been resolved.

Funding Cleanup Costs

Issue: Has there been enough money allocated to the Commonwealth of Pennsylvania to properly clean all of the sites in this state?

Response: Each site is funded and cleaned up on an individual basis, not a state-by-state basis.

Issue: We are concerned that OMB has put pressure on the EPA to cheapen its cleanup methods. Is there enough money in the Superfund to do a proper cleanup?

Response: Please keep in mind that each site is considered on an individual, site-by-site basis. EPA does not provide funds or remediate the sites according to states.

Issue: Can you give us information about the responsible parties? Names?

Response: Not here. The purpose of this meeting is to discuss our cleanup alternative for the site. We don't want to get sidetracked talking about responsible parties.

Superfund Program

Issue: When EPA has made its final selection of a remedial alternative, will you proceed immediately into the cleanup activities, or is pending litigation going to hold up that process?

Response: We have already identified a list of potentially responsible parties (PRPs) which consists of hazardous waste generators, hazardous waste transporters, and owners of contaminated properties. EPA has contacted a number of these PRPs and has met with them to present the preferred alternative. After the record of decision

(ROD) is signed, EPA has a 60-day negotiation period to get these PRPs to enter into a consent order to either fund or perform the remedial action. If this does not work, EPA can use Superfund monies. Then, later on, litigation may occur against the PRPs.

Issue: In the worst case, should the PRP choose not to go along with the order, would EPA still take the steps necessary to carry out the remedial action plan?

Response: Yes. We do not hold up the process while litigation is taking place.

Issue: The report on this study was late. No one has had a chance to review it. How can you solicit comments when we don't have the information to form a knowledgeable opinion?

Response: There were copies of the report in the Information Repository. We have extended the comment period until October 4, 1985.

Issue: How many people knew it (the report) was in the repository?

Response: There was a press release issued and local newspapers announced that there was an information repository and that the information was available. We have had several Freedom of Information Act requests for information, and we are trying to fill them as quickly as possible.

Remedial Action Alternatives

Issue: EPA will be monitoring air, soil, and water according to its criteria. Isn't there enough scientific evidence available already to determine what levels of PCBs and other chemicals are dangerous to the human body? Why add site-specific criteria? If criteria have already been developed, what is the cut-off on what is truly unsafe?

Response: For PCBs, there is an established level to protect human health related to the ingestion of water or the ingestion of aquatic life. There is no criteria available for soils. ~~But~~ we must conduct a risk assessment on a site-specific basis to look at soils. We use available water criteria to determine the safe levels in soils or in sediments.

Issue: The Yoder Wells are in proximity to the site. Is EPA going to install monitoring wells to detect a reversal of flow?

Response: This is one of our main concerns. Contamination is a possibility in the case of a severe drought or if someone was to come along later and install pumping wells. EPA will be monitoring groundwater in this case to be sure the hydraulic gradient is not reversing and coming back through those wells.

Issue: When is the work actually going to begin? So much time has already elapsed.

Response: The schedule is hard to predict. An immediate removal action has already taken place. This remedial activity is going to prevent any problems from occurring, in the future, because of this site. The record of decision should be signed by the first quarter of the fiscal year.

Issue: Will the site ever be developed?

Response: EPA is opposed to any future soil-disturbing activities.

Issue: There has been no search for abandoned wells in the area off site, north, in the direction of the groundwater.

Response: Not true. EPA has checked the area.

Issue: A lot of children play in the site area. You said fences won't work at this site. Why, since fences have worked at other sites, do you say they can't work here?

Response: Every site is different. Fences have been used to limit access at sites where there is a high risk of dermal contact. This site poses no acute threat to public health, and there have been many instances of vandalism at the site. We are presently reevaluating the need for a fence.

Issue: You say it may be 3 years before you have the site cleaned up. That's a long time to have unsupervised children playing on site. It would cost $200,000 for a fence that you say won't work. It would probably be cheaper to hire a security firm to patrol the site, and it would solve the community's problem with unsupervised children.

Response: I think it is going to be up to parents to keep their children away from the site. When we installed our monitoring wells and our trailer at the site, we hired a security firm, yet our wells and trailer were vandalized. Security did not seem to make a difference. That is a very large site, and especially at night, it is very hard to patrol.

Issue: A lot of tires are buried at the site, and rubber tires have a tendency to rise up to the surface through the clay cap--at least they have at other sites. Will the cap be thick enough to prevent this? How thick will it be?

Response: The cap will consist of 2 feet of clay. The cost of the selected remedial alternative will include operation and maintenance of the site, including fixing any cracks that might appear.

Issue: For how many years will operation and maintenance be conducted?

Response: Current RCRA regulations specify 30 years.

Issue: Will the contaminant plume be cleaned up by the clay cap?

Response: The plume should be cleaned up, but not by the cap. The cap is a preventive measure to prevent infiltration (of water into the contaminated soils).

Issue: There are reports of some 2000 liquid-filled drums being buried at the site and also reports that the trucking company that used the site dumped bulk wastes there. Yet, no testing was done in the area used by the trucking company.

Response: We looked everywhere for liquid-filled, buried drums during our investigation, and we could not find any. However, we are talking about two different things here. Bulk disposal means uncapping the drums and pouring the wastes onto the ground so that the drums can be reused. This may be why we cannot find liquid-filled drums here. Bulk disposal of oils, solvents, paints, and inks did occur here--especially in the eastern portion of the site where the PCBs are. That soil is saturated with oil.

Issue: This disposal supposedly occurred at the present site of the trucking company too, and you haven't done any testing in that area.

Response: We cannot go to the trucking firm and start digging test pits; we did install a monitoring well there. We did not find a high level of groundwater contamination there, but what we did find is attributable to the site itself. We do not have any strong evidence that there is anything buried there or that there was any actual disposal of hazardous materials there.

Issue: Why don't you cap the wastes where they are, instead of excavating and then capping?

Response: The idea is to get one continuous clay cap. A cap cannot be applied in blotches or around trees.

Issue: Why not line the site? Isn't it a landfill?

Response: The contamination will all be above the groundwater table. If you have a landfill with deep soil contamination, you have a problem with lateral groundwater movement but that's not a problem at this site. The cap we will use will greatly reduce the infiltration of groundwater through the contaminated soil. The permeability of the cap will be 10^{-7} cm/sec.

Issue: Caps are known to crack.

Response: Maintaining the cap is part of the maintenance cost; I am sure the cap will crack because of weather and that trees will try to grow on it, but maintenance is part of the capping alternative.

Issue: Sediment samples were taken along the drainage ditch at the north side of the site. What did they reveal about leachate getting into the ditch? During high water periods, that ditch must carry about half the water in that area.

Response: That might be true. During the rainy season, groundwater discharges to Marshall's Run, and I guess it is possible that the site may be discharging into the drainage ditch as well. There is a red stain in the ditch, and this is caused by anaerobic conditions. This stain is evidence of groundwater discharge to the ditch and it is possible that contaminants are entering that ditch during high water periods.

Issue: Will pumping the groundwater remediate the sediment in that ditch? In high water periods the water in that ditch and in my yard is all one continuous flow. If there are contaminants in the ditch, there must be contaminants in my yard.

Response: There were not significant levels of contaminants in offsite soil.

Issue: No matter what remedial action alternative you choose, it may eventually break down. Who will monitor the site after construction is done? Who will tell the EPA if there is a break down?

Response: Groundwater will be monitored periodically.

Issue: Then you will know right away (if a breakdown occurs)?

Response: Yes

Issue: If you pump the groundwater for a year or so, and you say the site has been dewatered, then you can just stop air stripping. That worries me.

Response: If we pump for a 24-month period in a worst-case basis, and we pump a total of 12 full volumes of groundwater, we should take most of the contaminants out of the groundwater. Hopefully, we won't be getting any new contamination so, obviously, contamination will not continue.

Issue: After you pump water out of these wells, are you going to dump it into Marshall's Run?

Response: All groundwater will be treated if necessary and then discharged into Marshall's Run.

Issue: How far down Michigan Avenue are the monitoring wells?

Response: About 1/4 mile directly north of the site.

Issue: Why are you going to pump the groundwater back down Marshall's Run instead of into the city sewer system?

Response: The sewer system cannot handle any additional flow. It is at capacity now, and the only recourse we have is to pump, treat, and then discharge into Marshall's Run.

Comment: I think I speak for 80 percent of the people here. There is one land owner who was conscious of the fact that there was dumping. He should be held accountable. If you have to sue him for that money, then do it, but get all that stuff out of here.

Groundwater and Water Quality Concerns

Issue: Could groundwater be leaching through the walls of our homes, into our basements?

Response: It does not seem likely unless there are deep basements in the area.

Issue: Is the mud in the pond contaminated? All the ground around it is.

Response: The pond sediments are contaminated, but they are 15 feet below the surface. There is very little chance for people to come into contact with them unless they swim 15 feet down to the bottom of the pond.

Issue: I am under the impression that EPA only has to test for volatile organics two times per year. Has the Millcreek water supply only been sampled twice?

Response: EPA has no set requirements for sampling. We have found no evidence of contamination in the public water supply.

Issue: Will the seep (of iron and manganese) be drained from the site when the cap is installed?

Response: Iron and manganese will exist as long as there are anaerobic conditions there. I think that it will continue until the anaerobic conditions cease, but the iron and manganese are not toxic metals and were not formed by hazardous waste itself. It is just a condition that is created by the bacteria in the landfill trying to consume the sludge. That process uses up all the oxygen, and consequently causes the anaerobic conditions that make these metals from the site leach out of the landfill.

Issue: What about lead?

Response: We did not find much dissolved lead in groundwater; lead is mostly sorbing to the soil particles. ERT samples show lead in the groundwater, but those were not filtered samples. As far as we are concerned, lead is not an offsite contaminant; neither is mercury or cadmium or chromium.

Issue: **Five years from now, could I install a well for drinking water if I bought a home on Harper Drive?**

Response: That would depend on the ACL level that is established at the site. The main groundwater contaminants are organic, not heavy metals. The ACL will be based on the risk level, especially for carcinogens, anywhere from 10^{-4} to 10^{-8}. That means that if you drink the groundwater regularly there is a 1 in 10,000 chance to a 1 in 100 million chance that you might get cancer. We are still debating what risk factor to use. Ordinarily, if people are using the groundwater, we treat to 10^{-6} level; but since no one is using the groundwater at this site, we may use a different risk factor here.

Issue: **PCBs are not water soluble. Will they percolate to the water table and then run off into Marshall's Run?**

Response: PCBs are organic, nonionic contaminants. They do not have an electronic charge. This means that they adsorb--they stick to the soil, strongly. There are lots of organic carbons in the soil at Millcreek; the more there are, the more the PCBs stick. Research shows that PCBs will stick to soil for many, many years, and nobody knows how long or whether it is an irreversible process. PCBs will be essentially immobile in that soil. They will not move to the groundwater.

Issue: If you divert the water that's coming underneath the railroad tracks and from south of the area all the way up to 26th Street, will it help the situation at the site?

Response: We looked into that too. It was not feasible because of the elevation differences around the site. It was also extremely expensive, and the scheme we are following now is much more cost effective.