4. DEVELOPMENT AND DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

4.1 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

The alternatives retained after the technology screening and secondary screening must be subjected to detailed examination. Alternatives retained to this point must be capable of achieving the remedial action objectives identified in Section 2. The only exception to this is the "No Action" alternative, which is examined in detail to provide a baseline for comparison of the other alternatives, pursuant to the NCP requirement.

As previously indicated in Section 3, the final remedial action at this site must include a ground-water action to meet the ARARs (specifically, SDWA MCLs). Therefore, it is recognized that all remedial actions will need to select one source-area alternative and one ground-water alternative, so that the final alternative addresses both source area and ground water.

Based on the standard procedures for feasibility studies under CERCLA, treatment alternatives should be developed ranging from those that would eliminate the need for long-term management at the site to those involving treatment that would reduce toxicity, mobility, or volume of the contaminant. Although the alternatives involve different technologies, they will mainly vary (1) to the degree in which they rely on long-term management of treatment residuals, (2) to the degree in which toxic levels are reduced in the environment, and (3) in costs.

Detailed analyses of remedial alternatives are presented in this section. A summary and comparison of remedial alternatives is provided in Section 5.

4.2 EVALUATION CRITERIA

This section describes the criteria used for the evaluation of the remedial action alternatives and includes both non-cost and cost criteria. Pursuant to current EPA guidance, alternatives must be examined for adherence to nine criteria as specified in the NCP. These criteria are as follows:

1. Overall protection of human health and environment.
2. Compliance with ARARs.
3. Long-term effectiveness and performance.
4. Reduction of toxicity, mobility, and volume of contamination.
5. Short-term effectiveness.
6. Implementability.
7. Cost
8. State acceptance.
9. Community acceptance.

Criteria numbers 8 and 9 are not addressed until completion of the review and comment period of the RI/FS. Adherence to these criteria is addressed in the Record of Decision document.

For the detailed evaluation of remedial alternatives, EPA's evaluation criteria can be grouped into four categories: technical feasibility, institutional requirements, public health/environmental issues, and cost.

Technical Feasibility

- Long-term effectiveness and performance.
- Reduction of toxicity, mobility, and volume through treatment.
- Short-term effectiveness.
- Implementability.

Institutional Requirements

- Compliance with ARARs.
- State acceptance (not specifically addressed in RI/FS).
- Community acceptance (not specifically addressed in RI/FS).

Public Health/Environmental Issues

- Overall protection of human health/environment.
- Reduction of toxicity, mobility, and volume through treatment.

Cost

- Capital cost.
- Operation and maintenance costs.

4.2.1 Non-Cost Criteria

4.2.1.1 Technical Feasibility

The technical evaluation of the alternative addresses the objectives of performance, reliability, implementation, and safety, and judges the ability of the alternative to achieve these goals.

- Performance is based on the effectiveness and useful life of the remedial action. Effectiveness refers to the degree to which an action will minimize threats to public health and the environment. Useful life is the length of time which this level of effectiveness can be maintained.

- Reliability refers to an alternative utilizing proven technologies which have shown a demonstrated record of use. The technology should also be capable of performing the remediation in the required length of time. Operation and maintenance activities should also be considered.

- Implementation considers the ease of installation of the alternative and the time needed to achieve the given objectives.

- Safety includes short-term threats to onsite workers, neighboring communities, and/or the environment during implementation of the remedial action.

4.2.1.2 Institutional Requirements

Institutional factors are important to the overall ability to select and implement an alternative. The acceptance of the remedial action by local, State, and Federal agencies is a necessary component of the feasibility study process, and compliance with existing or future regulatory policies is a must. Permits for various activities as well as ancillary equipment would be required. Criteria included here are

- Short-term impacts during construction, such as erosion, odors, dust, truck traffic, and noise.

- Federal, State, and local government approval and regulatory permits.

- ARARs.

- Local resident and community perceptions.

- Local zoning or other land-use/construction constraints.

- Long-term management and operational requirements.

- State and Federal DOT regulations for handling, shipping, and manifesting of hazardous wastes.

4.2.1.3 Public Health and Environmental Issues

The alternative selected must adequately protect public health, welfare, and the environment. The remedial actions are evaluated for their effectiveness in mitigating the existing or future contaminant exposure to the public and the environment.

Long-term control of the contamination should be an important factor to consider, as well as the short-term effects caused by the implementation of the remedial action. Applicable health and environmental standards are used to evaluate the alternatives.

In addition, worker health and safety during implementation of remedial actions must be considered with respect to OSHA requirements.

4.2.2 Cost Criteria

The cost-effectiveness of the alternative is a major factor to consider and includes

- Capital Costs
- Operation and Maintenance (O&M) costs
- Post-remediation (monitoring) costs

Monitoring and maintenance may be substantial portions of the remedial action, and consequently may have sizeable costs.

The present-worth value method based on 1990 dollars (using an 8 percent discount rate and a 30-year period) will be used to evaluate costs.

4.3 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 1: NO ACTION WITH SITE CONTROL

4.3.1 Description

The "No Action" alternative is presented as a baseline from which other remedial measures are compared. EPA requires that the No Action option be examined in detail during the remedial alternatives evaluation phase. No further action would be taken to remediate the contaminated source area under this alternative. Institutional actions would be initiated to minimize potential exposure to site contamination. Specific institutional actions to be implemented would be increased site security, deed restrictions, and ground-water monitoring.

Site security would be upgraded by constructing a perimeter fence around the site to restrict unauthorized access. Approximately 1,500 ft of fencing would be required to tie in to existing DOD fencing along the west and south boundaries of the Marsh Run Park site. A gate would be provided to allow access to Marsh Run Road. The gate would remain locked at all times.

Deed restrictions that could be applied to the property could limit the type and location of allowable development on the site, and could prohibit the use of ground water from the site for drinking water purposes.

Ground-water monitoring would be conducted to monitor the concentration of contaminants in both the surficial and deep aquifer over time. Ground-water monitoring would be conducted on a quarterly basis. Existing monitoring wells would be used. One new monitoring well would be installed downgradient of observed deep aquifer contamination to monitor movement of contaminants from the source area.

The NCP requires consideration of the No Action option as a stand-alone remedial action. For this FS, the No Action option will be examined both as a stand-alone action and as a source-area alternative in conjunction with a ground-water alternative to address remedial action objectives for the site.

4.3.2 Non-Cost Analysis

4.3.2.1 Technical Feasibility

Waste materials and soils would not be further treated, removed, immobilized, or reduced. Since a source area has been identified by the EM survey and sampling efforts, the source area may continue to contribute contamination to the shallow and deep aquifers. This alternative would not provide reduction of source contaminants, but would minimize the potential for human exposure to site contaminants. This alternative does not comply with ARARs as a stand-alone action, but may meet ARARs in conjunction with a ground-water alternative. No reduction of the source area contamination with respect to toxicity, mobility, or volume is achieved with this alternative. Under this alternative, a fence would be constructed around the site to prevent unauthorized access. Deed restrictions would be imposed to restrict land use. Construction of fencing would be in areas which are not contaminated, so the workers and community should not be affected. One advantage of no action over capping as a source-area action is that it allows for rainfall and surface infiltration to flush contaminants from the source area. Contaminants can then be extracted by pumping from new wells installed as part of the ground-water extraction/treatment alternative (see Sections 4.10 through 4.13).

Long-term monitoring and site maintenance would be required for a 30-year closure period. This alternative may be viable in conjunction with a ground-water remediation alternative. It would, however, require

a longer time frame for ground-water remediation to achieve Pennsylvania cleanup standards, since the alternative does not provide remediation of the source area contamination.

4.3.2.2 Institutional Requirements

Compliance with ARARs

This alternative will comply with the Pennsylvania Water Well Drillers License Act of 1956 during monitoring well installation.

Non-Compliance with ARARs

ARARs which are not complied with for this alternative are the MCLs developed by the EPA in response to the Safe Drinking Water Act, and which Pennsylvania has adopted for all waters of the state, including ground water. The alternative also does not comply with the Pennsylvania Hazardous Sites Cleanup Act which governs remediation of non-NPL hazardous waste sites; it does not comply with RCRA 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities); and it does not comply with RCRA 40 CFR 270 (EPA-administered Permit Programs: The Hazardous Waste Permit Program). In addition, the alternative does not comply with the Pennsylvania Solid Waste Management Act of 1980 which addresses requirements for the treatment of hazardous wastes.

Permit Requirements

The following factors affect the No Action alternative:

- This alternative does not comply with State Water Quality Standards as a stand-alone action.

- Fencing installation would require local permits for construction.

TABLE 4-1a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 1: NO ACTION WITH SITE CONTROL

Item	Description	Quantity	Unit Cost	Total
1	Security Fence/Gate	1,500 ft	$ 12.40/ft	$ 18,600
2	Deed Restrictions	LS	LS	$10,000
3	Monitoring Well	50 ft	$60/ft	$3,000
4	SUBTOTAL			$31,600
5	Mobilization/Demobilization, Construction Management, Site Services		10%	$3,160
6	Implementation, Design, Permits		22%	6,952
7	Contingency		25%	7,900
8	TOTAL			$49,612
			SAY	$50,000

TABLE 4-1b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 1: NO ACTION WITH SITE CONTROL (30 YEARS)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$ 40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	100 hours	40/hr	4,000
	. Analysis	48 samples	905/sample	43,440
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$78,112

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$78,112 (P/A, 8%, 30 yrs) = $879,369

- A well permit would be required for monitoring well installation.

- Legal assistance and property owner concurrence would be required in the development of deed restrictions.

- This alternative may not achieve remedial action objectives.

4.3.2.3 Public Health and Environmental Issues

This alternative would provide minimal additional health protection to the public and/or the environment by restricting potential contact with site contaminants. Chemical analysis data and risk assessment during the RI indicated that only exposure pathway that exhibited a significant health risk in ingestion of ground water from the site. Consequently, from a public health perspective, the No Action alternative will not exhibit a significant health risk as a source-area alternative. No action without ground-water action would not reduce health risks associated with ground-water contamination, except that it would minimize the potential for exposure to the contaminated ground water.

4.3.3 Cost Analysis

Capital costs for Source-Area Alternative No. 1, No Action with Site Control, are presented in Table 4-1a. Operation and maintenance costs for Source-Area Alternative No. 1 are presented in Table 4-1b.

4.4 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 2: CAPPING WITH SURFACE WATER AND GAS VENTING CONTROLS.

4.4.1 Description

This alternative involves closure of a designated area with a multilayered cap system. The cap would be constructed over the former landfill area and the VOC-contaminated area immediately north of the landfill. A total of approximately 6 acres would be capped. Figure 4-1 illustrates the extent of the capping option.

The purpose of the cap is to minimize infiltration of precipitation through the contaminated zones and thus minimize contaminant transport into the water systems and soil. The cap would be designed in accordance with Pennsylvania Department of Environmental Resources (PaDER) RCRA closure standards and would have the following features:

- The cap would be designed to minimize erosion and promote drainage by construction of a 3 percent minimum closure grade, establishment of vegetative measures, and stormwater management.

- A 2-ft-thick compacted clay liner (permeability $<1 \times 10^{-7}$ cm/sec) would be constructed above the existing fill area.

- A synthetic membrane liner serving as a hydraulic barrier would be placed over a prepared subbase to limit infiltration.

- A drainage layer consisting of sand or synthetic material (geonet) would be placed over the membrane liner to convey liquid off the cap.

- Soil would be placed over the drainage layer (separated by a synthetic filter or geotextile) to protect the liner and drainage system. This layer would have a 2-ft minimum

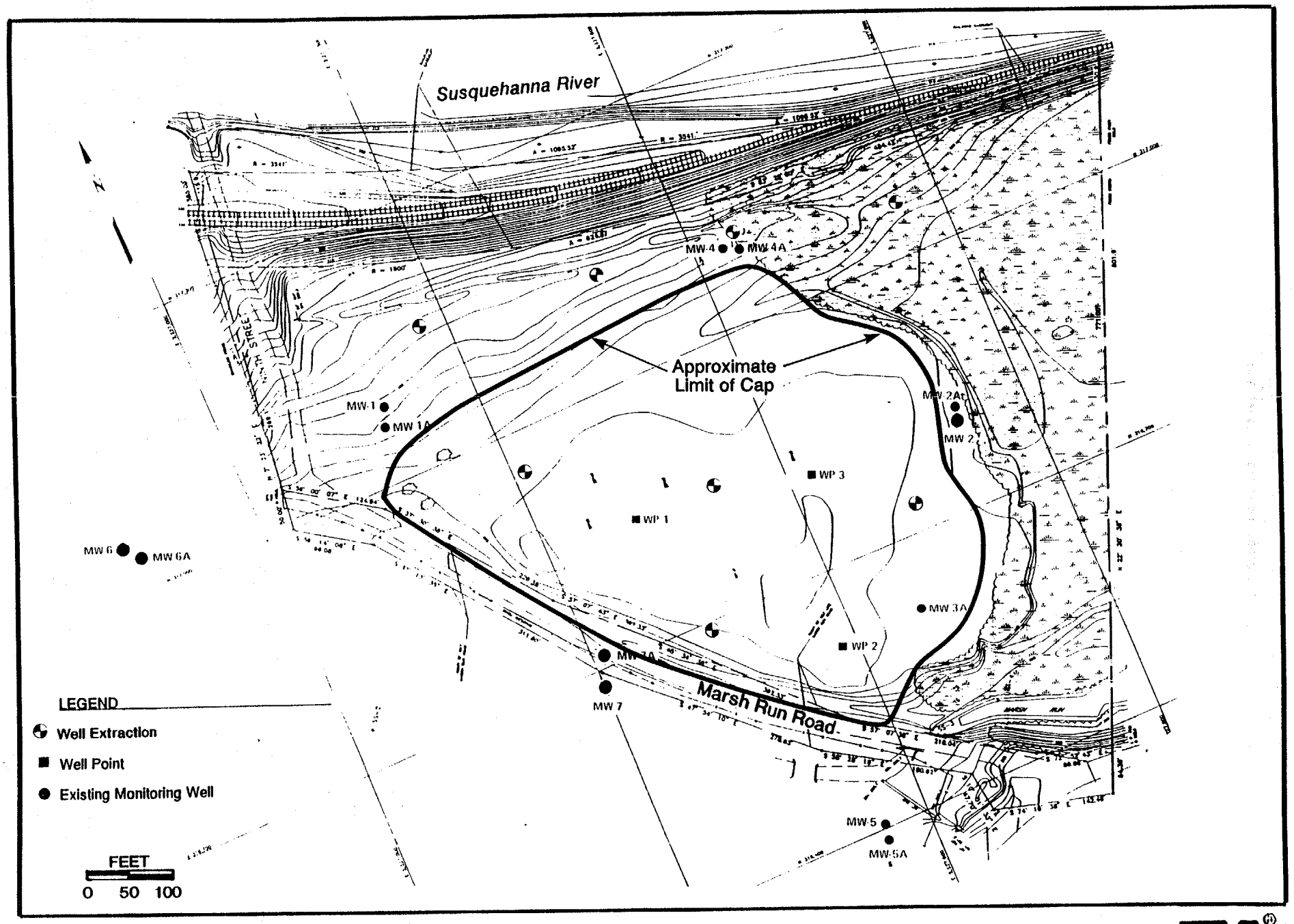

Figure 4-1. Site layout for Source Area Alternative #2: Capping with Surface Water and Gas Controls.

thickness and would also have sufficient thickness to prevent frost penetration. The uppermost portion of the 2-ft layer would be a 6-in. topsoil layer to support vegetative growth.

- Provision of PVC passive gas vents would prevent trapping of methane and other landfill gases within the capped area.

- A piping system would surround the perimeter of the cap to transmit water collected in the drainage layer away from the cap.

The area to be capped would require stripping, grading, and offsite fill to established proposed closure grades. It is estimated that 38,000 yd^3 of offsite soil would be necessary. The disturbed area would require stormwater, sediment, and erosion control devices, such as swales, berms, control ponds, and silt fencing. The extent of areal limits of the cap would be as determined by findings of the EM survey completed for the RI and the volatile organics source survey conducted during the FS.

Post-action ground-water and surface-water monitoring will be required to assess the long-term effectiveness of capping as a containment action. Quarterly monitoring of ground water from the surficial aquifer, downgradient wells, and from the surface water and sediments of Marsh Run Creek and the Susquehanna River would be conducted for the first year after implementation of remedial actions, and annually thereafter. Post-action monitoring requirements are addressed in more detail in Section 6.4.

4.4.2 Non-Cost Analysis

4.4.2.1 Technical Feasibility

During most onsite construction activities, workers would not likely be exposed to contaminated soils since the existing cover soil prevents exposure to the contaminated soils. Dust control and erosion/sediment

control and stormwater provisions would be required during earth-disturbance phases.

Upon completion of the multilayered cap system, the upgraded surface barrier would provide additional protection to public health and the environment by limiting the likelihood of contaminant release to ground water and surface water. An impervious cap would minimize production of leachate from the landfill. It is also possible that an impervious cap over the site would result in dropping the surficial aquifer water level. Since the site is located at a local topographic high point, and ground-water level monitoring data indicate that ground water is "mounded" beneath the landfill, it is possible that by restricting influent recharge to the landfill the result will be a decrease in the water level, and subsequent easing of the "mounding" conditions.

For the capping alternative to be an effective source remediation measure over the long term, maintenance of the vegetative layer and inspection of the cap system would be necessary. Erosion damage would require repair, and failure to maintain the cap system would result in an increase in leachate production and, subsequently, ground-water contamination. This alternative would allow contaminated soils to remain onsite. Long-term monitoring of the ground water and cap would be necessary to verify effectiveness of the cap alternative.

Landfill capping is an effective practice for long-term containment of contaminated materials; however, it does not reduce the toxicity or volume of the source area. It does reduce the mobility of the contamination due to (1) the aforementioned impermeability of the RCRA cap system which minimized precipitation infiltration, and (2) the subsequent effect of lowering the shallow saturated zone water level "mounding." Construction of the multilayered cap would be over approximately a 6-month period. The cap would require standard and established construction techniques and equipment. Fill material could be obtained from local sources,

and local contractors would be able to finalize construction once the synthetic liner and other specialized materials were placed.

4.4.2.2 Institutional Requirements

Compliance with ARARs

This alternative satisfies RCRA 40 CFR Par 264.310 (Closure and Post-Closure Care) due to its ability to minimize the infiltration of precipitation into the source area. The passive gas venting system will comply with National Ambient Air Quality Standards established in response to the Clean Air Act of 1971. The remedial action activities for capping will comply with OSHA health and safety requirements for worker safety as well as Threshold Limit Values for air concentrations established by the American Conference of Governmental Hygienists. The alternative will comply with the Pennsylvania Clean Streams Law which provides for erosion and sediment control; it will comply with the Pennsylvania Dam and Safety Encroachment Act of 1978 which protects wetlands; it will comply with the Pennsylvania Flood Plain Management Act of 1978 which regulates construction in areas located within the 100-year floodplain.

Non-Compliance with ARARs

This alternative will not comply with the MCLs established by EPA and adopted by the State of Pennsylvania under the Safe Drinking Water Act for contaminants in drinking water. This alternative does not comply with ambient water quality criteria established under the Clean Water Act in regards to the ground-water contamination.

Permit Requirements

Based upon the above, the following institutional considerations associated with capping of the source area should be evaluated:

- Construction permits would be required from local and State agencies.

- Erosion and sediment control would require permits from State agencies.

- Wetlands permits may be required for construction impacting wetlands areas.

- State air quality regulatory requirements would require management of the gas venting system.

- Permitting for closure and offsite transport/disposal of residual waste would be required under RCRA.

- Capping requirements should conform to RCRA closure requirements.

- A closure permit would be required from PaDER.

- The cap system would require maintenance and monitoring.

- Well permits will be required for installation of new monitoring wells.

- Post-action ground-water and surface-water monitoring would be required to assess effectiveness of source area remediation (see Section 6.4).

4.4.2.3 Public Health and Environmental Issues

Under this alternative, the source area would not be disturbed. Although existing site conditions pose minimal risks, the cap would provide an additional buffer between the source area and the surface, further reducing exposure potential. The impervious cap also limits

TABLE 4-2a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 2: CAPPING WITH SURFACE WATER AND GAS VENTING CONTROLS

Item	Description	Quantity	Unit Cost	Total
1	Security Fence/Gate	1,500 ft	$ 12.40/ft	$ 18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	Soil Backfill for Capping	38,300 yd^3	15/yd^3	574,500
5	Lining System[a]	260,000 ft^2	1.02/ft^2	265,000
6	Gas Vents	5 ea.	400/ea.	2,000
7	Revegetation	300,000 ft^2	0.0328/ft^2	9,850
8	Perimeter Trench	2,000 ft	3.75/ft	7,500
9	SUBTOTAL			$904,386
10	Mobilization/Demobilization, Construction Management, Site Services		10%	90,438
11	Implementation, Design, Permits		22%	198,965
12	Contingency		25%	226,096
13	TOTAL			$1.42 x 10^6

(a) Lining system includes 30 mil flexible membrane liner, three layers of geotextile, and geosynthetic drainage net.

TABLE 4-2b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 2: CAPPING WITH SURFACE WATER AND GAS VENTING CONTROLS (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Monthly Inspection	288 hours	$ 40/hr	$ 11,520
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$63,272

TABLE 4-2b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Monthly Inspection	288 hours	$ 40/hr	$ 11,520
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$32,522/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$63,272 + $32,522 (P/A, 8%, 29 yrs) = $426,165 ~ $430,000

surface water recharge or rain water infiltration through the source area, thus minimizing contaminant transport from the source area. This alternative does not address remediation of the source area, and thus the system would require long-term monitoring. The potential for future releases of contaminants is possible without proper monitoring of the cap.

4.4.3 Cost Criteria

Capital costs for Source-Area Alternative No. 2, Capping, are presented in Table 4-2a. Operation and maintenance costs for Source-Area Alternative No. 2 are presented in Table 4-2b.

4.5 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 3: ALTERNATIVE NO. 3A--EXCAVATION/OFFSITE INCINERATION ALTERNATIVE NO. 3B--EXCAVATION/ONSITE LOW-TEMPERATURE THERMAL TREATMENT

4.5.1 Description

Alternative No. 3A

This alternative involves the stripping and stockpiling of clean cover soils; excavation of the landfill waste and VOC-contaminated soil; loading of contaminated materials onto trucks; and transportation to a RCRA-permitted hazardous waste facility for incineration and disposal. After contaminated materials have been removed, the site will be back-filled with clean fill material from an offsite source. The existing clean cover soil material will be replaced, and the site will be revegetated.

Based upon the RI report, the estimated fill area is approximately 4.24 acres, with an average depth of about 4 ft (Figure 4-2). The estimated volume of fill is about 30,000 yd^3. The nature of the waste material in the fill is largely unknown; however, it is believed that the site was used for general refuse disposal. This assumes that the waste constituents include paper products, plastic, metals, and glass, comprising 50-80 percent of the volume. The remaining 20-50 percent of the volume is assumed to be soil.

In addition to the former landfill area, characterization studies of the source area during the FS identified an area of approximately ±52,000 ft^2 immediately north of the landfilled area in which surficial ground water (4-10 ft below ground) was found to be contaminated with TCE and other VOCs (Figure 4-2). This VOC area appears to be contributing to contamination of both the deep aquifer and the landfilled area. Excavation and disposal of soil from this area will also be considered as part of the source area remedial action. The approximate volume of affected soil

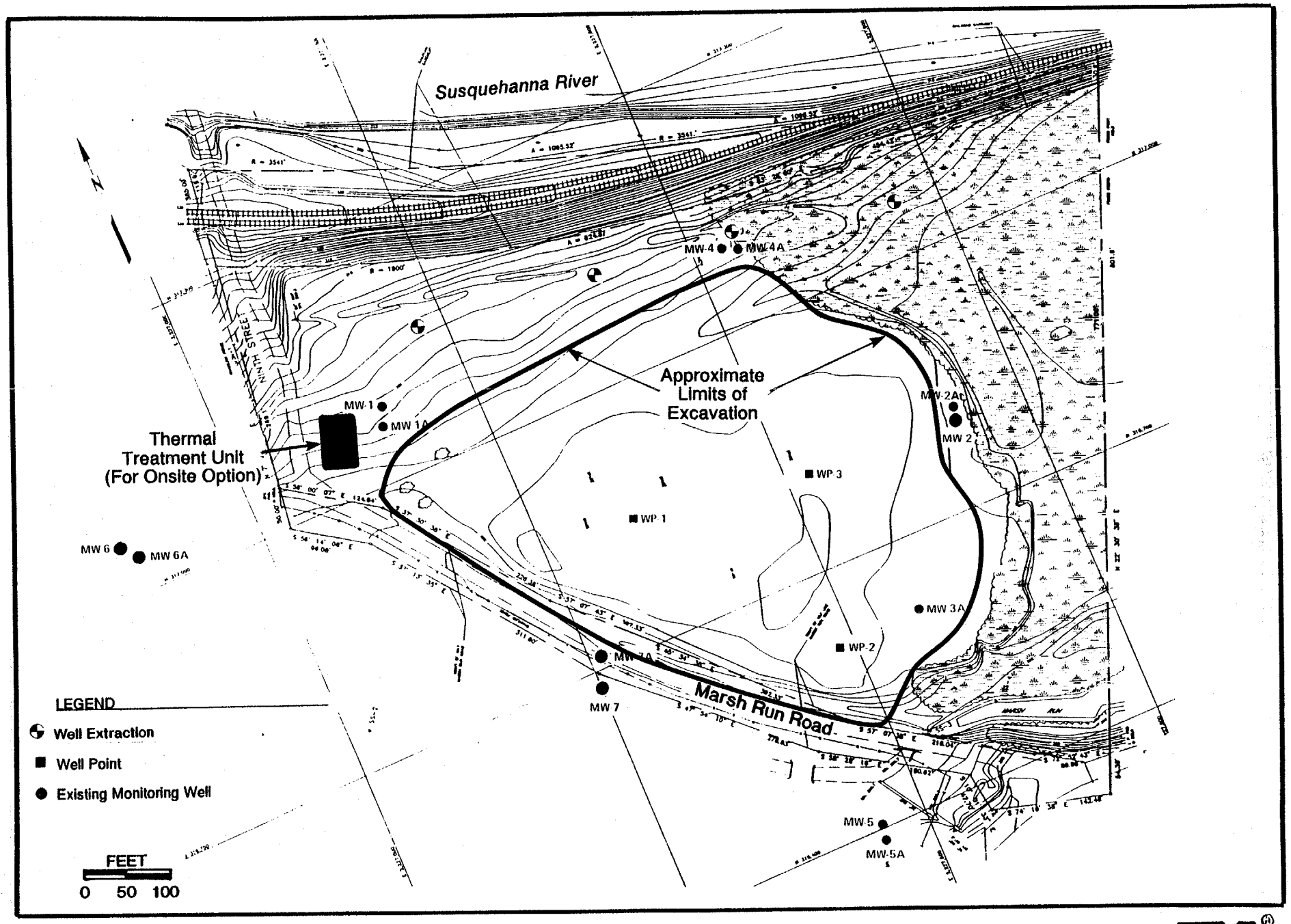

Figure 4-2. Site layout for Source Area Alternative #3: Excavation/Thermal Treatment.

is 17,500 yd^3. Therefore, the total estimated volume of contaminated material to be addressed under this alternative is approximately 47,500 yd^3.

Due to the variety of materials likely to be encountered during excavation, the site layout will be required to have specific areas for materials handling, separation, preparation, and loading. These areas will be contained within the exclusion zone.

Materials handling areas will have to be lined and bermed to prevent contamination from moving offsite. Materials handling will be required to separate the waste according to size, composition, extent of contamination, and ultimate treatment.

The installation of sediment/erosion control devices will be required. These will include silt fences, sediment/stormwater basins, and stormwater diversions to prevent runon and runoff. These measures should be conservatively designed and built, as the potential to contaminate the surface water is great. Dust control measures must also be considered. In addition to the contaminated materials handling area, a construction staging and management area will be required; this area will be considered the support zone. Office trailers will be set up in this area for site inspectors, supervisors, health and safety personnel, and visitors' check-in. A communications system will be part of this area.

Another major component of this option will be the decontamination area. Decontamination facilities will be provided for site workers, visitors, inspectors, equipment, and vehicles. This area will be considered the contamination reduction zone and will include a lined and bermed vehicle decontamination pad, wash equipment, and a liquid storage tank for handling the wash waters until further treatment. The personnel decontamination area should include a staging area and a mobile personnel decontamination trailer.

As part of the excavation process it will probably be necessary to dewater the waste area, primarily because the site was originally a marsh upon which the refuse was deposited. It is likely that ground water will infiltrate the excavation pit since ground water has been identified at 4-7 ft below ground surface in the vicinity of the former landfill. In addition, rain water will collect in the open excavation. For these reasons, ground-water containment measures may be needed during excavation, and ground water may need to be contained onsite and processed through the onsite treatment system (see ground-water alternatives in sections 4.10 through 4.13).

During the excavation it will also be necessary to monitor and control organic vapor and fugitive dust emissions. Respirators may be required for onsite personnel. It is expected that Level C personal protective equipment (PPE) will be required for excavation activities, although certain conditions may warrant use of Level B PPE.

After all the waste material has been removed, the excavated pit will require clean backfill, regrading, and revegetation.

After excavation, the waste material will have to be separated according to contamination level, compatibility, and size, prior to preparing it for transportation to an offsite disposal facility. Wastes will be sampled and analyzed for RCRA hazardous waste characteristics, including TCLP toxicity. Wastes exhibiting TCLP toxicity in excess of regulatory levels will be disposed of by incineration. Other wastes may be disposed of in a RCRA permitted landfill. The primary factors to consider for incineration are the size, type of incineration process, and the applicability of the process to the waste obtained from the site. Major types of incinerators are rotary kiln, cement kiln, liquid injection, and gas fueled. Waste applicability considerations include Btu content (generally required to be $\geq$5,000 Btu/lb), water content, viscosity, halogen content, ash content, size, shape, and state (solid, liquid) of waste materials.

For disposal at most RCRA-permitted incinerators, waste material must be packaged into containers (usually 55-gal fiberboard). This process has the potential to be time-consuming and hazardous to the onsite workers. There are no RCRA incineration facilities less than 200 mi from the site. The closest facility is the Rollins Environmental site in Bridgeport, New Jersey. Other facilities that could process the waste include the ENSCO facility in Little Rock, Arkansas, and Chem Waste Management's Emelle, Alabama, facility. The closest facility that would accept bulk solid waste is the former LWD facility in Calvert City, Kentucky. This site is not currently operational, but has been acquired by Chem Waste and may return to operational status within the near future.

Transportation of the waste to the incinerator requires special considerations relating to the vehicle, such as size and safety features. These features include bed liners, covers, and vents (for liquid containers). Both the vehicle and driver must be DOT approved. Vehicles should also be in excellent mechanical working condition. In addition, if the waste is transported in bulk, compatibility testing is required.

After incineration, it will be necessary to determine if the ash will have a hazardous or nonhazardous classification for landfill disposal. Then the nearest acceptable ash fill can be located to receive the remains of the incineration process.

This alternative is expected to be a permanent solution to remediation of the source area. When completed, Alternative No. 3A should exceed ARARs, in addition to achieving and maintaining the overall protection of human health and the environment. This is accomplished through the removal of the source material from the site and its offsite incineration, which eliminates the supply of contaminants to the ground water and destroys the pollutant, subsequently reducing the toxicity, mobility, and volume of the contaminant.

Alternative No. 3B

This alternative is basically the same as Alternative No. 3A; however, instead of transporting the excavated waste to an offsite incinerator, it is treated onsite with a low-temperature roasting process (400-450 F) which is designed to completely destroy the organics. The process utilizes a mobile unit which is similar to conventional incinerators but operates at a much lower temperature. It is treated onsite with a low-temperature roasting process that operates at a temperature range of 400-500 F and completely strips the volatile organics from the soil through evaporation. The volatiles are then recovered or destroyed using conventional methods such as carbon adsorption or through a flame afterburner. After treatment with this process, the soil is restored to an uncontaminated condition which is then suitable for backfill as a delisted waste pursuant to LDR considerations.

The full-scale system has four major components:

1. Solids Handling System
2. Hot Oil Heating System
3. Gas Handling System
4. Water System

The solids handling system screens the waste prior to feeding it into the thermal processing unit, where a temperature of 400 F is maintained by the hot oil heating system. The heating system can run on propane, natural gas, or oil and provides heat to the soil through the circulation of the hot oil. The gas handling system carries the volatiles through a condenser, then an afterburner to destroy the volatiles. The water system handles the condensate by first running it through an oil/water separator and then through carbon adsorption units.

The low-temperature stripping system can process a wide variety of soils with differing moisture and contaminant concentrations, and its effectiveness has been proven to remove over 99.9 percent of the volatile organics from the soil.

4.5.2 Non-Cost Analysis

4.5.2.1 Technical Feasibility

Excavation and incineration are proven technologies for the removal and destruction of hazardous waste material. Their combination is a permanent effective solution to the problem, and it is achieved within a relatively short time frame. The removal of the contaminant source area will also allow the treatment of the ground water to achieve the ARARs. In addition, there is a reasonably good availability of experienced, qualified contractors to perform the work.

Problems expected for this alternative are largely due to the uncertainty in the composition of the waste material. The contractor would have to be prepared to deal with a variety of shapes and sizes or material and be cognizant of the contamination. It is expected that the work would have to be performed in a Level C capacity. The waste material handling and separation would be a difficult consideration, and compatibility testing would be time consuming. Another problem of concern is the handling and disposal of ground water during excavation. Based on the fact that the fill material was placed on top of a marsh, and supported by the presence of adjacent wetlands and monitoring well data, it is reasonable to assume that ground water will be a consideration during excavation. A dewatering system to contain and pump the ground water from the excavation would be necessary. Treatment and disposal of ground water from the excavation would be handled by the onsite ground-water treatment system (see Sections 4.9 through 4.12).

Another concern is the proximity to the Susquehanna River, which has an average discharge of 34,100 cfs. The highest recorded discharge in this area was the flood of 24 June 1972, which had a discharge of 1,020,000 cfs (USGS Monthly Water Resources Summary for Pennsylvania, Water Resources Division, Harrisburg; and USGS 1975, Water Resources Data for Pennsylvania, 1974--Part 1: Surface Water Records, Water Resources Division, Harrisburg, 331 pp.). It is apparent that the Susquehanna River has the potential to affect the Marsh Run Park site through either flooding or higher ground-water tables.

Further problems to consider for this alternative are the short-term health risks associated with excavation. These include health and safety risks to onsite workers, including, but not limited to, injury from equipment or materials and contaminant exposure from dust and/or volatile organics. To a slightly lesser extent, contaminant exposure to nearby residents from excavation is also a short-term risk. Risk of pollution to the environment from volatiles and dust would be practically unavoidable, as it is extremely difficult to contain these emissions from open excavation, and constructing a cover would not be practical. Pollution runoff is a risk that can be avoided through proper stormwater management.

Another major concern associated with this technology is the risk associated with the transportation of the waste material from the Marsh Run Park site to the incineration facility. There is the potential for accidents to occur, with associated risks of a contaminant exposure to the driver and contaminant releases to the environment. This is not a concern for Alternative 3B, except as related to disposal of incinerator ash.

In addition, there are risks of exposure at the incineration facility itself, both to onsite personnel and to the environment from the off-gases and discharge waters. Nearby residents also may be exposed to odors and dust. However, State permits and requirements are assumed to address and prevent these concerns.

The last concern with incineration is ash disposal. Incineration concentrates heavy metals that were present in the waste feed into the resultant ash. The Land Ban regulations must be addressed. Consequently, disposal in a RCRA facility may be required, since relatively high metals concentrations were observed in soil samples taken during the RI.

For Alternative 3B, the ash may be stored onsite, but it will be necessary to provide for offsite treatment/disposal of some material after incineration to comply with RCRA LDRs. Incineration will remediate the VOC contamination, but will not address high observed metals concentrations in the excavated soil.

Incineration is a proven permanent technology for destruction of source area contaminants. This alternative will significantly reduce the toxicity, mobility, and volume of contamination in the source area. Short-term exposure conditions during excavation must be considered. Disposal of incinerator ash must also be considered.

4.5.2.2 Institutional Requirements

Alternative Nos. 3A and 3B, in conjunction with ground-water pumping and treatment, are expected to achieve Federal and State cleanup goals pertaining to ground water quality and drinking water standards, surface water quality, ambient water quality criteria for protection of human health and ambient water quality for protection of aquatic life. These alternatives meet or exceed cleanup goals related to the source area and destruction of the contaminants.

Compliance with ARARs

In particular, the ARARs with which these alternatives comply with are the Pennsylvania Hazardous Sites Cleanup Act, RCRA 40 CFR 261 (Identification and Listing of Hazardous Waste), 40 CFR 263 (Standards Applicable to Transporters of Hazardous Waste), 40 CFR 264 (Standards for Owners and

Operators of Hazardous Waste Treatment, Storage and Disposal Facilities), and 40 CFR 270 (EPA-Administered Permit Programs: The Hazardous Waste Permit Program). The alternative will also comply with National Ambient Air Quality Standards during excavation; it will comply with OSHA Health and Safety Requirements for worker safety; it will comply with DOT Rules for Hazardous Materials Transport; it will comply with Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists for all concentrations; it will comply with the Pennsylvania Clean Streams Law for erosion and sediment requirements; it will comply with the Pennsylvania Dam and Safety Encroachments Act of 1978 regarding encroachment of wetlands; it will comply with the Pennsylvania Flood Plain Management Act of 1978 which is concerned with construction within the 100-year floodplain; and it will comply with the Pennsylvania Solid Waste Management Act of 1980 which governs treatment and disposal of hazardous wastes.

Non-Compliance with ARARs

This alternative will contribute toward achieving MCLs established by EPA and adopted by the Commonwealth of Pennsylvania for ground water at the site boundary. This alternative would not likely achieve MCLs without some type of ground-water extraction and treatment in addition to the source area action.

Permit Requirements

Permits would be required for construction of the building, electrical work, and erosion and sediment control (grading). Permits would be required for any impacts to wetlands and floodplain construction. Permits would be required for materials handling, processing, chemical analysis, and compatibility testing. NPDES permits would be required for the ground-water treatment system. Site health and safety plans and permits would be required to include personal protection levels for site workers and air monitoring for dust and volatile organics.

Current permits would be required for both the onsite and offsite incinerator facilities in addition to the transportation of the waste over state and interstate highways (for Alternative No. 3A) or onsite replacement of ash from the onsite incinerator (Alternative No. 3B). These permits would be needed from the Federal and applicable State DOT and the EPA. Permits would be required for the ash disposal and to meet any delisting criteria. For Alternative No. 3B, a test burn would also be required under RCRA to determine treatment effectiveness for site wastes.

4.5.2.3 Public Health and Environmental Issues

Alternative Nos. 3A and 3B address site environmental issues which were identified in the RI report, specifically excavation/incineration alternatives:

- Provide a long-term solution to contaminant migration by removal of the source material.

- Provide for the destruction of pollutants in the source area.

There is the possibility of short-term public health and worker safety risks during the excavation, primarily dust emissions, organic vapor emissions, and sediment/pollutant transport from stormwater runoff. In addition, there are risks from gas emission and water discharge from the incinerator, as well as risks associated with the handling, loading, transportation, and unloading of hazardous materials.

Environmental short-term risks associated with these alternatives include sedimentation and pollutant discharge to Marsh Run Creek (and subsequently the Susquehanna River) from stormwater runoff while excavation is in process. There is also the potential of damage to the adjacent wetlands from construction/excavation activities, including, but not limited to, habitat degradation from filling (either intentional or non-intentional) and/or encroachment.

4.5.3 Cost Criteria

Capital costs for Source-Area Alternative No. 3A, Excavation/Offsite Incineration, are presented in Table 4-3a. Operation and maintenance costs for Source-Area Alternative No. 3A are presented in Table 4-3b.

Capital costs for Source-Area Alternative No. 3B, Excavation/Onsite Low-Temperature Thermal Treatment, are presented in Table 4-4a. Operation and maintenance costs for Source-Area Alternative No. 3B are presented in Table 4-4b.

TABLE 4-3a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 3A: EXCAVATION/OFFSITE INCINERATION

Item	Description	Quantity	Unit Cost	Total
1	Security Fence	1,500 ft	$12.40/ft	$ 18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	a. Waste Excavation (includes health and safety, materials handling areas, decon facilities, materials loading, etc.)	30,000 yd^3	50/yd^3	1,500,000
	b. VOC-Contaminated Soil Excavation	17,500 yd^3	$10/$yd^3$	$175,000
5	Transportation and Incineration	70,600 tons	1,000/ton	70,600,000
6	Soil Replacement	47,500 yd^3	15/yd^3	712,500
7	SUBTOTAL			$73,033,036
8	Mobilization/Demobilization, Construction Management, Site Services		10%	7,303,304
9	Implementation, Design, Permits		22%	16,067,268
10	Contingency		25%	18,258,259
11	TOTAL			$114,661,867
			SAY	$115 x 10^6

TABLE 4-3b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 3A: EXCAVATION/OFFSITE INCINERATION (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$55,592

TABLE 4-3b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$55,592 + $24,842 (P/A, 8%, 29 yrs) = $332,789 ~ $330,000

TABLE 4-4a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 3B: EXCAVATION/ONSITE INCINERATION

Item	Description	Quantity	Unit Cost	Total
1	Security Fence	1,500 ft	$ 12.40/ft	$ 18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	a. Waste Excavation (includes health and safety, materials handling areas, decon facilities, materials loading, etc.)	30,000 yd^3	50/yd^3	1,500,000
	b. VOC-Contaminated Soil Excavation	17,500 yd^3	10/yd^3	175,000
5	Onsite Low-Temperature Stripping	70,600 tons	300/ton	21,180,000
6	Ash Disposal	56,480 tons	112/ton	6,325,760
7	Soil Replacement	47,500 yd^3	15/yd^3	712,500
8	Testing	LS	LS	30,000
9	SUBTOTAL			$29,968,796
10	Mobilization/Demobilization, Construction Management, Site Services		10%	2,996,880
11	Implementation, Design, Permits		22%	6,593,135
12	Contingency		25%	7,492,199
13	TOTAL			$47,051,010
			SAY	$47.1 X 10^6

TABLE 4-4b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 3B: EXCAVATION/ONSITE INCINERATION (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Monthly Inspection	288 hours	$40/hr	$ 11,520
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$63,272

TABLE 4-4b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$63,272 + $24,842 (P/A, 8%, 29 yrs) = $340,469 ~ $340,000

4.6 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 4: IN SITU SOIL VENTING

4.6.1 Description

Soil venting is a vacuum extraction process in which volatile organic contaminants are removed from the vadose (unsaturated) zone of soil. Soil venting is effective at contaminant extraction through both liquid and vapor phases. Generally, source area VOC contamination exists in three phases:

- As dissolved constituents in the ground water,
- As a liquid adsorbed to the soil matrix, and
- As free product in liquid and vapor forms located in the interstitial pore spaces of the soil.

Vacuum extraction wells and laterals are installed in the contaminated area and are connected by piping to an air/liquid separator device and off-gas treatment system. The wells are designed with a vacuum-tight seal at the surface of the ground, and a slotted screen in the desired extraction zone. Extraction wells are installed vertically, but slotted piping may be installed horizontally in trenches to cover a larger area, minimizing the number of extraction wells. The horizontal system is also utilized exclusively in high ground-water table conditions.

A high-capacity vacuum pump and/or blower is used to produce a lateral air flow through the soil. This flow carries the contaminant that is located in the interstitial soil pore spaces into the extraction wells and to the surface treatment system. In addition, the volatile contaminants that are adsorbed to the soil are stripped and volatilized into the air stream. Also, ground water containing the dissolved contaminant can be extracted and treated. In general, higher vacuum pressures will achieve faster cleanup of the contamination.

Due to the two-phase flow of the air and water, a liquid/vapor separator is required as part of the treatment system. At this step, the contaminated water is removed and either treated onsite or shipped to an offsite treatment facility. Water generated from the soil venting process at Marsh Run Park will be circulated through the ground-water treatment plant that will be provided at the site (see Sections 4.10-4.13). The contaminated air flows through activated carbon to remove the volatiles and prevent their discharge to the atmosphere. An added feature of soil venting is that the pumping action of the extraction process enhances in situ biodegradation of VOCs remaining in the soil. The process provides a continuous oxygen flow which is essential to effective bioremediation. Figure 4-3 shows a typical soil vapor extraction system configuration.

There are a number of variables to consider in the design of a vapor extraction system. These are listed below.

Initial Site Conditions	Control Variables	Response Variables
. Initial soil VOCs	. Well-head vacuum	. Final soil VOCs
. Depth to ground water	. Extracted air flow	. Extracted air VOCs
. Soil permeability	. Extraction well spacing	. Adsorption equilibria
. Soil moisture	. Screened depth	. Radius of influence
. Soil porosity	. Duration of operation	
. Soil bulk density	. Power consumption	
. Soil particle density		
. Soil organic carbon		
. Henry's Constant		
. Solubility		
. Temperature		
. Consistency of existing cap		

The initial variables are the given site conditions, the control variables (which can be chosen for in the system design), and the response variables (which change as a function of the control variables). One control variable which is critical to efficient remediation is the well spacing, which depends primarily on the soil characteristics, including permeability, porosity, moisture content, stratigraphy, and depth to ground water. Prior to the design of the extraction system, a vapor flow model would be required to refine site conditions and design parameters.

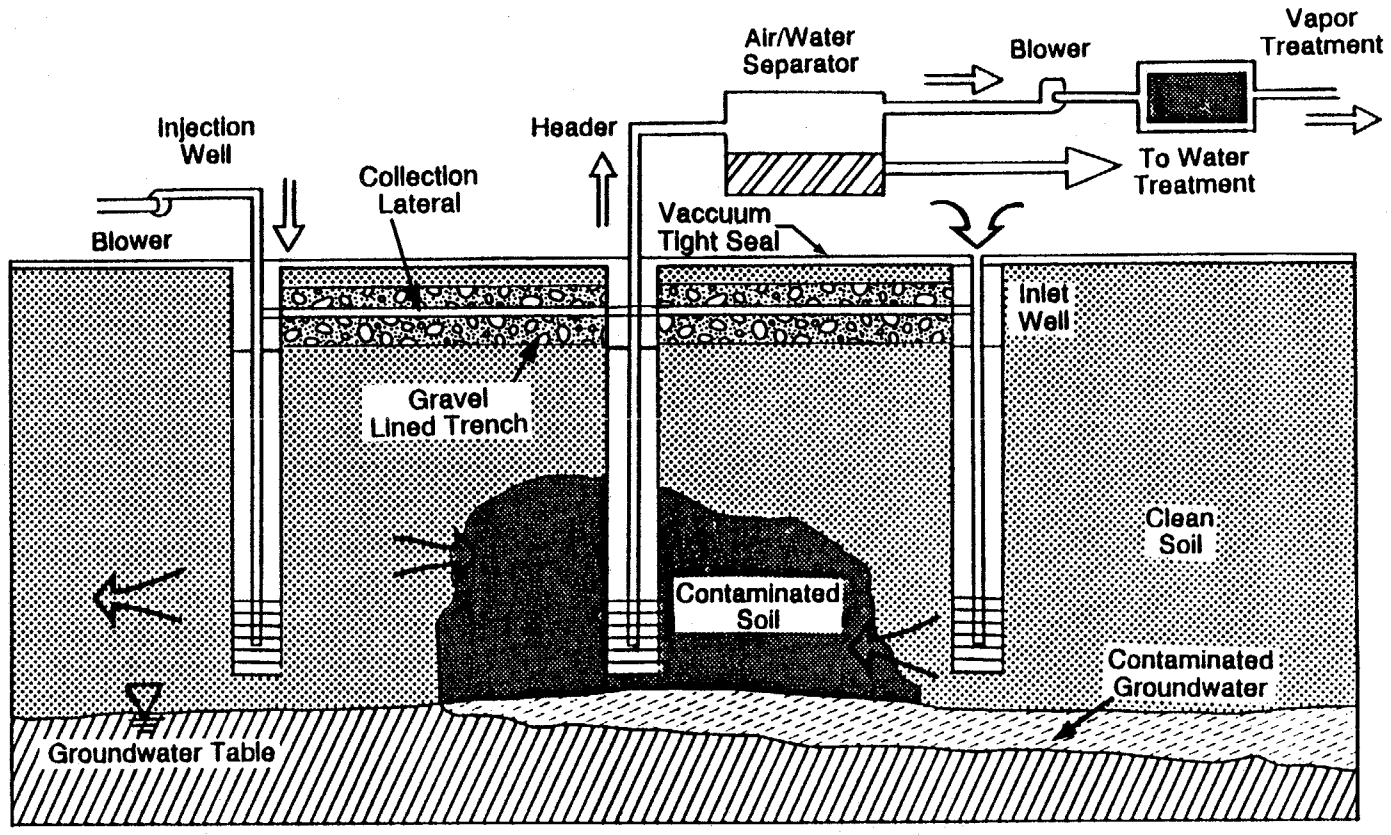

Figure 4-3. A typical soil vapor extraction system configuration.

From this modeling, pilot testing should be conducted prior to full-scale system installation.

The approximate limits of area to be treated by soil venting are shown in Figure 4-4. Initially, soil venting wells and laterals will be concentrated in the identified "hot spots" (Figure 1-16). Further, refinement of the area to be treated will be made during the pre-design phase. The first objective will be to dewater the shallow saturated zone using the shallow zone wells installed for the soil venting system. This extracted ground water will be pumped to the ground water treatment system (Sections 4.10 through 4.13). Pumping of the bedrock aquifer will be initiated shortly thereafter to keep the shallow saturated zone dewatered to as great a degree as possible.

Once the shallow zone has been sufficiently dewatered, soil venting will be initiated. Soil venting will be continued until analysis of samples from the source area indicates that target treatment levels have been achieved. The target treatment level will be specified in the ROD and will be based upon the concentration of target VOCs in soil samples. The target treatment level will be expressed as "percent removal of VOCs from source area soil." This level will be established based on technical capabilities of soil vapor extraction systems, and upon the objective of providing source area treatment that reduces source area contributions to the bedrock aquifer to below SDWA MCL concentration. Confirmatory soil samples will be collected at selected intervals throughout the soil venting process to assess system performance.

For this alternative, a construction staging area would be required to locate office trailers, construction trailers, and materials storage. These areas would be considered the support zone. A contamination exclusion zone would need to be established during construction of the ground-water treatment system and the extraction wells. Between these two zones would be a contamination reduction zone, which would serve to decontaminate site workers, visitors, and vehicles which have entered the exclusion zone. See Figure 4-4.

Installation of sediment and erosion control devices would be required. Erosion/sediment control provisions could include silt fences, sediment basins, and stormwater diversions. After the site work were completed, the area would have to be stabilized through revegetation.

A Hazardous Materials Contingency Plan will be developed during the design phase as a component of this action. The plan will identify procedures and methods for handling, separating, and removing (if necessary) hazardous materials that may be encountered during implementation of the remedial action. Key provisions of the Hazardous Materials Contingency Plan will be developed into the technical specifications for construction activities and the Contractor will be required to abide by these provisions.

4.6.2 Non-Cost Analysis

4.6.2.1 Technical Feasibility

In situ soil venting is a relatively new technique for hazardous waste cleanups. However, it has the potential to eliminate the source of organic contamination and the subsequent impact to ground water. Soil venting has been used extensively in petroleum contamination remedial actions and it has been demonstrated to be very effective at treating TCE and other solvent contamination. Several factors impact the effectiveness of *in situ* soil venting. They include porosity and water content of the soil, soil permeability, and physical/chemical characteristics of soil contaminants.

Sufficient air-filled porosity is required to allow the vacuum extraction system to move air through the soil and strip the TCE and other VOC contamination which is adsorbed to the soil particles. Too much water would reduce the stripping effectiveness and prolong the cleanup process, as the water must first be removed from the soil. The presence of ground

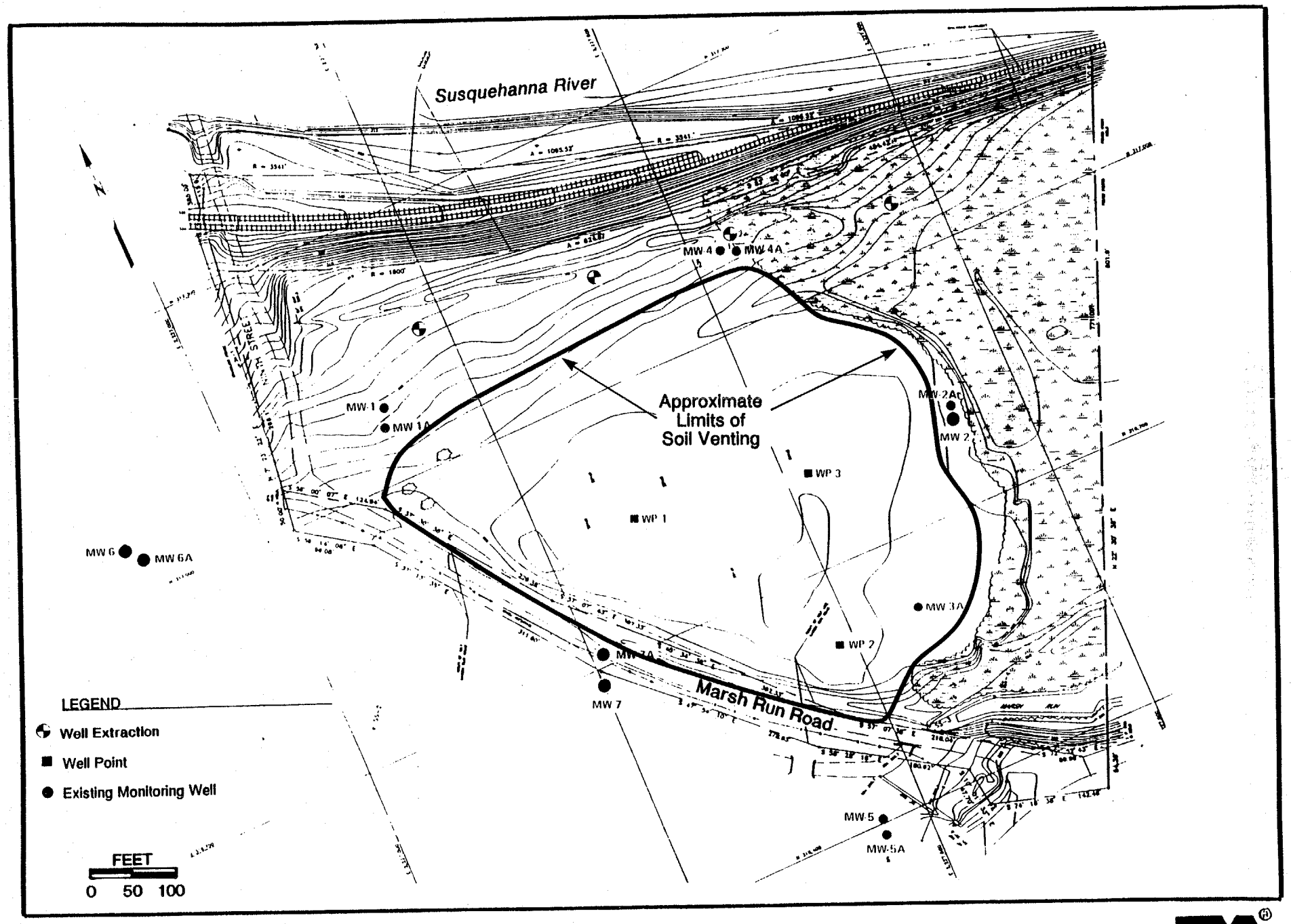

Figure 4-4. Site layout for Source Area Alternative #4: In Situ Soil Venting.

water at 4-10 ft below ground surface may negatively impact the performance of soil venting. Soil venting has, however, been demonstrated to be effective even in high water-table conditions. System modifications can allow the system to pump all vapor, all liquid, or a combination of both. Initial dewatering of the shallow saturated zone can also be conducted to optimize soil venting effectiveness. Furthermore, this process should still be quite effective in remediation of the VOC contamination at Marsh Run Park since much of the contaminated waste is above the ground-water table.

Soil permeability considerations also impact the use of soil venting. Vacuum extraction is not particularly effective for clay soils (hydraulic conducitivity less than 10^{-7} cm/sec). Since much of the Marsh Run Park site is a former uncontrolled waste fill (hydraulic conductivity between 7×10^{-4} and 7×10^{-2} cm/sec), permeability conditions should not limit the effectiveness of this technology.

The nature of the contaminant itself is another factor that affects system performance. Soil vapor vacuum extraction is based on Henry's Law, which states that when a gas and a liquid are in contact, the weight of the gas that dissolves in a given quantity of liquid is proportional to the pressure of the gas above the liquid. From this law, a value called Henry's Constant (K_H) is used to determine if the contaminant can be removed effectively. Generally a K_H value greater than 0.001 atm·m^3/mole is required for satisfactory performance of soil venting. The Henry's Law Constant for TCE ranges from 0.0091 to 0.0196, and TCE has been proven to be successfully extracted using this venting technique. The K_H values for other VOCs at this site also significantly exceed 0.001. Off-gas treatment will be required to satisfy air discharge regulations. Vapor phase activated carbon and catalytic oxidation are two proven off-gas treatment technologies often used in conjunction with soil venting.

Minimal risks of exposure to onsite personnel and nearby residents are achieved with this alternative. The only risk of exposure would be due to contacting the ground water during system installation.

Although this is a relatively new technology for hazardous waste site remediation, there are sufficient qualified contractors in the regional area to assure reasonable construction bids, since soil venting has been applied quite extensively for remediation of petroleum-contaminated sites. The estimated construction time for this option is less than 6 months. It is estimated that remediation of source area VOC contamination could be achieved in 9-12 months, based upon experience at sites with similar contamination levels and based upon consultation with system vendors. Soil venting is an innovative waste treatment process and is endorsed under EPA's SITE program.

This action will contribute to reduction of toxicity, mobility, and volume of source area contaminants and will provide permanent long-term treatment of the source area.

4.6.2.2 Institutional Requirements

Compliance with ARARs

In particular, the ARARs with which these alternatives comply with are the Pennsylvania Hazardous Sites Cleanup Act, 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities), and 40 CFR 270 (EPA-Administered Permit Programs: The Hazardous Waste Permit Program). The alternative will also comply with National Ambient Air Quality Standards during venting; it will comply with OSHA Health and Safety Requirements for worker safety; it will comply with Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists for all concentrations; it will comply with the Pennsylvania Clean Streams Law for erosion and sediment requirements; it will comply with the Pennsylvania Dam and Safety Encroachments Act of 1978 regarding encroachment of wetlands; it will

comply with the Pennsylvania Flood Plain Management Act of 1978 which is concerned with construction within the 100-year floodplain; and it will comply with the Pennsylvania Solid Waste Management Act of 1980 which governs treatment and disposal of hazardous wastes.

Non-Compliance with ARARs

This alternative will contribute toward achieving MCLs established by EPA and adopted by the Commonwealth of Pennsylvania for ground water at the site boundary. This alternative would not likely achieve MCLs without some type of ground-water extraction and treatment in addition to the source area action.

Permit Requirements

The construction and operation of the *in situ* soil venting system must comply with all State and Federal regulations as a hazardous waste treatment facility. The system must have approval from all regulatory agencies. The vacuum extraction and treatment system must meet State and local approval. Well permits would be required for installation of any new wells.

Construction permits would be required for the vacuum extraction system and the ground-water treatment system.

Sediment and erosion control measures and permits would be required. Wetland and/or floodplain permits would be required if site activities may impact the wetlands or floodplains associated with Marsh Run Creek or the Susquehanna River.

Post-action ground-water and surface-water monitoring would be required to assess the effectiveness of source area remediation. Post-action monitoring is addressed in Section 6.4.

4.6.2.3 Public Health and Environmental Issues

This alternative provides a long-term solution to contaminant migration. It also provides a significant reduction or elimination of the potential public health risks and environmental impacts resulting from

- Direct contact with contaminants.
- Migration of contaminants via ground/surface water contact with contaminated soils.

Sediment and erosion controls to prevent pollutant runoff would be required.

4.6.3 Cost Criteria

Capital costs for Source-Area Alternative No. 4, *In Situ* Soil Venting, are presented in Table 4-5a. Operation and maintenance costs for Source-Area Alternative No. 4 are presented in Table 4-5b.

TABLE 4-5a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 4: IN SITU SOIL VENTING

Item	Description	Quantity	Unit Cost	Total
1	Security Fence	1,500 ft	$ 12.40/ft	$ 18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	Venting System[a]	48,600 tons	50/ton	2,430,000
5	SUBTOTAL			$2,475,536
6	Mobilization/Demobilization, Construction Management, Site Services		10%	247,554
7	Implementation, Design, Permits		22%	544,618
8	Contingency		25%	618,884
9	TOTAL			$3.89 X 10^6

(a) Cost includes equipment, construction of the system, and costs for labor, materials and supplies, analytical testing, effluent treatment, residual disposal, and facility modifications during the operational period of the system (estimated at 1 year).

TABLE 4-5b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 4: IN SITU SOIL VENTING (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	Confirmatory Soil Sampling			
	. Labor	96 hours	40/hr	3,840
	. Analysis	40 samples	220/sample	8,800
6	TOTAL			$ 68,232

TABLE 4-5b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$68,232 + $24,842 (P/A, 8%, 29 yrs) = $345,429 ~ $350,000

4.7 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 5: IN-SITU SOIL FLUSHING/BIOREMEDIATION

4.7.1 Description

This alternative consists of treating the contaminated soil and ground water through biological processes. The treatment system consists of a bioreactor which degrades the TCE and other VOCs in the water after it is pumped from the ground. The treated water is then discharged into the ground via either injection wells or an infiltration basin to enhance the subsurface microflora. Microbes, nutrients, and oxygen are added to both the bioreactor and the injection/infiltration water to aid the growth of the microorganisms which degrade the TCE and other VOCs. The injected/infiltrated water is then recovered from the surficial aquifer through pumped wells to produce a closed treatment system. Figure 4-5 is a schematic representation of an in situ bioremediation system that could be constructed at the Marsh Run Park site.

The design of the treatment system depends on the contaminants, soil permeability, regulatory constraints, and nature of the vadose zone. In addition, an understanding of the metabolic pathways of the microorganisms is required in order to effectively control and manipulate the environment for optimum bioremediation.

The biological degradation of the subsurface contamination is accomplished through injection or infiltration of the oxygenated nutrient solution into the contaminated zone to stimulate the natural microbial activity. Additional microbes (naturally occurring) may be added here. The water is cycled through a series of recharge basins or wells and recovery wells until the contamination is reduced to required levels. The recharge causes mounding of the ground water to occur in the area of contamination, which aids in providing a suitable environment for biological degradation.

Treatability studies would be required to establish the degradation potential rates, microbial growth kinetics, and hydraulic residence times for the injected/infiltrated water. These studies include

- Laboratory screening,
- Bench-scale testing, and
- Pilot-scale testing.

Laboratory screening is first performed as a relatively quick determination of the contaminant concentration and to isolate and establish a population of TCE-degrading microorganisms. Once established, a bench-scale test is set up to produce information on the performance of the biodegradation process, including rates of contaminant reduction, levels achieved, and required amounts and chemical forms of nutrients and oxygen which optimize the process. Once the bench-scale testing is completed, pilot-scale testing in the field is necessary to evaluate the hydraulics of the treatment process under site conditions. This step is critical, as in situ conditions are always poorer and less controlled than conditions in the laboratory. As a consequence, bioremediation rates are usually much slower, and larger amounts of nutrient and oxygen additives are required.

Necessary studies to support the above are soil borings and their characterization as to classification, permeability, depth, and contaminant concentration. In addition, ground-water pumping capabilities are needed in order to design the system to accommodate pumping rates, size the treatment system components, and determine the recycle rates.

The two primary considerations of a bioremediation treatment system are the nature of the contaminant and the soil characteristics. TCE has been shown to be biodegradable with the addition of nutrients, oxygen, and specific TCE-degrading bacteria. It is not as degradable as petroleum hydrocarbons, but is more degradable than highly chlorinated substances.

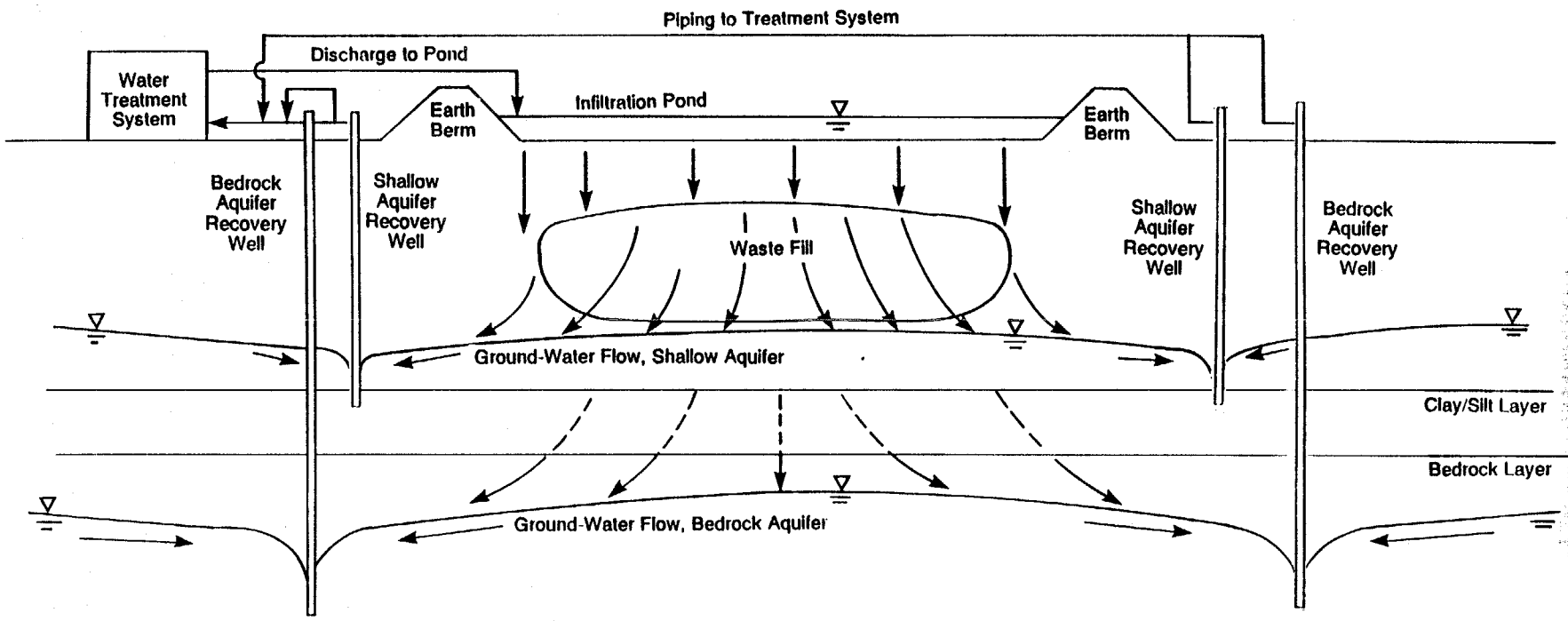

Figure 4-5. Schematic showing cross-section of waste flushing system to be used in conjunction with bioremediation.

There are examples of sites where subsurface contamination of TCE has been proven to be biodegraded, therefore it is concluded that the pollutant may be amenable to this process.

The soil characteristics of concern are primarily related to the permeability and subsequent flow of ground water. For bioremediation to be successful, sufficient hydraulic conductivity in the contamination area is required. This will ensure that the solution of nutrients, microbes, and oxygenated water which is injected or infiltrated into the ground is able to migrate and provide the naturally occurring microorganisms with a favorable environment for their growth. This, in turn, will allow the growing population of indigenous bacteria, yeast, and fungi to consume and degrade the pollutant.

Figure 4-6 shows the approximate limits of the area to be treated by in situ bioremediation. Further refinement of the area to be treated will be made during the design and construction phases. Bioremediation will be continued until analysis of samples from the source area indicate that target treatment levels have been achieved. The target treatment level will be specified in the ROD and will be based on the concentration of target VOCs in soil samples. The target treatment level will be established as a percent removal efficiency. This percent removal efficiency will be a function of technical capabilities of VOC removal through bioremediation, and of the objective of providing source area treatment that reduces source area contributions to the bedrock aquifer to below SDWA MCL concentration. Confirmatory soil samples will be collected at selected intervals throughout the bioremediation process to assess system performance.

For this alternative, a construction staging area would be required to locate office trailers, construction trailers, and materials storage. This area would be considered the support zone. A contamination exclusion zone would need to be established to contain the water treatment system and the injection wells or infiltration basin. This area would

require Level C protection. Between these two zones would be a contamination reduction zone, which would serve to decontaminate site workers, visitors, and vehicles which have entered the exclusion zone. Figure 4-6 is a representation of the site layout and area to be treated with this alternative.

Because site work would consist of earth moving, the installation of sediment and erosion control devices would be required; these could include silt fences, sediment basins, and stormwater diversion. After the site work is completed, the area would have to be stabilized through revegetation.

A Hazardous Materials Contingency Plan will be developed during the design phase as a component of this action. The plan will identify procedures and methods for handling, separating, and removing (if necessary) hazardous materials that may be encountered during implementation of the remedial action. Key provisions of the Hazardous Materials Contingency Plan will be developed into the technical specifications for construction activities, and the Contractor will be required to abide by these provisions.

4.7.2 Non-Cost Analysis

4.7.2.1 Technical Feasibility

Advantages

In situ bioremediation is a relatively new technique for hazardous waste cleanups. However, it has the potential to eliminate the source of organic contamination and the subsequent impact to ground water, thereby achieving a substantial reduction in toxicity, mobility, and volume of the source area contamination. In addition, the ground water is treated as part of the process. Bioremediation is recognized as an effective innovative technology for remediation of VOC contamination in soils.

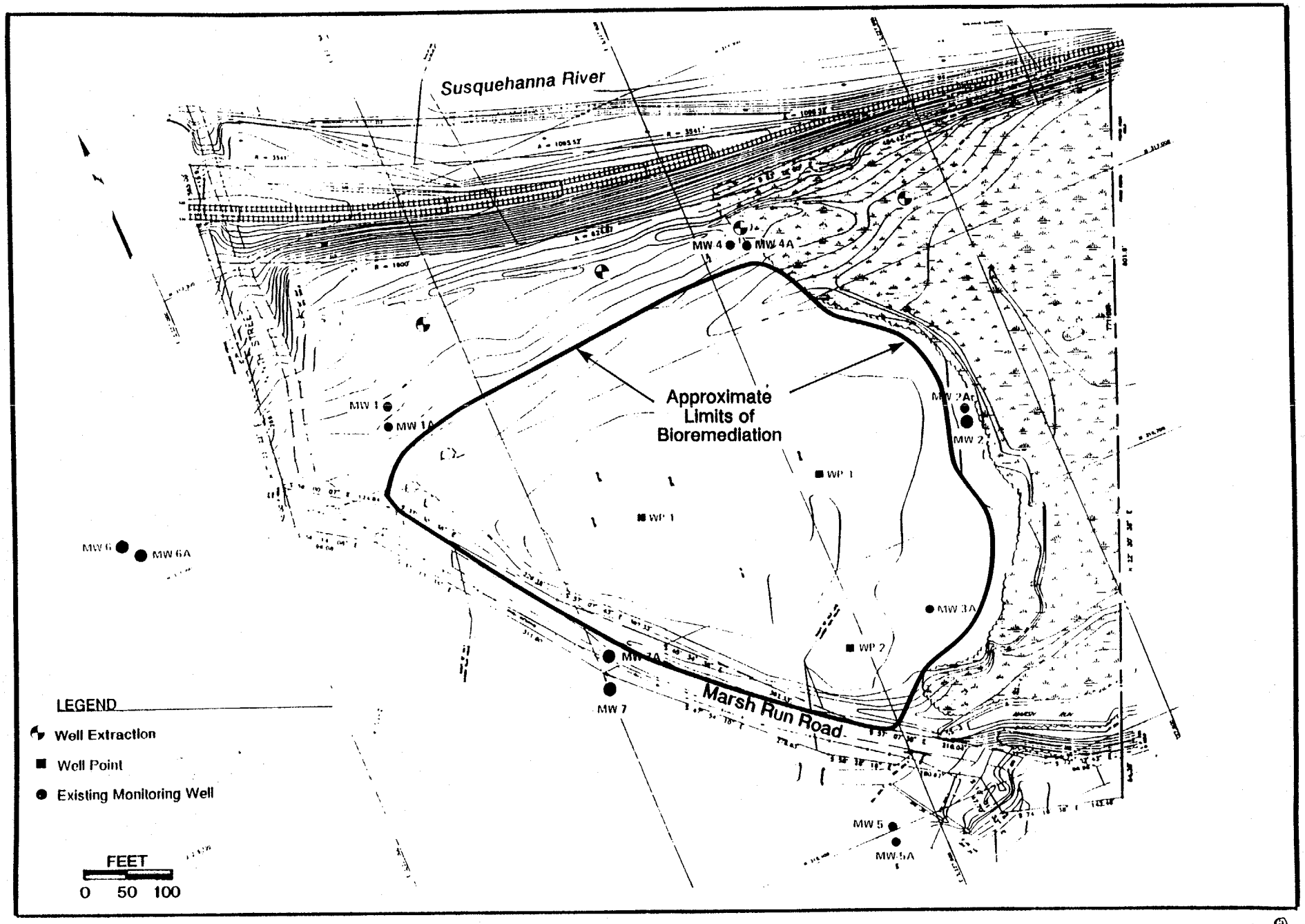

Figure 4-6. Site layout for Source Area Alternative #5: In Situ Soil Flushing/Bioremediation.

Several bioremediation processes have been selected for development under EPA's SITE program.

Minimal risks of exposure to onsite personnel and nearby residents are achieved with this alternative. The only risk of exposure would be from contact with ground water.

There is a limited supply of contractors with demonstrated experience in degradation of volatile organic solvents because bioremediation is a relatively new technique. Bioremediation has been used extensively in cleanup of petroleum and wood preserving process contamination. A sufficient number of qualified contractors is available to assure competitive construction bids.

Disturbance of the surrounding area, which is necessary for this alternative, consists primarily of the installation of the water treatment system, ground-water pumps, and reinjection wells. An infiltration basin would require more area than injection wells, but may be more effective for the site conditions at Marsh Run Park.

Disadvantages

Variations in subsurface soil permeability and porosities could cause channeling and/or plugging when water is injected or infiltrated.

The nature of the contaminants (TCE and TCE-degradation products) may not be conducive to biodegradation in the environment of this site.

The process is relatively long-term, and depends on soil permeability and contaminant concentration. There could be an odor problem from the bio-treatment system on the surface and from the infiltration basin.

Conclusions

Bioremediation is a demonstrated effective process for in situ treatment of VOC-contaminated soils. TCE has been found to be less amenable to bioremediation than other types of VOCs. Construction of a bioremediation system could be accomplished in less than 6 months. It is estimated that a time period of 3-5 years would be required to remediate the source area at Marsh Run Park.

This technology should be effective at reducing the toxicity and volume of source area contamination. It will increase mobility of contaminants through soil flushing, but mobilized contaminants should be extracted through the ground-water extraction system (see Section 4.10 through 4.13).

4.7.2.2 Institutional Requirements

Compliance with ARARs

In particular, the ARARs with which these alternatives comply are the Pennsylvania Hazardous Sites Cleanup Act, 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities) and 40 CFR 270 (EPA-Administered Permit Programs: The Hazardous waste Permit Program). The alternative will also comply with National Ambient Air Quality Standards during excavation; it will comply with OSHA Health and Safety Requirements for worker safety; it will comply with Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists for all concentrations; it will comply with the Pennsylvania Clean Streams Law for erosion and sediment requirements; it will comply with the Pennsylvania Dam and Safety Encroachments Act of 1978 regarding encroachment of wetlands; it will comply with the Pennsylvania Flood Plain Management Act of 1978 which is concerned with construction within the 100-year floodplain; and it will comply with the Pennsylvania Solid Waste Management Act of 1980 which governs treatment and disposal of hazardous wastes.

For discharge of any treated water, this alternative will comply with Federal Ambient Water Quality Criteria under the Clean Water Act, specifically regarding NPDES permits, and therefore it will concurrently comply with Pennsylvania Water Quality Standards.

Non-Compliance with ARARs

This alternative will contribute toward achieving MCLs established by EPA and adopted by the Commonwealth of Pennsylvania for ground water at the site boundary. This alternative would not likely achieve MCLs without some type of ground-water extraction and treatment in addition to the source area action.

Permit Requirements

The construction and operation of the *in situ* bioremediation system must comply with State and Federal regulations for hazardous waste treatment facilities. The system must have approval from all regulatory agencies. The injection/recovery system must meet State and local approval. Well permits would be required for installation of any new wells.

NPDES permits would be required for

- discharge of treated bioremediation process water
- discharge of excess process water
- discharge of the final treated recycled stream

Construction permits would be required for the injection/recovery system and the wastewater treatment system.

Sediment and erosion control measures and permits would be required. Ground-water and source remediation must achieve cleanup goals for

- drinking water
- ambient water quality criteria
- other risk-based considerations

At this time, bioremediation is strongly supported by EPA and State environmental organizations.

The introduction of microorganisms must meet with Federal, State, and local approval. Permits would be required.

4.7.2.3 Public Health and Environmental Issues

This alternative provides a long-term solution to contaminant migration. It also provides a significant reduction or elimination of the potential public health risks and environmental impacts resulting from

- direct contact with contaminants

- migration of contaminants via ground/surface water contact with contaminated soils

Sediment and erosion controls to prevent pollutant runoff would be required.

The addition of microorganisms to the injection/infiltration water must not pose a threat to the environment.

4.7.3 Cost Criteria

Capital costs for Source-Area Alternative No. 5, *In Situ* Soil Flushing/Bioremediation are presented in Table 4-6a. Operation and maintenance costs for Source-Area Alternative No. 5 are presented in Table 4-6b.

TABLE 4-6a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 5: IN SITU SOIL FLUSHING/BIOREMEDIATION

Item	Description	Quantity	Unit Cost	Total
1	Security Fence/Gate	1,500 ft	$ 12.40/ft	$ 18,600
2	Site Clearing/Soil Stripping	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	Treatability Testing	LS	LS	50,000
5	Bioremediation Treatment System(a)	47,500 yd^3	20/yd^3	950,000
6	SUBTOTAL			$1,045,536
7	Mobilization/Demobilization, Construction Management, Site Services		10%	104,554
8	Implementation, Design, Permits		22%	230,018
9	Contingency		25%	261,384
10	TOTAL			$1,641,492
				SAY $1.65 x 10^6

(a) Cost includes equipment, construction of the system, and costs for labor, materials and supplies, analytical testing, effluent treatment, residual disposal, and facility modifications during the operational period of the system.

TABLE 4-6b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 5: IN SITU SOIL FLUSHING/ BIOREMEDIATION (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$55,592

TABLE 4-6b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$55,592 + $24,842 (P/A, 8%, 29 yrs) = $332,789 ~ $330,000

4.8 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 6: IN SITU VITRIFICATION

4.8.1 Description

In Situ Vitrification (ISV) is a new treatment method that may be applied directly to the in situ waste material. The ISV process electrically melts inorganic soil material so that a thermo-chemical process can treat, free, and/or containerize contaminants in the waste volume. Natural soils or other process residual inorganics (sludges, tailings, sediments) may be treated by the melting process. Utilizing soil in the waste, the ISV process destroys and/or removes organic contaminants while chemically incorporating and immobilizing inorganics (metals) into a chemically inert and stable glass crystalline residual.

Typically, three stages are required in the ISV melting process, as illustrated by Figure 4-7. During stage 1, electrodes (usually four) are configured to a design depth around a design treatment volume. Soils in the waste usually do not have sufficient electrical conductive capacity to initiate the melting process; therefore, a conductive material comprised of graphite and glass frit is placed as a starter conductive material between the electrodes. As electric potential flows through the starter materials, between the electrodes, the adjacent soil heats to its fusion temperature (±1,000 C). This heat in the soil allows the soil to become electrically conductive enough to be the primary electric conductor.

The applied electrical energy, stage 2, causes the melted material to subside downward and outward to encompass the desired waste volume. A total melt mass of up to 1,000 tons and a maximum width and depth of 30 ft are reported to be feasible for a setting at Marsh Run Park. The depth of fill is considerably less; therefore, the total waste depth could be treated in a single setting. Geophysical, optical, and thermal principles may be used to determine the actual extent of the melt.

The third stage involves backfilling over the treatment zone with clean soil since a subsidence volume above the melt is created. The volume reduction is created by a void volume present in particulate materials (20-40 percent depending on soil type) and by materials present in the soil, such as humus and organic materials, which are removed as gases and vapors during the melt.

The molten soil mass is usually at a temperature of 1,600 to 2,000 C depending on the chemistry of the waste. A large-scale ISV process melts soil at a 4-6 ton/hr rate or a melt rate of 1-2 in./hr. As the thermal gradient advances on organic materials, vaporization into elemental components occurs, followed by pyrolysis decomposition in the absence of oxygen. When the organic material undergoes pyrolysis, typical products are gases, which move slowly due to the high viscosity of the molten material, from the melt to the upper surface of the melt. Gases may dissolve in the melt itself while the remaining gases move to the surface, where the combustible fraction burns in the presence of air. The pyrolysis and combustion products are trapped in an off-gas collection hood to be treated to air emissions requirements. Due to the high temperatures of the melt process, no residual organic contamination remains in the original <u>in situ</u> organic compound from the vitrified product. Based on the extent and volume of material to be treated at Marsh Run Park, this process would be expected to take approximately 1 year using multiple units.

The inorganic fraction of the waste behaves similar to an organic under the thermal process. They may decompose or enter reactions with the melt. While nitrates and sulfates decompose into gas products to be collected in an off-gas collection hood with organic vapors, inorganic elements are incorporated into the vitrified residual.

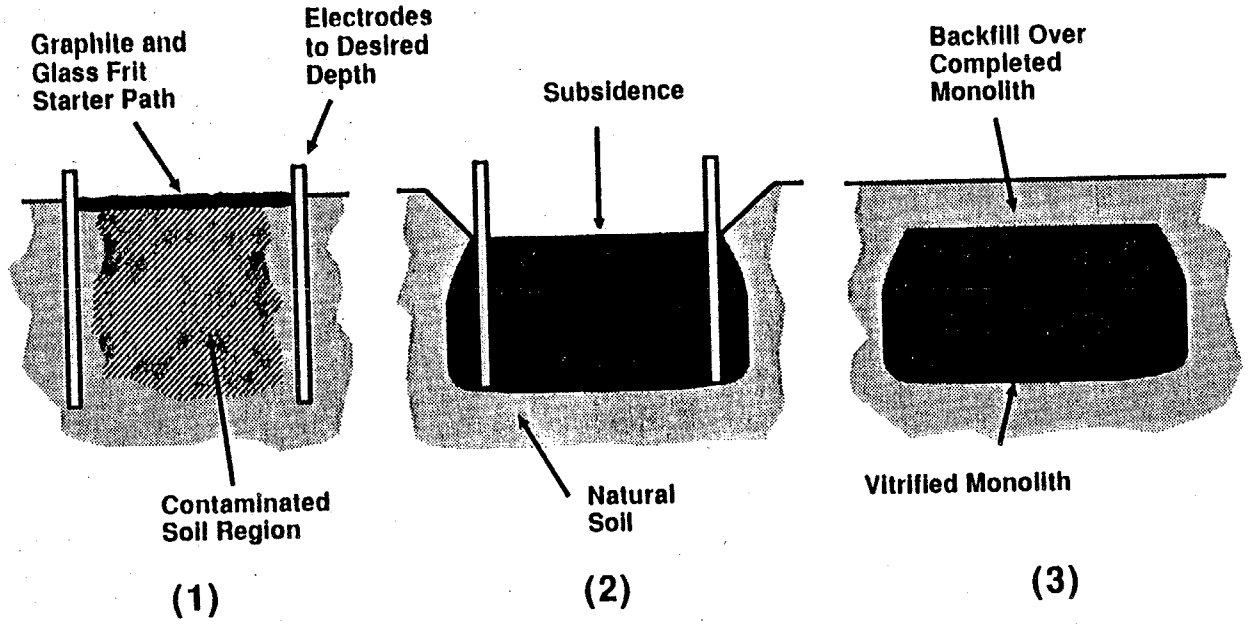

Figure 4-7. Stages of ISV Processing.

Off-Gas Collection

The gases emitted in the ISV melt process are collected by an octagonal hood with a maximum dimension across the flats of 55 ft. The buffer between the hood width and melt width allows for off-gas containment from subsidence.

A draft blower transports the off-gases (combustion products and air) into a treatment system which utilizes the following unit processes for air compliance:

- quenching
- pH-controlled scrubbing
- mist elimination
- heating
- particulate filtration
- activated carbon adsorption

A glycol cooling system is used to cool the quenching/scrubbing solution to avoid the need for constant onsite water supply. The off-gas treatment system would employ a backup treatment system in the event of power failure. This backup system has its own diesel-powered generator, blower, mist cooler, filter, and carbon unit. This system can treat off-gases during power outage or during the initial cooling time at completion of a setting.

Figure 4-8 shows the ISV equipment system.

Waste Composition and Properties

The ISV melting process is applicable to all types and mixtures of waste. The entire treatment volume is melted simultaneously, as opposed to other treatment technologies where varying waste components are treated separately. Generally, nearly all organic contaminants in the waste volume may undergo destruction by pyrolysis during the melt or may

be collected in the off-gas treatment system. Materials captured in the off-gas system may be recycled back to a treatment volume for additional destruction or immobilization. By this process, nearly all of the contaminants are destroyed, removed, or immobilized; however, it is possible for trace contaminants to remain as untreated residual in the soil adjacent to the residual monolith. This would not impact overall treatment efficiency and destruction since it is reported that concentrations typically are below cleanup levels. Obviously, specific treatment performance depends on properties of individual organics. The ability of equipment to accommodate the response of contaminants to processing relates to the off-gas treatment hood, which has volumetric throughput and heat removal capabilities. Therefore, limits on concentration of combustible organics and other materials must be set so that an adequate factor of safety is maintained in the collection and treatment process.

The inorganic fraction will be incorporated into the melt and become part of the residual monolith with the exception of compounds decomposed into the gaseous product. This will essentially immobilize the inorganic product. To determine the effectiveness of non-leaching characteristics of the product, it is necessary to analyze the contaminants in conjunction with the soil matrix. The following evaluation is required:

- Concentration of inorganics in the waste relative to solubility glass.

- Expected retention percentage in the melt.

- Leaching characteristics in the residual product.

Generally, organic and inorganic contaminants in the soil that are, respectively, in the 5-10 and 5-15 percentage by weight categories are treatable by ISV. There are exceptions due to variations in the waste; therefore, a site-specific evaluation would be performed. ISV has been previously used in treatment of soils contaminated with TCE and other solvents, and heavy metals.

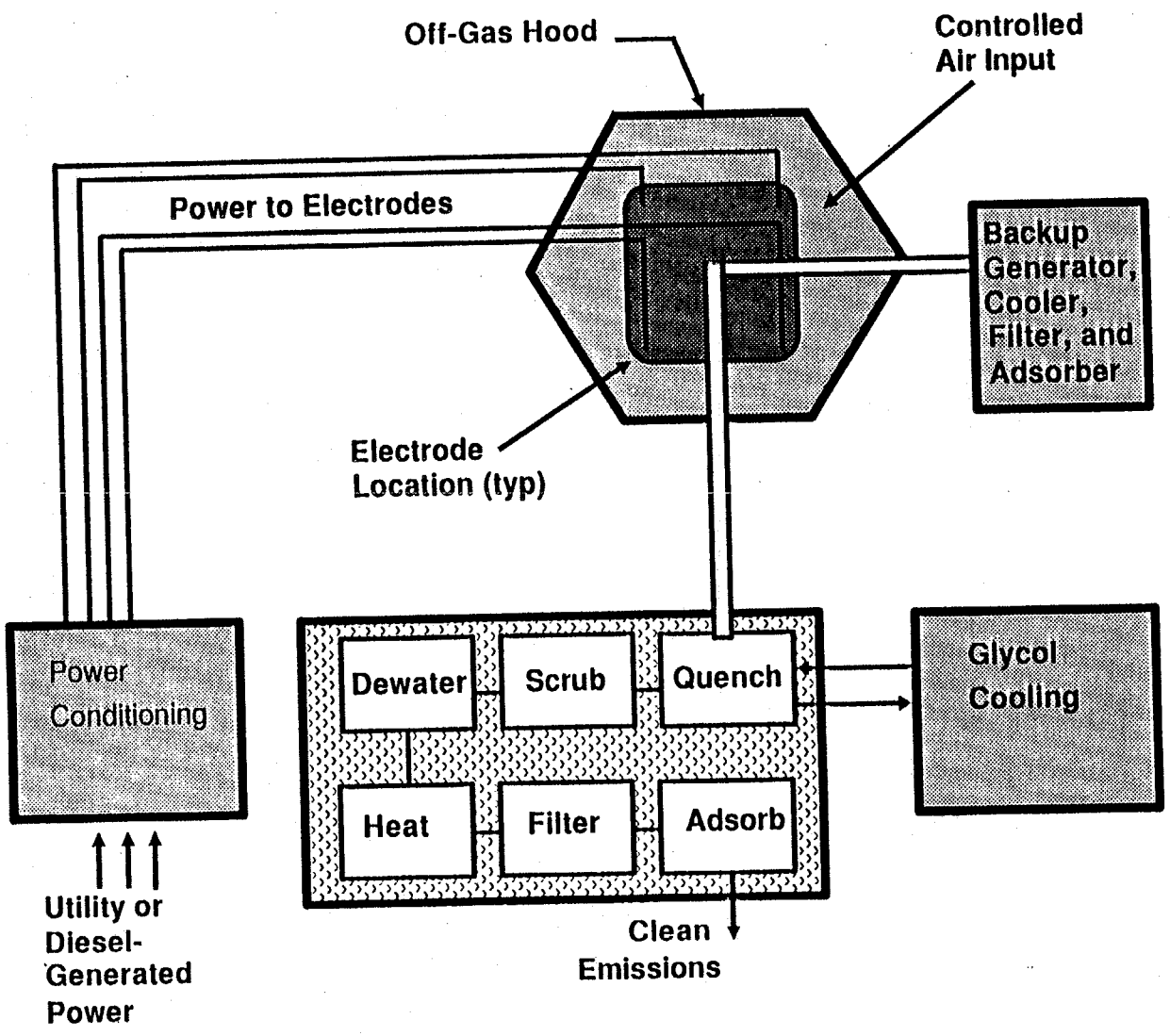

Figure 4-8. ISV Equipment System.

Glass-forming properties (presence of silica and aluminum oxides) are required in the soil around the waste material to produce a high-temperature melt. It is also necessary to have sufficient monovalent alkali cations to provide electrical conductivity needed for the process. If this is not present in sufficient quantities, a $NaCO_3$ fluxing material may be added. It has been demonstrated that most all sludges and naturally occurring soils, sediments, and tailings meet the glass-forming properties. A treatability study (along with specific wastes) would be required to verify melt suitability.

Ground-Water Restrictions

Saturated soils may be processed by vaporizing water to 100 C; however, the energy required to remove the water fraction is approximately equal to that required to melt an equal weight of soil. It is therefore advantageous to have the soil in a dry condition for processing. The ground-water elevation at Marsh Run Park may affect the treatment volume at different periods. An option would be to attempt to lower the water table using extraction wells. It is also possible to process the waste in the water table if recharge is slow enough. It is generally feasible to process below the water table if soil permeability is less than 10^{-4} cm/sec. Moisture content in the soil, matrix permeabilities, and recharge rates would be evaluated for final design.

Presence of Inclusions

The waste characteristics of the Marsh Run Park site are not definitely known. There may be areas of high concentrated contaminants, metal scrap, demolition rock, or other non-homogenous materials or conditions. Most inclusions (with the exception of ceramics) may be treated as other waste materials.

Inclusions (e.g., wood) may produce gases which require volumetric and heat removal design considerations. Obviously, varying materials in the waste affect the melt process. General limits for presence of inclusion in the waste volume are

- rubble 10-20 percent by weight
- combustible solids 5-10 percent by weight
- metal 5-15 percent by weight
- combustible liquids 5-10 percent by weight
- void volumes <150 ft^3
- continuous metal <90 percent distance between electrodes
- combustible packages <30 ft^3

It is not anticipated that there is a waste inclusion limitation at the Marsh Run Park site.

Figure 4-9 shows the approximate limits of the area to be treated by in situ vitrification. Further refinement of the area to be treated will be made during the design and construction phases. Successful performance of this system will be determined through analysis of samples taken from the solidified mass, and subjected to contaminant leaching tests. The target treatment levels for this remedial action will be based upon TCLP extract contaminant concentrations and contaminant concentrations as measured by the California Wet Test, in an upon the objective of limiting source area contribution to the berock aquifer to below SDWA MCLs. The target treatment level for this technology will be specified in the ROD.

A Hazardous Materials Contingency Plan will be developed during the design phase as a component of this action. The plan will identify procedures and methods for handling, separating, and removing (if necessary) hazardous materials that may be encountered during implementation of the remedial action. Key provisions of the Hazardous Materials Contingency Plan will be developed into the technical specifications for construction activities and the Contractor will be required to abide by these provisions.

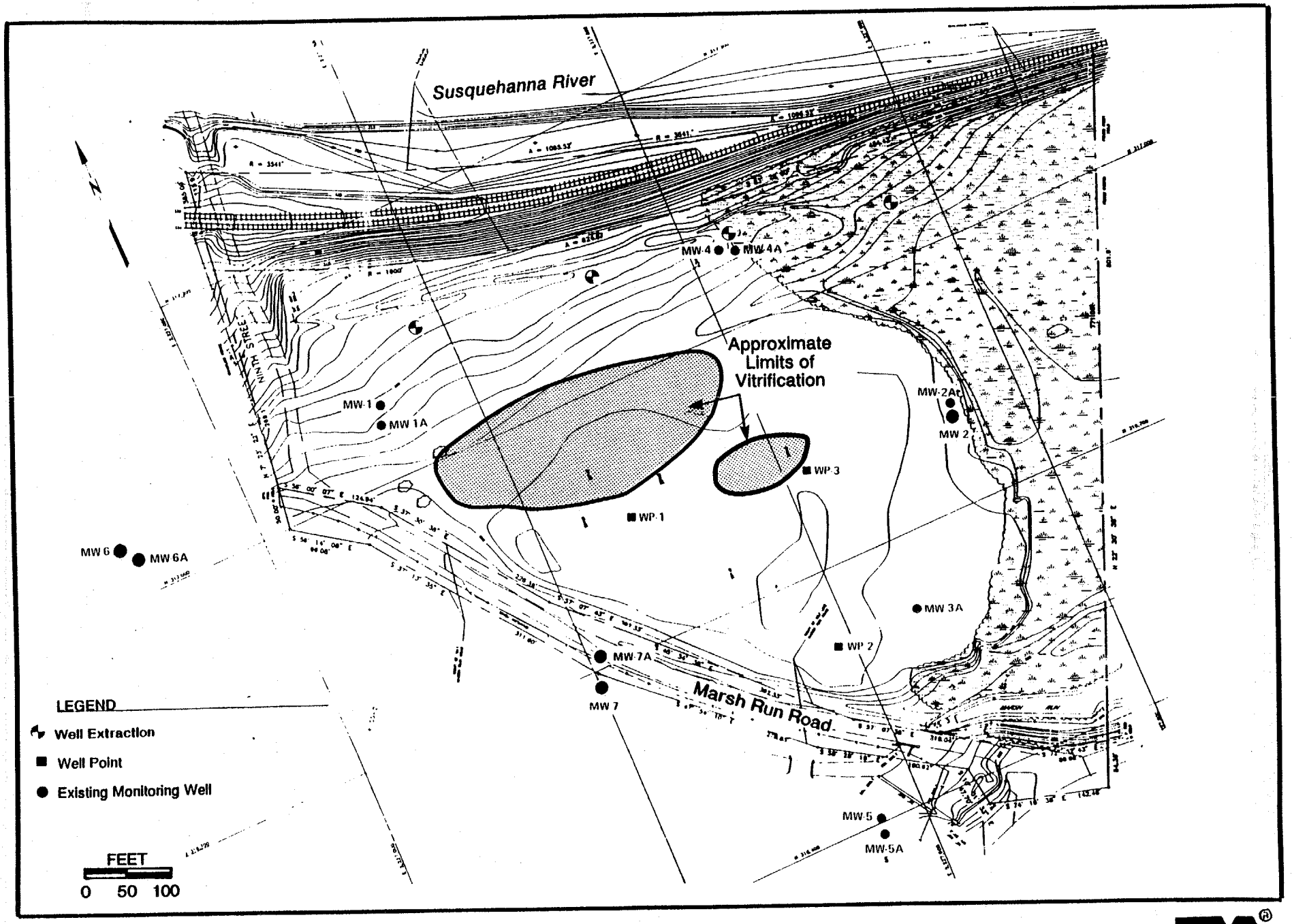

Figure 4-9. Site layout for Source Area Alternative #6: In Situ Vitrification.

4.8.2 Non-Cost Analysis

4.8.2.1 Technical Feasibility

By applying ISV, hazardous materials are irreversibly destroyed or removed from the treatment volume, while remaining inorganic elements are incorporated into the residual product able to withstand long-term environmental exposure. By destruction or immobilization in the residual, ISV is an effective long-term solution for the source area.

It is reported that the residual product has been subjected to leaching tests (EPA's EP Toxicity and TCLP) and has shown a leach rate of heavy metals of less than TCLP limits for classification as a RCRA characteristic waste. The residual will also have excellent structural strength and should not be affected by freeze and effects. Therefore, the remaining residual could be backfilled, after settlement occurs, without concern of additional settlements.

Erosion and sediment control provisions (silt fence, seeding, etc.) would be required. Large-scale equipment can process about 4-6 tons/hr, or, at typical outputs, 600-800 tons/wk. If more rapid remediation is needed, other equipment may be brought in. Assuming that approximately 35,000 tons would be treated, two units operating at 600 tons/wk each would be deployed for about 30 weeks (6-7 months).

The ISV process, developed for large-scale operations, is an innovative technology for which there has been limited commercial experience. It is necessary, therefore, to thoroughly evaluate site-specific conditions in a treatability test prior to large-scale operations. A treatability test would require actual waste samples to be shipped to a laboratory for testing. Typically, data from bench-scale testing yield the necessary data for applicability evaluation. A large-scale *in situ* test may also be performed to warrant continuation of remediation.

If it is desired to access ground water (for pump and treat systems) after ISV remediation, such access can be gained by drilling at elective placement locations in the monolith. It is possible to consider ISV treatment of the source area followed by or concurrent with ground-water remediation. The monolith residual or adjacent soil can be monitored by core samples.

The availability of equipment is limited since it is a new technology. GeoSafe Corporation reports that it is able to produce ISV equipment within 4-6 months, which is less time than required for actual implementation phases, and that it will make additional efforts if existing equipment is not available to meet project demands. Exclusive rights to the ISV technology are held by GeoSafe, so the actual ISV work could not be competitively bid, although other contract work could be.

In the ISV process, the hazardous inorganics are not destroyed but are immobilized in the residual product. The inorganics are chemically incorporated, rather than the constituents being immobilized by encapsulation or other stabilization measures. Therefore, while there is minimal reduction of toxicity or volume, there is a substantial reduction in mobility of the source area contamination.

4.8.2.2 Institutional Requirements

Compliance with ARARs

In particular, the ARARs with which these alternative comply are the Pennsylvania Hazardous Site Cleanup Act, 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities), and 40 CFR 270 (EPA-Administered Permit Programs: The Hazardous Waste Permit Program). The alternative will comply with National Ambient Air Quality Standards during excavation; it will comply with OSHA Health and Safety Requirements for worker safety; it will comply with Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists for all concentrations; it will comply with the

Pennsylvania Clean Streams Law for erosion and sediment requirements; it will comply with the Pennsylvania Dam and Safety Encroachments Act of 1978 regarding encroachment of wetlands; it will comply with the Pennsylvania Flood Plain Management Act of 1978 which is concerned with construction within the 100-year floodplain; and it will comply with the Pennsylvania Solid Waste Management Act of 1980 which governs treatment and disposal of hazardous wastes.

Non-Compliance with ARARs

This alternative will contribute toward achieving MCLs established by EPA and adopted by the Commonwealth of Pennsylvania for ground water at the site boundary. This alternative would not likely achieve MCLs without some type of ground-water extraction and treatment in addition to the source area action.

Permit Requirements

The operation of the ISV process must comply with State and Federal regulations for hazardous waste treatment facilities. Regrading would require sediment and erosion control measures and permitting from State agencies. The off-gas collection system would require approval from the State Air Quality Department for discharge. Additional electrical loads to the site must comply with local requirements.

4.8.2.3 Public Health and Environmental Issues

ISV treatment provides long-term source remediation and source contaminant migration reduction. Other public health and environmental issues associated with the ISV process are as follows:

- With erosion, sediment, and surface water control, the local environment will not be impacted by contaminated or other sediments.

- Since the contaminants are largely destroyed or immobilized, remaining risks of the source are primarily contaminants present in the ground water, which are addressed with ground-water remedial action.

- Decomposition of the glass-like residual is measured in geologic time, and is therefore essentially immobilized.

- The in situ process is advantageous. Risks to workers and the community are reduced since there is little removal or transport of hazardous material.

- The melting produces heating of soils; however, the heat is not dissipated far from the melt and would not affect residences.

4.8.3 Cost Criteria

Capital costs for Source-Area Alternative No. 6, In Situ Vitrification, are presented in Table 4-7a. Operation and maintenance costs for Source-Area Alternative No. 6 are presented in Table 4-7b.

TABLE 4-7a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 6: IN SITU VITRIFICATION

Item	Description	Quantity	Unit Cost	Total
1	Security Fence/Gate	1,500 ft	$ 12.40/ft	$ 18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	Treatability Study	LS	LS	105,000
5	Vitrification	70,600 tons	450/ton	31,770,000
6	Soil Backfill	22,000 yd^3	15/yd^3	330,000
7	Regrading/Revegetation	LS	LS	6,500
8	SUBTOTAL			$32,257,036
9	Mobilization/Demobilization, Construction Management, Site Services		10%	3,225,704
10	Implementation, Design, Permits		22%	7,096,548
11	Contingency		25%	8,064,259
12	TOTAL			$50,643,547
			SAY	$50.65 x 10^6

TABLE 4-7b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 6: IN SITU VITRIFICATION (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$55,592

TABLE 4-7b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$55,592 + $24,842 (P/A, 8%, 29 yrs) = $332,789 ~ $330,000

4.9 EVALUATION OF SOURCE-AREA ALTERNATIVE NO. 7: SELECTIVE EXCAVATION WITH OFFSITE DISPOSAL

4.9.1 Description

This alternative is basically the same as Alternative No. 3, with the exception that it is only necessary to excavate the portions of the waste fill which have been identified by the ground-water sampling study performed in April 1990 as the major sources of contamination. These areas will be considered the "hot spots." The volume of this material is estimated to be 18,000 yd^3, of which 4,000 yd^3 are waste material and 14,000 yd^3 are contaminated soil.

Figure 4-10 shows the estimated limits of excavation for this alternative. The limits shown correspond to the "hot spots" as identified in the VOSS. Further refinement of the area to be excavated will be made during the design and construction phases. The actual limits of excavation will be based upon action specific target treatment levels that will be specified in the ROD. The target treatment level for selective excavation will be based on the concentration of target VOCs in the leachable extract from source area soil samples. For selective excavation, soil samples will be extracted according to the TCLP procedure. The TCLP extract samples will be analyzed for volatile oganic contaminants. The target treatment levels for TCLP extract concentrations will be the SDWA MCLs.

Confirmatory soil samples will be collected at selected intervals to assess limits of excavation. The scope of confirmatory soil sampling shall be defined in the design phase.

Due to the variety of materials likely to be encountered during excavation, the site layout will be required to have specific areas for materials handling, separation, preparation, and loading. These areas will be considered the exclusion zone.

The areas will have to be lined and bermed to prevent contamination from moving offsite via stormwater runoff. Materials handling will be required to separate the waste according to size, composition, extent of contamination, and ultimate treatment.

The installation of sediment and erosion control devices will be required. These will include silt fences, sediment/stormwater basins, and stormwater diversions to prevent runon and runoff. These measures should be conservatively designed and built, as the potential to contaminate the surface water is great.

In addition to the contaminated materials handling area, a construction staging and management area will be required; this area will be considered the support zone. Office trailers will be set-up in this area for site inspectors, supervisors, health and safety personnel, and visitors' check-in. A communications system will be part of this area.

A major component of this option will be a decontamination facility for site workers, visitors, inspectors, equipment, and vehicles. This area will be contained within the contamination reduction zone and will include a lined and bermed vehicle decontamination pad, wash equipment, and a liquid storage tank for handling the wash waters until further treatment. A mobile personnel decontamination trailer will be provided.

As part of the excavation process it will probably be necessary to dewater the waste area, primarily because the site was originally a marsh upon which the refuse was deposited. It is likely that ground water will infiltrate the excavation pit. In addition, rain water will collect in the pit. For these reasons, ground-water containment and pumping provisions should be considered with excavation. Ground water encountered during excavation will be contained onsite and treated with the onsite water treatment system (see sections 4.10 through 4.13).

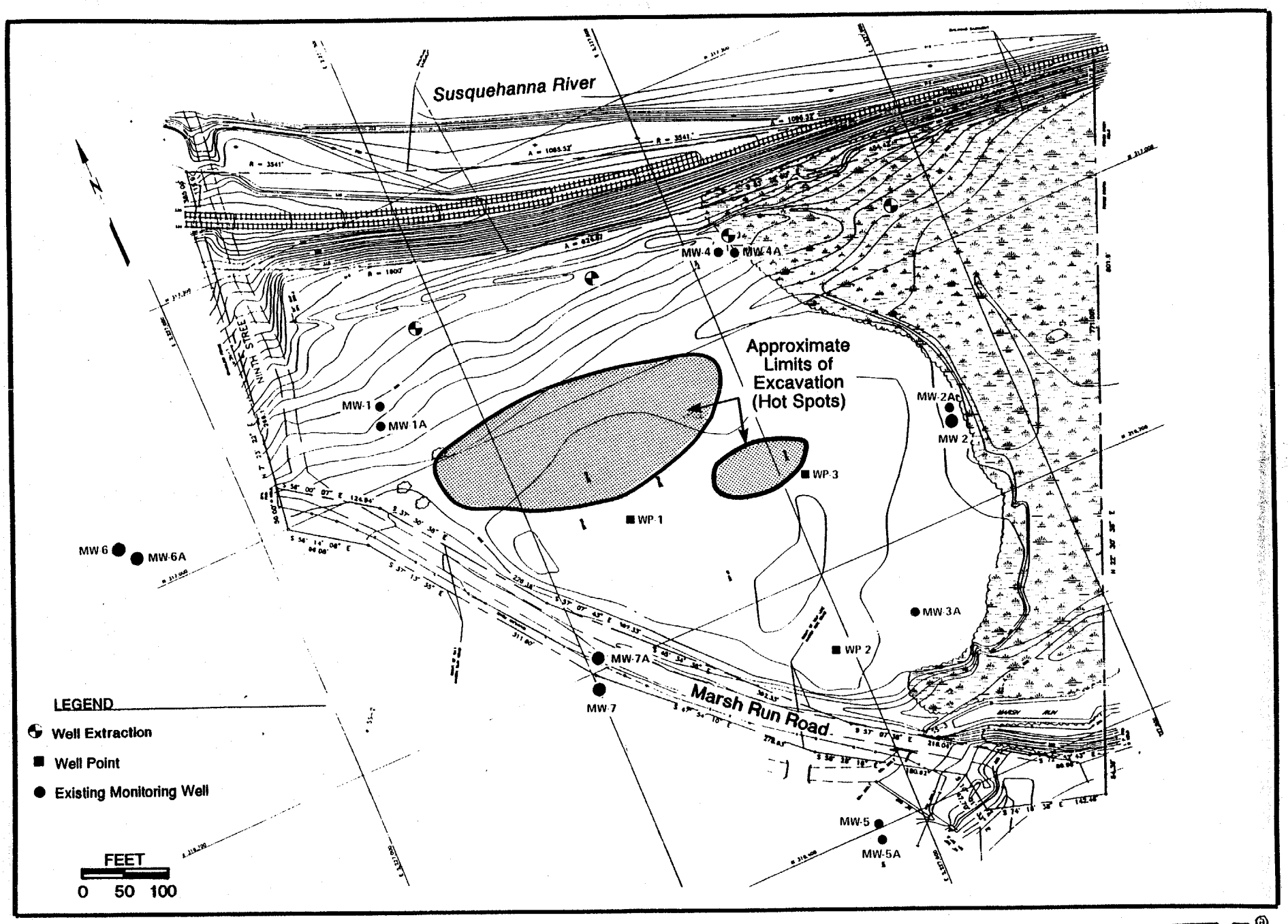

Figure 4-10. Site layout for Source Area Alternative #7: Selective Excavtion/Thermal Treatment.

During the excavation it will also be necessary to monitor and control organic vapor and fugitive dust emissions. Respirators may be required for onsite personnel. It is anticipated that excavation activities will be conducted in Level C PPE, although Level B may be required as conditions warrant.

After all the waste material has been removed, the excavated pit will require clean backfill, regrading, and revegetation.

Waste material that has been excavated will have to be separated according to contamination level, compatibility, and size, prior to preparing it for transportation to an offsite RCRA-permitted TSD facility. Incineration will probably be the required disposal practice for much of the excavated material. The primary factors to consider are waste size, type of incineration process, and the applicability of the process to the waste obtained from the site. Major types of incinerators are rotary kiln, cement kiln, liquid injection, and gas fueled. Waste applicability considerations include Btu content (generally required to be $\geq$5000 Btu/lb), water content, viscosity, halogen content, ash content, size, shape, and state (solid, liquid) of waste materials.

For disposal at most RCRA-permitted incinerators, waste material must be packaged into containers (usually 55-gal fiberboard). This process has the potential to be time-consuming and hazardous to the onsite workers. There are no RCRA incineration facilities less than 200 mi from the site. The closest facility is the Rollins Environmental site in Bridgeport, New Jersey. Other facilities that could process the waste include the ENSCO facility in Little Rock, Arkansas, and Chem Waste Management's Emelle, Alabama, facility. The closest facility that would accept bulk solid waste is the former LWD facility in Calvert City, Kentucky. This site is not currently operational, but has been acquired by Chem Waste and may return to operational status in the near future.

Transportation of the waste to the incinerator requires special considerations relating to the vehicle, such as size and safety features. These features include bed liners, covers, and vents (for liquid containers). Both the vehicle and driver must be DOT approved. Vehicles should also be in excellent mechanical working condition. In addition, if the waste is transported in bulk, compatibility testing is required.

After incineration, it will be necessary to determine if the ash will have a hazardous or nonhazardous classification for landfill disposal. Then the nearest acceptable ash fill can be located to receive the remains of the incineration process.

A Hazardous Materials Contigency Plan will be developed during the design phase as a component of this action. The plan will identify procedures and methods for handling, separating, and removing (if necessary) hazardous materials that may be encountered during implementation of the remedial action. Key provisions of the Hazardous Materials Contingency Plan will be developed into the technical specifications for construction activities, and the Contractor will be required to abide by these provisions.

4.9.2 Non-Cost Analysis

4.9.2.1 Technical Feasibility

Excavation and incineration are proven technologies for the removal and destruction of hazardous waste material. Their combination is a permanent effective solution to the problem, and it is achieved within a relatively short time frame. The removal of "hot spots" within the contaminant source area will also assist in effectiveness of ground-water treatment to achieve the ARARs. In addition, there is good availability of experienced, qualified contractors to perform the work.

Problems expected for this alternative are largely due to the uncertainty in the composition of the waste material. The contractor would have to be prepared to deal with a variety of shapes and sizes of material and be cognizant of the contamination. It is expected that the work would have to be performed in a Level C capacity. The waste material handling and separation would be a difficult consideration, and compatibility testing would be time consuming. Another problem of concern is the handling and disposal of ground water during excavation. Based on the fact that the fill material was placed on top of a marsh, and supported by the presence of adjacent wetlands and monitoring well data, it is reasonable to assume that ground water will be a consideration during excavation. A dewatering system to contain and pump the ground water from the excavation would be necessary. Treatment and disposal of ground water from the excavation would be handled by the onsite ground-water treatment system (see Sections 4.9 through 4.12).

Another concern is the proximity to the Susquehanna River, which has an average discharge of 34,100 cfs. The highest recorded discharge in this area was the flood of 24 June 1972, which had a discharge of 1,020,000 cfs (USGS Monthly Water Resources Summary for Pennsylvania, Water Resources Division, Harrisburg; and USGS 1975, Water Resources Data for Pennsylvania, 1974--Part 1: Surface Water Records, Water Resources Division, Harrisburg, 331 pp.). It is apparent that the Susquehanna River has the potential to affect the Marsh Run Park site through either flooding or higher ground-water tables.

Further problems to consider for this alternative are the short-term health risks associated with excavation. These include health and safety risks to onsite workers, including, but not limited to, injury from equipment or materials and contaminant exposure from dust and/or volatile organics. To a slightly lesser extent, contaminant exposure to nearby residents from excavation is also a short-term risk. Risk of pollution to the environment from volatiles and dust would be practically unavoidable, as it is extremely difficult to contain these emissions from open

excavation, and constructing a cover would not be practical. Pollution runoff is a risk that can be avoided through proper stormwater management.

Another major concern associated with this technology is the risk associated with the transportation of the waste material from the Marsh Run Park site to the incineration facility. There is the potential for accidents to occur, with associated risks of a contaminant exposure to the driver and contaminant releases to the environment. This is not a concern for Alternative 3B, except as related to disposal of incinerator ash.

In addition, there are risks of exposure at the incineration facility itself, both to onsite personnel and to the environment from the off-gases and discharge waters. Nearby residents also may be exposed to odors and dust. However, State permits and requirements are assumed to address and prevent these concerns.

The last concern with incineration is ash disposal. Incineration concentrates heavy metals that were present in the waste feed into the resultant ash. The Land Ban regulations must be addressed. Consequently, disposal in a RCRA facility may be required, since relatively high metals concentrations were observed in soil samples taken during the RI.

This alternative is expected to be a permanent solution to remediation of the source area, substantially reducing the toxicity, mobility, and volume of the source area contamination. When completed, Alternative No. 7 should exceed ARARs, in addition to achieving and maintaining the overall protection of human health and the environment. This is accomplished through the removal of the primary source material from the site and its offsite incineration, which eliminates the supply of contaminants to the ground water and destroys the pollutant.

4.9.2.2 Institutional Requirements

Compliance with ARARs

In particular, the ARARs with which these alternatives comply are the Pennsylvania Hazardous Sites Cleanup Act, RCRA 40 CFR 261 (Identification and Listing of Hazardous Waste), 40 CFR 263 (Standards Applicable to Transportation of Hazardous Waste), 40 CFR 264 (Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities), and 40 CFR 270 (EPA-Administered Permit Programs: The Hazardous Waste Permit Program). The alternative will also comply with National Ambient Air Quality Standards during excavation; it will comply with OSHA Health and Safety Requirements for worker safety; it will comply with DOT Rules for Hazardous Materials Transport; it will comply with Threshold Limit Values established by the American Conference of Governmental Industrial Hygienists for all concentrations; it will comply with the Pennsylvania Clean Streams Law for erosion and sediment requirements; it will comply with the Pennsylvania Dam and Safety Encroachments Act of 1978 regarding encroachment of wetlands; it will comply with the Pennsylvania Flood Plain Management Act of 1978 which is concerned with construction within the 100-year floodplain; and it will comply with the Pennsylvania Solid Waste Management Act of 1980 which governs treatment and disposal of hazardous wastes.

Non-Compliance with ARARs

This alternative will contribute toward achieving MCLs established by EPA and adopted by the Commonwealth of Pennsylvania for ground water at the site boundary. This alternative would not likely achieve MCLs without some type of ground-water extraction and treatment in addition to the source area action.

Permit Requirements

Permits would be required for construction of the building, electrical work, and erosion and sediment control (grading). Permits would be required for any impacts to wetlands and floodplain construction. Permits would be required for materials handling, processing, chemical analysis, and compatibility testing. NPDES permits would be required for the ground-water treatment system. Site health and safety plans and permits would be required to include personal protection levels for site workers and air monitoring for dust and volatile organics.

Current permits would be required for both the onsite and offsite incinerator facilities in addition to the transportation of the waste over state and interstate highways or onsite replacement of ash from the onsite incinerator. These permits would be needed from the Federal and applicable state DOT and the EPA. Permits would be required for the ash disposal and to meet any delisting criteria.

The advantages of this alternative are that it exceeds ARARs for the source area and achieves the cleanup goals of the Federal and State agencies for volatile organics. The disadvantage is that the concentration of metals in the ash material is high, as metals are not destroyed or recovered through incineration.

4.9.2.3 Public Health and Environmental Issues

Alternative No. 7 addresses site environmental issues which were identified in the RI report. This alternative provides a long-term solution to contaminant migration by removal of the source material. The pollutants in the source material are subsequently destroyed through incineration, and the organics and metals in the ground water are removed through treatment.

TABLE 4-8a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR SOURCE-AREA ALTERNATIVE NO. 7: SELECTIVE EXCAVATION WITH OFFSITE DISPOSAL

Item	Description	Quantity	Unit Cost	Total
1	Security/Fence	1,500 ft	$ 12.40/ft	18,600
2	Surface Preparation	LS	LS	1,936
3	Erosion/Sediment Control	LS	LS	25,000
4	Waste Excavation (includes health and safety, materials handling area, decon facilities, etc.) Materials Loading	4,000 yd^3	50/yd^3	200,000
5	Soil Excavation	14,000 yd^3	10/yd^3	140,000
6	Transportation/Incineration	26,800 tons	1,000/ton	26,800,000
7	Soil Replacement	18,000 yd^3	15/yd^3	270,000
8	SUBTOTAL			$27,455,536
9	Mobilization/Demobilization, Construction Management, Site Services		10%	2,745,554
10	Implementation, Design, Permits		22%	6,040,218
11	Contingency		25%	6,863,884
12	TOTAL			$43.11 X 10^6

TABLE 4-8b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR SOURCE-AREA ALTERNATIVE NO. 7: SELECTIVE EXCAVATION WITH OFFSITE DISPOSAL (FIRST YEAR)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	80 hours	40/hr	3,200
	. Analysis	24 samples	905/sample	21,720
3	Surface Water Sampling			
	. Labor	40 hours	40/hr	1,600
	. Analysis	16 samples	905/sample	14,480
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$55,592

TABLE 4-8b (Cont.) (O&M FOR YEARS 2-30)

Item	Description	Quantity	Unit Cost	Total
1	Quarterly Inspection	96 hours	$40/hr	$ 3,840
2	Ground-Water Monitoring			
	. Labor	20 hours	40/hr	800
	. Analysis	6 samples	905/sample	5,430
3	Surface Water Sampling			
	. Labor	10 hours	40/hr	400
	. Analysis	4 samples	905/sample	3,620
4	Lawn Mowing			
	. Labor	384 hours	20/hr	7,680
	. Equipment	384 hours	8/hr	3,072
5	TOTAL			$24,842

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$55,592 + $24,842 (P/A, 8%, 29 yrs) = $332,789 ~ $330,000

There is the possibility of short-term public health risks during the excavation, primarily dust emissions, organic vapor emissions, and sediment/pollutant transport from stormwater runoff. In addition, there are risks from gas emission and water discharge from the incinerator, as well as risks associated with the handling, loading, transportation, and unloading of the hazardous material.

Environmental short-term risks associated with this alternative include sedimentation and pollutant discharge to Marsh Run Creek (and subsequently the Susquehanna River) from stormwater runoff while excavation is in process. There is also the potential of damage to the adjacent wetlands from construction/excavation activities, including, but not limited to, habitat degradation from filling (either intentional or non-intentional) and/or encroachment.

4.9.3 Cost Criteria

Capital costs for Source-Area Alternative No. 7, Selective Excavation with Offsite Disposal, are presented in Table 4-8a. Operation and maintenance costs for Source-Area Alternative No. 7 are presented in Table 4-8b.

4.10 EVALUATION OF GROUND-WATER ALTERNATIVE NO. 1: EXTRACTION/ CARBON ADSORPTION/DISCHARGE TO MARSH RUN CREEK

4.10.1 Description

The purpose of the ground-water remediation alternatives is to intercept and contain contaminated ground water moving from the site, thus preventing discharge to the Susquehanna River while removing contaminants for offsite disposal. By placing pumping wells close together, the water table can be lowered, and the combined cones of depressions of each well can result in a depression network effectively lowering the ground-water elevation so that discharge offsite is hydraulically contained.

Extraction

To estimate required interceptor wells, pumping rates, and placement of wells to contain the plume, data from slug tests performed for the RI were used in a computer model, RESSQ (Groundwater Treatment, Handbook of Mathematical Models, 1984). The RESSQ model was used with slug test data and other site data obtained during the RI. The preliminary RI/FS data yielded a three-well system pumping at approximately 30 gpm (total system pumping rate) to prevent offsite migration.

Figure 4-11 shows the input and output parameters used with the RESSQ model. Specific contamination source node locations were modeled to correspond to hot spots within the source area. Regional ground-water flow was characterized through a series of ground-water flow nodes. Known aquifer parameters (obtained through RI slug tests) were input to the model. Several model runs were attempted to optimize the number and location of wells. A scenario using three extraction wells and a combined pumping rate of 30 gpm was ultimately chosen as the best approach to controlling ground-water flow based on available data. For purposes of conservative estimating, a fourth extraction well was provided.

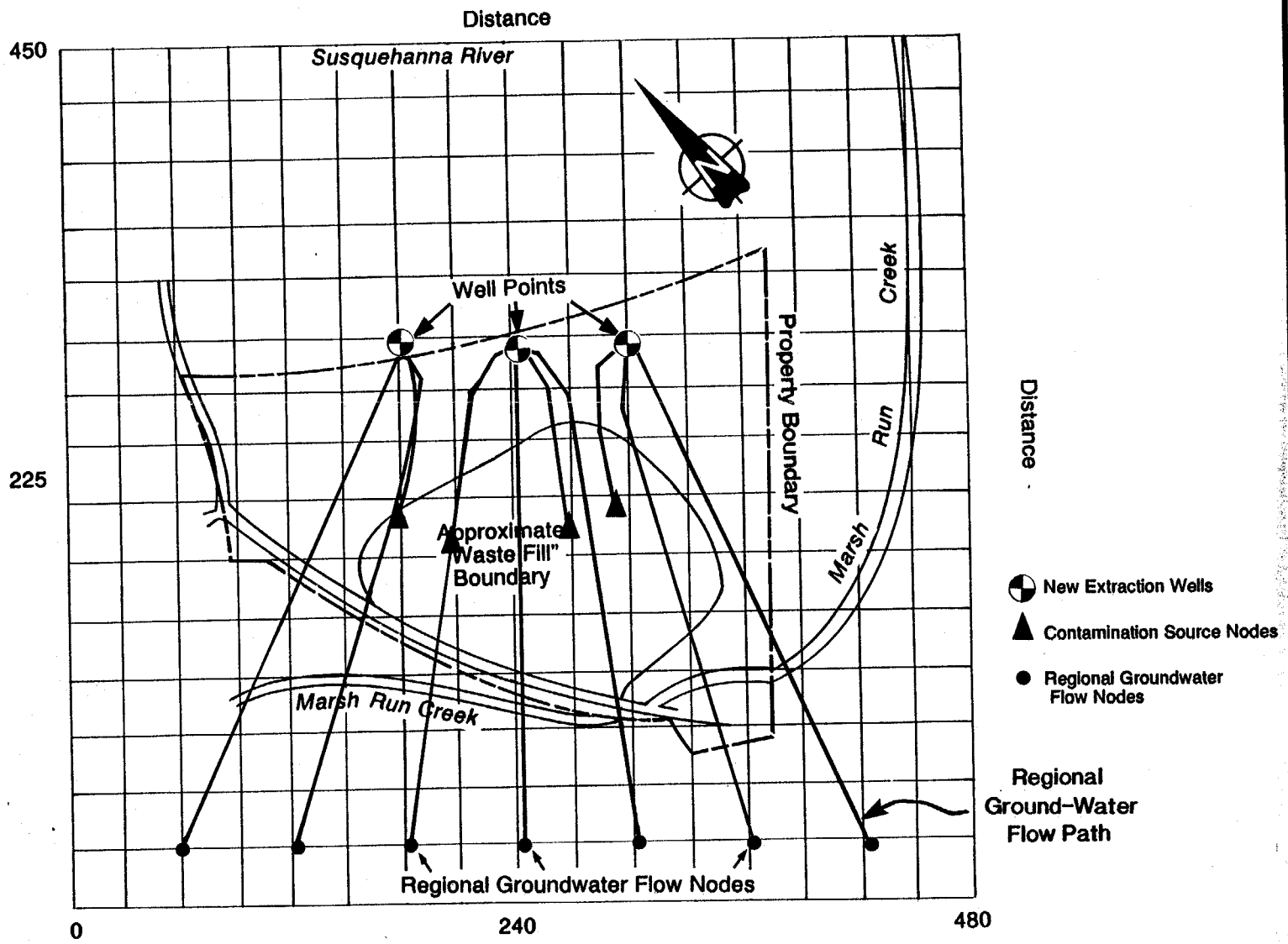

Figure 4-11. Ground-water extraction model.

It should be noted that these modeling data are not sufficient for remedial design activities. These data are based upon slug test results for permeability and do not account for the complex hydrogeological conditions that could be expected in a fractured bedrock aquifer. Pre-design testing will be necessary to refine ground-water modeling and to optimize ground-water extraction system design (see Section 6.2). For purposes of this FS, the results of RESSQ modeling will be used to estimate the approach and costs of ground-water extraction.

Figure 4-12 shows the proposed ground-water extraction/treatment system layout. Pursuant to the modeling, four extraction wells will be installed along the northwest boundary of the site beyond the waste fill limits. The extraction wells will be drilled to depths between 50 and 100 ft subsequent to pre-design aquifer characterization results. Wells will be 4-in. diameter PVC and will be screened in the bedrock aquifer. The screened intervals will also be determined from aquifer characterization results.

It is likely that a series of shallow wells will also be pumped to dewater the shallow saturated zone. Existing wells may be used, and new wells may be required. Dewatering of the shallow saturated zone will be provided primarily to optimize concurrent source area remedial actions. Shallow saturated zone dewatering will also be helpful in optimizing the bedrock aquifer extraction process.

Ground-water extraction from the bedrock aquifer will be through the new extraction wells E-1 through E-4. Wells would be designed to draw water down to approximately 50 ft below the ground surface to contain the plume. Pumps would be placed in each well to maintain the lowered ground-water elevation to a design depth. Water would be pumped to pretreatment and VOC-treatment processes and would be ultimately discharged to the wetlands associated with Marsh Run Creek.

For purposes of this FS, the slug test data and RESSQ model were used. It should be stressed that additional aquifer characterization (long-term pumping tests, geophysical well logging, etc.) should be conducted in the pre-design phase to optimize the number and spacing of wells, well depths, screened intervals, and well pumping rates for detailed design.

Pretreatment

Prior to volatile organic contaminant removal, extracted water would be pretreated to remove inorganics exceeding MCLs discussed in Section 2. Pretreatment is also provided to aid the volatile organic treatment process by limiting clogging and buildup of inorganics (particularly iron).

Pretreatment would consist of addition of a caustic agent (lime, sodium hydroxide or soda ash) to raise the pH and allow metals precipitation followed by either filtration or clarification. Pretreated effluent would then be pumped to the selected organic removal system (i.e., carbon adsorption, air stripping, UV oxidation, or aerobic bioreactor).

- Sludges that would require offsite disposal would be created in the pretreatment process.

- Chemical addition and other system operations would require operators to monitor and maintain the system.

- Additional testing would be required to determine contaminant design loadings and final treatment processes.

Carbon Adsorption

Granular activated carbon removes dissolved organic pollutants from water through adsorption. Organic contaminants exceeding MCLs can be removed by the carbon adsorption process. As water passes through the porous granules in the carbon, molecules of organic pollutants are held to the

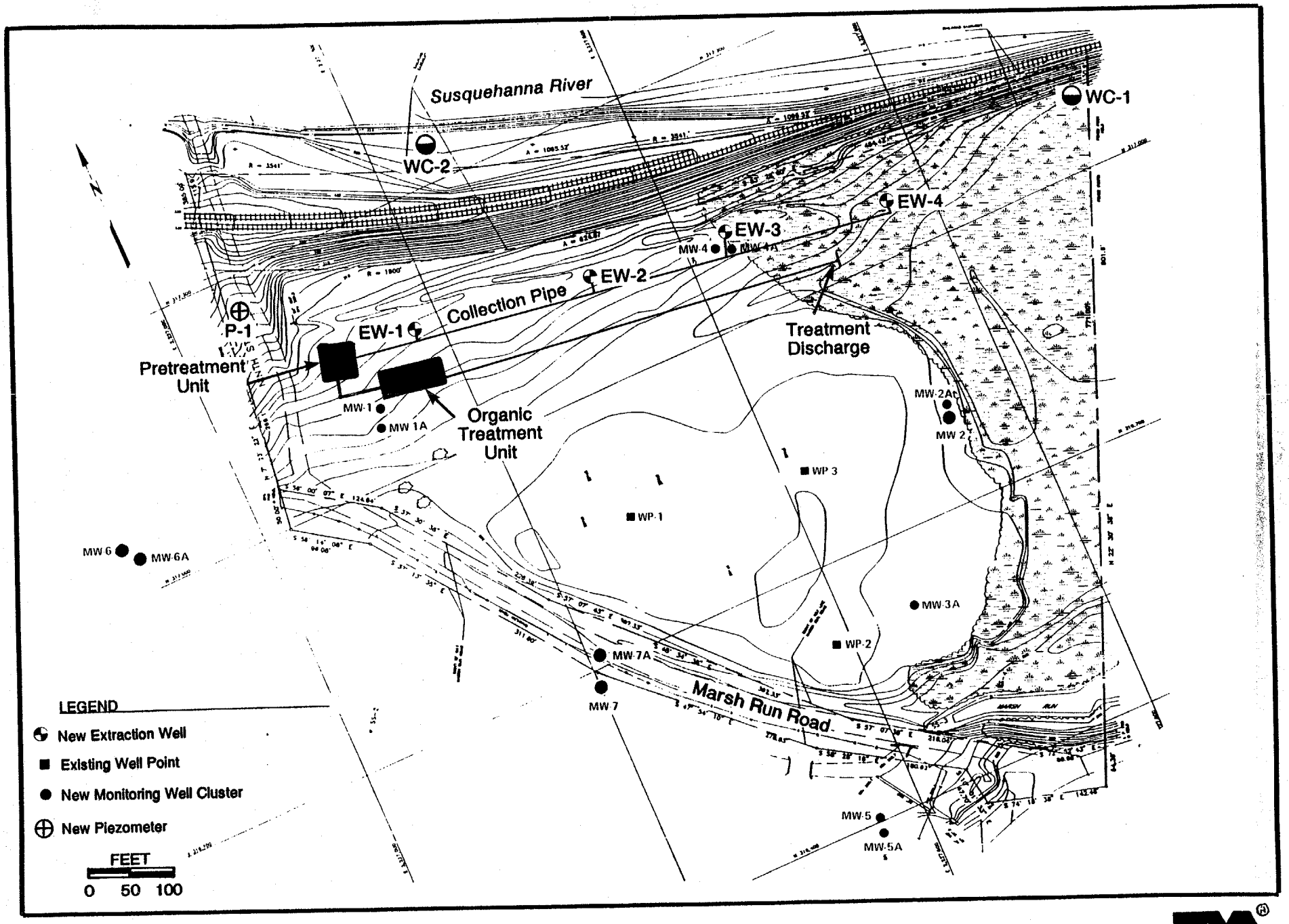

Figure 4-12. Extraction/ground water treatment.

surface of the pores. Over continued contaminant loading to the carbon, saturation occurs in the pores. Then the carbon is discarded or reactivated with a high-temperature process.

Adsorption systems consisting of granular activated carbon are typically in the form of packed beds contained within closed reaction vessels or columns within the reaction vessel. The function of the activated carbon bed is two-fold: the packed bed acts as both a filter medium for organic adsorption and as a filter for suspended particles not removed during pretreatment. Two units would operate in parallel or series depending on final design conditions. Units would have to be serviced periodically to provide fresh carbon and general maintenance.

Pilot testing would be performed to select the best carbon system for application. Organic contaminants exceeding MCLs can be removed by the carbon adsorption process.

Following carbon treatment, water would be discharged to the wetlands associated with Marsh Run Creek.

Discharge Technology

Review of available discharge technologies (Chapter 2) indicated that four possible approaches would be feasible. It was concluded that discharge to Marsh Run would be most feasible from the standpoint of effectiveness, implementability, and cost. Further assessment indicates that discharge to the wetlands associated with Marsh Run will be the optimal configuration to discharging treated effluent under this approach. The primary advantage of discharging to the wetlands instead of the stream is that the discharge has an opportunity to dissipate across a large wetlands area, thus minimizing potential erosive effects of discharge directly to the stream. This will also allow some of the treated ground water to infiltrate into the soil and recharge the wetlands area.

Sludge Handling/Residuals Disposal

Ground-water treatment activities will generate some quantity of sludge and other residuals that will require subsequent handling and disposal. Pretreatment by sedimentation or filtration will generate a waste sludge with high metals concentrations. The volume of sludge generated is not expected to be large, but the material will probably require special handling and disposal based upon metals concentrations. RCRA Land Ban restrictions may apply.

In addition to pretreatment sludge, many of the VOC treatment processes will generate a residual waste that will require handling and disposal. VOC treatment by activated carbon transfers contaminants to the carbon medium. In most instances, the carbon can be regenerated and the VOCs burned off. Under certain conditions, spent carbon must be treated as a waste material. As a waste, the carbon would probably be classified as a RCRA characteristic waste due to high TCLP TCE concentrations. Activated carbon is also used often as a polish filter for air stripping off-gas treatment.

4.10.2 Non-Cost Analysis

4.10.2.1 Technical Feasibility

Extraction/Pretreatment followed by carbon adsorption has the potential for meeting or exceeding MCLs in the extracted ground water. It can be expected to significantly further reduce offsite migration of contaminants. The time frame for achieving cleanup goals in the aquifer is not known with certainty, but it is estimated that MCLs could be achieved in the ground water after 5 years if "pump and treat" is conducted concurrently with source area treatment or removal. If the source area is contained or if "no action" is taken at the source area, the ground-water cleanup time frame is estimated to be significantly more than 10 years This alternative would be effective at reducing the toxicity, mobility, and volume of ground-water contaminants. Without source area treatment,

contaminants may leach out in the future and would require continued monitoring of the site to assess ground-water improvements. The effectiveness of pump and treatment technologies to reach cleanup goals without addressing the source is uncertain.

Pump testing and further aquifer characterization would be required (see Section 6.2). Pilot testing of treatment processes and contaminant loadings to the system should be further identified for design. System components such as additional pumping and observation wells, modification, or addition of treatment units can be incorporated in the future, should conditions change.

Two additional well clusters would be provided to augment the existing monitoring well network at the site. Well clusters WC-1 and WC-2 in Figure 4-12 would consist of two 4-in. diameter wells each (one screened in the shallow saturated zone and one screened in the bedrock aquifer). Using these wells, in addition to existing monitoring wells around the perimeter of the site, it should be possible to obtain essential data related to drawdown and contaminant removal effectiveness and plume containment (see Section 6.4).

Well drilling, excavation of piping trenches, foundations, access roads, fence installation, equipment housing provisions, utility construction, and staging areas would be required. Residuals from pretreatment and spent carbon would require offsite disposal. Spent carbon could probably be regenerated by the carbon supplier. Pretreatment sludge would likely require disposal as a RCRA characteristic waste. Vendors for all phases of treatment are available and the treatment technologies are well established. Construction of the treatment system could be accomplished in 6 to 9 months.

This alternative would begin to be effective at reducing mobility and volume of ground-water contamination immediately after the first extraction well comes on-line. Dewatering of the shallow saturated zone will aid in increasing source area treatment efficiency and reduce the

magnitude of continued source area recharge to the bedrock aquifer. Long-term pumping should achieve the SARA objective of reduction of contaminant toxicity, mobility, and volume, and should ultimately achieve ground-water ARARs.

4.10.2.2 Institutional Requirements

Compliance with ARARs

This alternative will meet ground-water cleanup levels in accordance with Section 121 of CERCLA. As such, ground-water treatment will achieve the objective of reducing ground-water contaminant concentrations at the site boundary to equal to or less than MCLs for contaminants in drinking water established by EPA and adopted by the Commonwealth of Pennsylvania under the Safe Drinking Water Act. All extraction, observation, and monitoring wells will be installed in accordance with provisions of Pennsylvania's Water Well Drillers License Act. Construction of the treatment plant structures will be in accordance with the Pennsylvania Clean Streams Law with regard to erosion and sediment control provisions. Wetlands considerations will be in accordance with the Pennsylvania Dam and Safety Encroachments Act, and any construction within the 100-year floodplain of the Susquehanna River will be in accordance with provisions of the Pennsylvania Flood Plain Management Act.

Construction activities during system installation will comply with OSHA's health and safety requirements for hazardous waste activities 29 CFR, Parts 1910, 1926, and 1904, and ACGIH Threshold Limit Values will be applied to establish respiratory protection standards during construction.

Operation of the treatment plant will be subject to Clean Air Act emission standards, but permits should not be required since this action does not inherently contribute to release of airborne contaminants.

Discharge of treated effluent will comply with NPDES discharge permitting requirements as established under the Federal Clean Water Act and shall meet Pennsylvania Water Quality Standards (see Appendix D). Sludge and other residuals handling will be in accordance with all provisions of RCRA, particularly 40 CFR, Parts 261-264 and 268. Land disposal restrictions (40 CFR 268) may impact sludge and residuals disposal.

Non-Compliance with ARARs

This action will meet the requirements of all identified ARARs.

Permit Requirements

Based on the above, the following institutional considerations associated with this alternative should be evaluated.

- Construction permits would be required from local agencies for erection of pretreatment, treatment, and other facilities to comply with local building and construction codes.

- Site grading and other disturbance activities would require erosion and dust control measures to comply with State standards.

- NPDES discharge permits would be required for outfall into Marsh Run Creek.

- Treated residuals from pretreatment and spent carbon would be disposed of in accordance with PaDER and Federal regulations.

- Cleanup levels within the aquifer would be to State MCL standards.

- The ground-water extraction process, in addition to well installation, would require permitting by State agencies.

4.10.2.3 Public Health and Environmental Issues

Under this alternative, the source area would not be disturbed. Contaminated water from the extraction process would be contained in piping and other treatment units. The following public health and environmental issues are listed.

- Volatiles will be removed from the ground water captured by the carbon system and will not impose significant risks.

- Air emissions must conform to state standards.

- Short-term exposure risks associated with earth moving and trenching activities would be addressed during implementation planning. Short-term exposure risks are anticipated to be minimal.

- The added flow to Marsh Run Creek from the treatment system flow of 30 gpm is not expected to impact local ecological systems. The additional flow is estimated to account for approximately a 6 percent increase in total daily flow.

- It is anticipated that the disposal area and treatment systems would be fenced in to prevent unauthorized access.

4.10.3 Cost Criteria

Capital costs for Ground-Water Alternative No. 1, Carbon Adsorption, are presented in Table 4-9a. A 50 percent contingency is applied to this action due to uncertainty associated with construction of ground-water extraction systems in fractured bedrock aquifers. This contingency would include additional aquifer characterization and

TABLE 4-9a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR GROUND-WATER ALTERNATIVE NO. 1: CARBON ADSORPTION

Item	Description	Quantity	Unit Cost	Total
1	Aquifer Characterization			
	. Deep Observation Wells (2)	200 ft	$100/ft	$20,000
	. Shallow Observation Wells (2)	60 ft	$60/ft	3,600
	. Borehole Geophysics (6 wells)	LS	LS	5,000
	. Discrete Fracture Sampling (2 wells)	LS	LS	8,000
	. Long-Term Pump Testing (1 well)	LS	LS	15,000
	. Ground-Water Modeling (S-D MODFLOW)	LS	LS	15,000
				$66,600
2	Extraction Wells	400 ft	$ 100/ft	40,000
3	Pumping System	4	5,500/ea.	22,000
4	Piping			
	. Pressure Pipe	550 ft	20/ft	11,000
	. Gravity Pipe	500 ft	13.80/ft	6,900
5	Outfall Structure	1 ea.	LS	1,000
6	Metering	LS	LS	10,000
7	Electrical	LS	LS	30,000
8	Pretreatment	LS	LS	175,000
9	Treatability Testing for Ground Water	LS	LS	5,000
10	Carbon Adsorbers	1 unit	150,000 ea.	150,000
11	System Operator	1,000 hours	$45/hr	45,000
12	SUBTOTAL			$562,500
13	Mobilization/Demobilization, Construction Management, Site Services		10%	56,250

TABLE 4-9a (Cont.)

Item	Description	Quantity	Unit Cost	Total
14	Implementation, Design, Permits		22%	123,750
15	Contingency		50%	281,250
16	TOTAL			$1,023,750
			SAY	$\$1.0 \times 10^6$

TABLE 4-9b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR GROUND-WATER ALTERNATIVE NO. 1: CARBON ADSORPTION (YEARS 1-5)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	80 hours	$ 40/hr	$ 3,200
	. Analysis	16 samples	905/sample	14,480
2	Treatment Costs			
	. Pretreatment	15,770,000 gal	2.25/1,000 gal	35,483
	. VOC Treatment	15,770,000 gal	2.50/1,000 gal	39,425
3	System Maintenance (10% of capital equipment cost)	LS	LS	15,000
4	TOTAL			$107,588/yr

TABLE 4-9b (Cont.) (O&M FOR YEARS 6-30)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	20 hours	$ 40/hr	$ 800
	. Analysis	4 samples	905/sample	3,620
2	TOTAL			$4,420/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$107,588 (P/A, 8%, 5 yrs) +
$4,420 (P/A, 8%, 25 yrs) (P/F, 8%, 5 yrs) = $461,712

SAY $462,000

additional extraction wells and piping that may be required to achieve cleanup goals. Operation and maintenance costs for Ground-Water Alternative No. 1 are presented in Table 4-9b.

4.11 EVALUATION OF GROUND-WATER ALTERNATIVE NO. 2: EXTRACTION/ AIR STRIPPING/DISCHARGE TO MARSH RUN CREEK

Ground-water extraction, pretreatment, discharge, and residuals handling considerations are the same as for Ground-Water Alternative No. 1 (see Section 4.10.1). This alternative differs only in the approach to treatment of volatile organic contaminants. For this alternative, the ground water will be extracted and pretreated as described in Section 4.10. Following pretreatment, the water will be treated for VOC removal using packed-column air stripping with vapor control. Discharge and residuals handling will be as described in Section 4.10.

4.11.1 Description

Removing VOCs using packed-column air stripping is a common and established method for treating contaminated ground water. An air stripping system consists of a cylindrical tower of aluminum, fiberglass, or steel filled with high-efficiency packed media. Contaminated waste is evenly distributed from the top of the vessel while forced air is blown from the base of the tower producing a countercurrent air and water flow system. The enclosed medium provides a large surface area for air/liquid contact and enables the transfer of VOCs from the liquid to gas phase. The forced air carries the contaminant from the stripper unit to the atmosphere where it is either dissipated and degraded naturally or treated by an off-gas system (catalytic oxidation, carbon absorption). Treated ground water is discharged to the wetlands associated with Marsh Run Creek.

Treatment Description/Performance Requirements

A prediction of the mass transfer of VOCs to the gas phase is dependent on the contaminant's Henry's Law Constant, which states that the concentration of the contaminant in the gas above the solution is proportional to the concentration of the contaminant in solution. The chlorinated organics defined for cleanup are capable of being treated by an air

stripping unit since the Henry's constants of the contaminants of concern are all >1 x 10^{-3} atm·m³/mole. Three organic compounds which have maximum observed concentrations greater than MCLs are trichloroethene, 1,2-dichloroethane, and vinyl chloride. These compounds must have a final effluent concentration of 5, 70, and 2 µg/L, respectively, to meet MCL criteria prior to discharge. To achieve the above-mentioned concentrations, at conceptual design, a stripping unit would have the following design features:

Tower Diameter:	2 ft
Packing Height:	20 ft
Air/Water Ratio:	30/1
Flow Rate:	30 gpm
Packing:	1-in. rings

These conceptual design parameters were developed from available RI/FS data and the computer model AIRSTRIP (Haarhoff, Schoeller 1988). These parameters are shown for conceptual use only and are not to be used as a basis for detailed design.

It is recommended that a pilot study be conducted prior to initiation of full-scale design. For a pilot study, a variety of air and water loading rates are induced into a scale tower with sampling at varying packing depths and air/water ratios. Analysis of samples is performed to determine final dimensions of the stripper. Pilot scale modeling is a conservative approach to full-scale design due to evaporation in other system components.

Limitations

The stripping unit removes volatile organics only. Although oxidation of metals occurs within the unit, it is not a design component. Pretreatment units would need to address removal of metals prior to VOC treatment using the air stripper. Typically, design would be based on

the maximum observed VOC levels at the site with a selected factor of safety. It is assumed that chemical levels will not be above the design value. Theoretical design removal efficiencies are usually accurate and can be confirmed by pilot testing.

4.11.2 Non-Cost Analysis

4.11.2.1 Technical Feasibility

Considerations for extraction, pretreatment, residuals handling, and discharge would be as described in Section 4.10.2.1. The only difference between this alternative and Ground-Water Alternative No. 1 is the method of VOC treatment.

Air stripping techniques have been developed to remove VOCs from ground water and are readily available from many vendors. Implementation of this alternative would require pilot testing to determine optimum design dimensions and performance rates. The overall effectiveness of treating extracted ground water for VOCs by air stripping is demonstrated and reliable.

Emissions from the stripper would be further treated by an off-gas treatment unit. An air quality permit would likely be required to limit emissions loadings. This alternative is likely to cause short-term impacts typical of construction projects, namely traffic, equipment, noise, and erosion. The tower unit itself would impact aesthetics due to its height.

Oxidized metals not removed in the tower require periodic cleaning and maintenance of the tower. Electrical service is required for operation of the pumps, blowers, and monitoring services.

Vendors for all phases of treatment are available, and treatment technologies are well established. Construction of the treatment system could be accomplished in 6 to 9 months.

This alternative would begin to be effective at reducing mobility and volume of ground-water contamination immediately after the first extraction well comes on-line. Dewatering of the shallow saturated zone will aid in increasing source area treatment efficiency and reduce the magnitude of continued source area recharge to the bedrock aquifer. Long-term pumping should achieve the SARA objective of reduction of contaminant toxicity, mobility, and volume, and should ultimately achieve ground-water ARARs.

4.11.2.2 Institutional Requirements

Compliance with ARARs

This alternative will meet ground-water cleanup levels in accordance with Section 121 of CERCLA. As such, ground-water treatment will achieve the objective of reducing ground-water contaminant concentrations at the site boundary to equal to or less than MCLs for contaminants in drinking water established by EPA and adopted by the Commonwealth of Pennsylvania under the Safe Drinking Water Act. All extraction, observation, and monitoring wells will be installed in accordance with provisions of Pennsylvania's Water Well Drillers License Act. Construction of the treatment plant structures will be in accordance with the Pennsylvania Clean Streams Law with regard to erosion and sediment control provisions. Wetlands considerations will be in accordance with the Pennsylvania Dam and Safety Encroachments Act, and any construction within the 100-year floodplain of the Susquehanna River will be in accordance with provisions of the Pennsylvania Flood Plain Management Act.

Construction activities during system installation will comply with OSHA's health and safety requirements for hazardous waste activities 29 CFR, Parts 1910, 1926, and 1904, and ACGIH Threshold Limit Values will be applied to establish respiratory protection standards during construction.

Operation of the treatment plant will be subject to Clean Air Act emission standards. Vapor phase carbon or catalytic oxidation will be used to control off-gas emissions and comply with CAA requirements.

Discharge of treated effluent will comply with NPDES discharge permitting requirements as established under the Federal Clean Water Act and shall meet Pennsylvania's Water Quality Standards (see Appendix D). Sludge and other residuals handling will be in accordance with all provisions of RCRA, particularly 40 CFR, Parts 261-264 and 268. Land disposal restrictions (40 CFR 268) may impact sludge and residuals disposal.

Non-Compliance with ARARs

This action will meet the requirements of all identified ARARs.

Permit Requirements

Based on the above, the following institutional considerations associated with air stripping should be evaluated.

- Construction permits would be required from local agencies for erection of pretreatment, treatment, and other facilities complying with local building and construction codes.

- During stripping and grading and other disturbance activities, erosion and dust control measures must be implemented to comply with State requirements.

- NPDES discharge permits would be required for outfall to Marsh Run Creek.

- State emissions standards and permits for volatile release would have to be adhered to.

- Treated residuals from pretreatment of inorganics would be disposed of in accordance with Federal and PaDER requirements.

- Cleanup levels within the aquifer must be to State MCL standards.

- The ground-water extraction process must be permitted by State agencies and permitting for new wells would be required.

4.11.2.3 Public Health and Environmental Issues

Under this alternative, the source area would not be disturbed. Contaminated water from the extraction process would be contained in piping and other treatment units. The following public health and environmental issues are listed:

- Volatiles are removed from the ground water, captured by off-gas treatment systems, and disposed of offsite.

- Air emissions must conform to State standards.

- Short-term exposure risks associated with earth moving and trenching activities would be addressed during implementation planning.

- The added flow to Marsh Run Creek from the treatment system flow of 30 gpm is not expected to impact local ecological systems.

- It is anticipated that the disposal area and treatment systems would be fenced in to prevent unauthorized access.

4.11.3 Cost Criteria

Capital costs for Ground-Water Alternative No. 2, Air Stripping, are presented in Table 4-10a. A 50 percent contingency is applied to this action due to uncertainty associated with construction of ground-water extraction systems in fractured bedrock aquifers. This contingency would include additional aquifer characterization and additional extraction wells and piping that may be required to achieve cleanup goals. Operation and maintenance costs for Ground-Water Alternative No. 2 are presented in Table 4-10b.

TABLE 4-10a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR GROUND-WATER ALTERNATIVE NO. 2: AIR STRIPPING

Item	Description	Quantity	Unit Cost	Total
1	Aquifer Characterization			
	. Deep Observation Wells (2)	200 ft	$100/ft	$20,000
	. Shallow Observation Wells (2)	60 ft	$60/ft	3,600
	. Borehole Geophysics (6 wells)	LS	LS	5,000
	. Discrete Fracture Sampling (2 wells)	LS	LS	8,000
	. Long-Term Pump Testing (1 well)	LS	LS	15,000
	. Ground-Water Modeling (S-D MODFLOW)	LS	LS	15,000
				$66,600
2	Extraction Wells	400 ft	$ 100/ft	$ 40,000
3	Pumping System	4	5,500/ea.	22,000
4	Piping			
	. Pressure Pipe	550 ft	20/ft	11,000
	. Gravity Pipe	500 ft	13.80/ft	6,900
5	Outfall Structure	1 ea.	LS	1,000
6	Metering	LS	LS	10,000
7	Electrical	LS	LS	30,000
8	Pretreatment	LS	LS	175,000
9	Treatability Testing for Ground Water	LS	LS	5,000
10	Air Stripping System (tower, foundation, blower, media)	1 each	44,000/ea.	44,000
11	System Operator	1,000 hours	$45/hr	45,000
12	SUBTOTAL			$455,900
13	Mobilization/Demobilization, Construction Management, Site Services		10%	45,590

TABLE 4-10a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR GROUND-WATER ALTERNATIVE NO. 2: AIR STRIPPING

Item	Description	Quantity	Unit Cost	Total
14	Implementation, Design, Permits		22%	100,298
15	Contingency		50%	227,950
16	TOTAL			$829,738
			SAY	$850,000

TABLE 4-10b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR GROUND-WATER ALTERNATIVE NO. 2: AIR STRIPPING (YEARS 1-5)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	80 hours	$ 40/hr	$ 3,200
	. Analysis	16 samples	905/sample	14,480
2	Treatment Costs			
	. Pretreatment	15,770,000 gal	2.25/1,000 gal	35,483
	. VOC Treatment	15,770,000 gal	0.50/1,000 gal	7,885
	. Off-Gas Treatment	15,770,000	1.00/1,000 gal	15,770
3	System Maintenance (10% of capital equipment cost)	LS	LS	4,400
4	TOTAL			$81,218/yr

TABLE 4-10b (Cont.) (O&M FOR YEARS 6-30)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	20 hours	$ 40/hr	$ 800
	. Analysis	4 samples	905/sample	3,620
2	TOTAL			$4,420/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$82,218 (P/A, 8%, 5 yrs) +
$4,420 (P/A, 8%, 25 yrs) (P/F, 8%, 5 yrs) = $360,410

SAY $360,000

4.12 EVALUATION OF GROUND-WATER ALTERNATIVE NO. 3: EXTRACTION/ AEROBIC BIOREACTOR/REINJECTION TO AQUIFER

Ground-water extraction and pretreatment considerations are the same as for Ground-Water Alternative No. 1 (4.10). For this alternative, the ground water will be extracted and pretreated as described in Section 4.10. Following pretreatment, the water will be treated for VOC removal using an aerobic bioreactor. This alternative also differs from other ground-water alternatives in the approach to treated effluent discharge. Under this alternative, treated effluent will be recycled through the aquifer by infiltration and/or injection methods.

4.12.1 Description

Once the metals have been removed, the water is pumped into an aerobic bioreactor for treatment of VOCs. The aerobic bioreactor system consists primarily of a mixing tank where oxygen, nutrients, and microorganisms are added to the water to facilitate the biological degradation of VOCs. The mixing tank allows the process to maintain an optimum temperature for the microbes to live and breed, utilizing the VOCs as a substrate for their growth. Depending on the conditions inside the tank, a co-metabolizer such as methane may be added to aid the organisms' growth by providing an easily utilized carbon source. In addition, the pH of the system is maintained through the use of analyzers and adjusters.

Various examples of bioreactors include fixed-film, liquid-solid contact (slurry), and trickling filter. These types have been used extensively in public water treatment systems, but with the growth of biotechnology and its application to hazardous waste remediation, methods for bioremediation are becoming increasingly diverse.

In order to design an effective aerobic bioreactor system, it is necessary to perform various tests to determine optimum flow in addition to nutrient, aeration, temperature, and pH requirements. The first step is a pump test to ascertain the maximum and average flow from the aquifers (both shallow and bedrock). Once the flow rates have been obtained, a three-phase approach is conducted to assess the capabilities of the bioremediation process:

- Laboratory screening,
- Bench-scale testing, and
- Pilot-scale testing.

Laboratory screening is first performed to determine which microorganisms are effective in utilizing the contaminant as a substrate and, therefore, causing its breakdown. In addition, various nutrient, oxygen, temperature, and pH combinations are tried to pinpoint optimum conditions.

Once the laboratory screening has narrowed the choices of the previously mentioned parameters, a bench-scale test is run to evaluate and compare the most effective combinations. During this testing, leachate is periodically collected and analyzed to obtain contaminant degradation rates, and the nutrient and oxygen uptake is recorded. In addition, optimum temperature and pH conditions are determined. The primary goal of the bench-scale test is to determine the optimum conditions for the biodegradation of the pollutants.

Upon conclusion of the bench-scale test, a pilot-scale test is conducted in the field to evaluate the treatment process under site conditions. It is necessary to understand the subsurface, from which infiltration and pumping (recovery) rates can be determined. This test is necessary to collect information to assist in the actual design of the treatment system, including pump sizing, treatment system component sizing, and infiltration basin sizing. The use of ground-water models would also be advantageous.

A major component of the aerobic bioremediation system is the infiltration basin which serves to provide the solution containing the microorganisms, nutrients, and oxygen to the source material underground. The basin is built above the waste fill area and the water is able to percolate through the cover soil down into the waste material. The added microbes supplement the indigenous bacteria, yeast, and fungi and provide a healthy and abundant population which can utilize the pollutants as a substrate and cause their breakdowns (degradation) to carbon dioxide and water. The shallow-aquifer pumps act to contain the water around the waste fill and prevent its lateral migration away from the fill. The pumped water is then run through the above-ground treatment system before being discharged back into the infiltration basin, completing the recycling process.

Feedback controls would be required, analyzing the ground water and adding proper amounts of nutrients, oxygen, and pH adjusters. The system should also be flexible enough to discharge the treated water to the nearby wetlands of Marsh Run Creek if sufficient volume is not available in the infiltration basin.

Because site work would include earth moving, the installation of sediment and erosion control devices, which could include silt fences, sediment basins, and stormwater diversion, would be required. After the site work is completed, the area will have to be stabilized through revegetation.

4.12.2 Non-Cost Analysis

4.12.2.1 Technical Feasibility

Considerations for extraction, pretreatment, and residuals handling will be as described in Section 4.10.2.1. The primary difference between this alternative and Ground-Water Treatment Alternative No. 1 is the method of VOC treatment.

In situ bioremediation is a relatively new technique for hazardous waste cleanup. However, it has the potential to eliminate the source of organic contamination and the subsequent impact to ground water. In addition, the ground water is treated as part of the process.

Minimal risks of exposure to onsite personnel and nearby residents are achieved with this alternative. The only risk of exposure would be due to contacting the ground water.

There is a limited supply of available contractors due to this being a relatively new technique; however, they are available.

Disturbance of the surrounding area necessary for this alternative consists primarily of the installation of the water treatment system and ground-water pumping and reinjection wells. An infiltration basin would require more area than injection wells.

Variations in the subsurface soil permeability and porosities could cause channeling and/or plugging when water is injected or infiltrated.

The process is relatively long-term, and depends on the soil permeability and contaminant concentration. There could be an odor problem from the biotreatment system on the surface, and from the infiltration basin.

Vendors for all phases of treatment are available and treatment technologies are established and proven. Bioremediation of volatile organic solvents, however, does require special consideration, and the number of contractors that have demonstrated capability of biodegrading TCE is limited. Construction of the system could be accomplished in less than 6 months although the implementation time may be considerably longer due to permitting considerations.

This alternative would begin to be effective at reducing mobility and volume of ground-water contamination immediately after the first extraction well comes on-line. Dewatering of the shallow saturated zone will

aid in increasing source area treatment efficiency and reduce the magnitude of continued source area recharge to the bedrock aquifer. Long-term pumping should achieve the SARA objective of reduction of contaminant toxicity, mobility, and volume, and should ultimately achieve ground-water ARARs.

4.12.2.2 Institutional Requirements

Compliance with ARARs

This alternative will meet ground-water cleanup levels in accordance with Section 121 of CERCLA. As such, ground-water treatment will achieve the objective of reducing ground-water contaminant concentrations at the site boundary to equal to or less than MCLs for contaminants in drinking water established by EPA and adopted by the Commonwealth of Pennsylvania under the Safe Drinking Water Act. All extraction, observation, and monitoring wells will be installed in accordance with provisions of Pennsylvania's Water Well Drillers License Act. Construction of the treatment plant structures will be in accordance with the Pennsylvania Clean Streams Law with regard to erosion and sediment control provisions. Wetlands considerations will be in accordance with the Pennsylvania Dam and Safety Encroachments Act, and any construction within the 100-year floodplain of the Susquehanna River will be in accordance with provisions of the Pennsylvania Flood Plain Management Act.

Construction activities during system installation will comply with OSHA's health and safety requirements for hazardous waste activities 29 CFR, Parts 1910, 1926, and 1904, and ACGIH Threshold Limit Values will be applied to establish respiratory protection standards during construction.

Operation of the treatment plant will be subject to Clean Air Act emission standards, but permits should not be required since this action does not inherently contribute to release of airborne contaminants.

Discharge of treated effluent will comply with NPDES discharge permitting requirements as established under the Federal Clean Water Act and shall meet Pennsylvania Water Quality Standards (see Appendix D). Sludge and other residuals handling will be in accordance with all provisions of RCRA, particularly 40 CFR, Parts 261-264 and 268. Land disposal restrictions (40 CFR 268) may impact sludge and residuals disposal.

Non-Compliance with ARARs

This action will meet the requirements of all identified ARARs.

Permitting Requirements

The construction and operation of the *in situ* bioremediation system must comply with all State and Federal regulations as a hazardous waste treatment facility. The system must have approval from all regulatory agencies. The injection/recovery system must meet State and local approval. Well permits would be required for installation of any new wells.

NPDES permits would be required for

- discharge of excess process water, and
- discharge of final treated recycled stream.

Construction permits would be required for the injection/recovery system and the wastewater treatment system.

Sediment and erosion control measures and permits would be required. Ground-water and source remediation must achieve cleanup goals for

- drinking water,
- ambient water quality criteria, and
- other risk-based considerations.

TABLE 4-11a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR GROUND-WATER ALTERNATIVE NO. 3: AEROBIC BIOREACTOR

Item	Description	Quantity	Unit Cost	Total
1	Aquifer Characterization			
	. Deep Observation Wells (2)	200 ft	$100/ft	$20,000
	. Shallow Observation Wells (2)	60 ft	$60/ft	3,600
	. Borehole Geophysics (6 wells)	LS	LS	5,000
	. Discrete Fracture Sampling (2 wells)	LS	LS	8,000
	. Long-Term Pump Testing (1 well)	LS	LS	15,000
	. Ground-Water Modeling (S-D MODFLOW)	LS	LS	15,000
				$66,600
2	Extraction Wells	400 ft	$ 100/ft	$ 40,000
3	Pumping System	4	5,500/ea.	22,000
4	Piping			
	. Pressure Pipe	550 ft	20/ft	11,000
	. Gravity Pipe	500 ft	13.80/ft	6,900
5	Outfall Structure	1 ea.	LS	1,000
6	Metering	LS	LS	10,000
7	Electrical	LS	LS	30,000
8	Pretreatment	LS	LS	175,000
9	Treatability Testing for Ground Water(a)	--	--	--
10	Aerobic Bioreactor (bioreactor unit, foundation, microorganisms, nutrient and oxygen additives, pH controls)	LS	LS	60,000
11	SUBTOTAL			$422,500

(a) Estimated cost for treatability is $50,000. This cost has been included in the costing for Source Area Alternative No. 5: In Situ Soil Flushing/Bioremediation, and is not considered here.

TABLE 4-11a (Cont.)

Item	Description	Quantity	Unit Cost	Total
12	Mobilization/Demobilization, Construction Management, Site Services		10%	42,250
13	Implementation, Design, Permits		22%	92,950
14	Contingency		50%	211,250
15	TOTAL			$768,950
			SAY	$770,000

TABLE 4-11b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR GROUND-WATER ALTERNATIVE NO. 3: AEROBIC BIOREACTOR (YEARS 1-5)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	80 hours	$ 40/hr	$ 3,200
	. Analysis	16 samples	905/sample	14,480
2	Treatment Costs			
	. Pretreatment	15,770,000 gal	2.25/1,000 gal	35,483
	. Electrical	15,770,000 gal	0.15/1,000 gal	2,366
	. Nutrients	15,770,000 gal	0.14/1,000 gal	2,208
	. Labor	15,770,000 gal	0.49/1,000 gal	7,727
3	System Maintenance (10% of capital equipment cost)	LS	LS	6,000
4	TOTAL			$71,464/yr

TABLE 4-11b (Cont.) (O&M FOR YEARS 6-30)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	20 hours	$ 40/hr	$ 800
	. Analysis	4 samples	905/sample	3,620
2	TOTAL			$4,420/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$71,464 (P/A, 8%, 5 yrs) +
$4,420 (P/A, 8%, 25 yrs) (P/F, 8%, 5 yrs) = $317,469

SAY $317,500

Funding must be made available for post-action ground-water monitoring programs.

The introduction of microorganisms into the ground water must meet with Federal, State, and local approval; permits would be required.

4.12.2.3 Public Health And Environmental Issues

This alternative provides a long-term solution to contaminant migration. It also provides a significant reduction or elimination of the potential public health risks and environmental impacts resulting from

- Direct contact with contaminants.
- Migration of contaminants via ground/surface water contact with contaminated soils.

Sediment and erosion controls to prevent pollutant runoff would be required.

4.12.3 Cost Criteria

Capital costs for Ground-Water Alternative No. 3, Aerobic Biotreatment, are presented in Table 4-11a. A 50 percent contingency is applied to this action due to uncertainty associated with construction of ground-water extraction systems in fractured bedrock aquifers. This contingency would include additional aquifer characterization and additional extraction wells and piping that may be required to achieve cleanup goals. Operation and maintenance costs for Ground-Water Alternative No. 3 are presented in Table 4-11b.

4.13 EVALUATION OF GROUND-WATER ALTERNATIVE NO. 4: EXTRACTION/ UV OXIDATION/DISCHARGE TO MARSH RUN CREEK

Ground-water extraction, pretreatment, discharge, and residuals handling considerations are the same as shown for Ground-Water Alternative No. 1 (see Section 4.10.1). For this alternative, the ground water will be extracted and pretreated as described in Section 4.10. Following pretreatment, the water will be treated for VOC removal using an ultraviolet light/oxidation process. Treated effluent will be discharged to the wetlands associated with Marsh Run Creek. Discharge and residuals handling will be as described in Section 4.10.

4.13.1 Description

The treatment of the VOCs is through a process developed by Ultrox International for the SITE program. It utilizes ultraviolet (UV) light combined with the addition of oxygen, either as ozone (OZ) or hydrogen peroxide (H_2O_2), or both, to produce a highly oxidative environment. The UV serves to enhance the ozone and peroxides' reactivities by

- transforming them to highly reactive OH^- radicals,
- raising the VOCs to higher energy levels, and
- initially attacking and breaking down the VOCs.

The end products of the process reactions are carbon dioxide, water, and innocuous salts. The unused ozone is treated by a catalytic ozone decomposer unit to reduce discharge levels to acceptable air quality standards.

Prior to designing an ultraviolet treatment system, laboratory-scale treatability studies are preformed to assess the effectiveness of the UV oxidation process for the ground water. If the treatment shows promise, then a pilot plant is installed onsite to collect design and economic data. These data are then used to prepare specifications for a full-scale system. The full-scale system is primarily automated

through the use of microprocessors, requiring minimal periodic monitoring. Depending upon site and/or treatment constraints, the UV oxidation system can be designed to operate continuously or in a batch mode.

Components of the system include a reactor module, an air compressor/ozone generator module and/or hydrogen peroxide feed system. The size is based upon flow rates and required residence time.

For this alternative, a construction staging area would be required to locate office trailers, construction trailers, and materials storage. This area would be considered the support zone. A contamination exclusion zone would need to be established to contain the water treatment system and the extraction wells. This area would require Level C protection. Between these two zones would be a contamination reduction zone which would serve to decontaminate site workers, visitors, and vehicles that have entered the exclusion zone.

Because site work would consist of earth moving, the installation of sediment and erosion control devices would be required, which could include silt fences, sediment basins, and stormwater diversions. After the site work is completed, the area would have to be stabilized through revegetation.

4.13.2 Non-Cost Analysis

4.13.2.1 Technical Feasibility

Considerations for extraction, pretreatment, residuals handling, and discharge would be as described in Section 4.10.2.1. The only difference between this alternative and Ground-Water Alternative No. 1 is the method of VOC treatment.

UV oxidation is a relatively new technique for hazardous waste cleanups. However, it has the potential to eliminate organic contamination of the

ground water. The system is endorsed by EPA through the SITE program and it has demonstrated effectiveness of treating TCE and other solvents.

Minimal risks of exposure to onsite personnel and nearby residents are achieved with this alternative. The only risk of exposure would be due to contacting the ground water.

There is a limited supply of available contractors because this is a relatively new technique; however, they are available.

Disturbance of the surrounding area necessary for this alternative consists primarily of the installation of the air and water treatment system and ground-water pumping and extraction wells.

This technique has been shown to be effective for TCE. This alternative would being to be effective at reducing mobility and volume of ground-water contamination immediately after the first extraction well comes on-line. Dewatering of the shallow saturated zone will aid in increasing source area treatment efficiency and reduce the magnitude of continued source area recharge to the bedrock aquifer. Long-term pumping should achieve the SARA objective of reduction of contaminant toxicity, mobility, and volume, and should ultimately achieve ground-water ARARs.

4.13.2.2 Institutional Requirements

Compliance with ARARs

This alternative will meet ground-water cleanup levels in accordance with Section 121 of CERCLA. As such, ground-water treatment will achieve the objective of reducing ground-water contaminant concentrations at the site boundary to equal to or less than MCLs for contaminants in drinking water established by EPA and adopted by the Commonwealth of Pennsylvania under the Safe Drinking Water Act. All extraction, observation, and

monitoring wells will be installed in accordance with provisions of Pennsylvania's Water Well Drillers License Act. Construction of the treatment plant structures will be in accordance with the Pennsylvania Clean Streams Law with regard to erosion and sediment control provisions. Wetlands considerations will be in accordance with the Pennsylvania Dam and Safety Encroachments Act, and any construction within the 100-year floodplain of the Susquehanna River will be in accordance with provisions of the Pennsylvania Flood Plain Management Act.

Construction activities during system installation will comply with OSHA's health and safety requirements for hazardous waste activities 29 CFR, Parts 1910, 1926, and 1904, and ACGIH Threshold Limit Values will be applied to establish respiratory protection standards during construction.

Operation of the treatment plant will be subject to Clean Air Act emission standards, but permits should not be required since this action does not inherently contribute to release of airborne contaminants.

Discharge of treated effluent will comply with NPDES discharge permitting requirements as established under the Federal Clean Water Act and shall meet Pennsylvania Water Quality Standards (see Appendix D). Sludge and other residuals handling will be in accordance with all provisions of RCRA, particularly 40 CFR, Parts 261-264 and 268. Land disposal restrictions (40 CFR 268) may impact sludge and residuals disposal.

Non-Compliance with ARARs

This action will meet the requirements of all identified ARARs.

Permit Requirements

The construction and operation of the UV oxidation treatment system must comply with all State and Federal regulations as a hazardous waste treatment facility. The system must have approval from all regulatory

agencies. The vacuum extraction and treatment system must meet State and local approval. Well permits would be required for installation of any new wells.

NPDES permits would be required for

- discharge of treated bioremediation process water,
- discharge of excess process water, and
- discharge of the final treated recycled water.

Construction permits would be required for the water treatment system.

Sediment and erosion control measures and permits would be required. Ground-water and source remediation must achieve cleanup goals for

- drinking water,
- ambient water quality criteria, and
- other risk-based considerations.

Funding must be made available for ground-water monitoring programs.

4.13.2.3 Public Health and Environmental Issues

This alternative provides a long-term solution to contaminant migration. It also provides a significant reduction or elimination of the potential public health risks and environmental impacts resulting from

- Direct contact with contaminants.

- Migration of contaminants via ground/surface water contact with contaminated soils.

Sediment and erosion controls to prevent pollutant runoff would be required.

TABLE 4-12a PRELIMINARY ESTIMATE OF CAPITAL COSTS FOR GROUND-WATER ALTERNATIVE NO. 4: UV OXIDATION

Item	Description	Quantity	Unit Cost	Total
1	Aquifer Characterization			
	. Deep Observation Wells (2)	200 ft	$100/ft	$20,000
	. Shallow Observation Wells (2)	60 ft	$60/ft	3,600
	. Borehole Geophysics (6 wells)	LS	LS	5,000
	. Discrete Fracture Sampling (2 wells)	LS	LS	8,000
	. Long-Term Pump Testing (1 well)	LS	LS	15,000
	. Ground-Water Modeling (S-D MODFLOW)	LS	LS	15,000
				$66,600
2	Extraction Wells	400 ft	$ 100/ft	$ 40,000
3	Pumping System	4	5,500/ea.	22,000
4	Piping			
	. Pressure Pipe	550 ft	20/ft	11,000
	. Gravity Pipe	500 ft	13.80/ft	6,900
5	Outfall Structure	1 ea.	LS	1,000
6	Metering	LS	LS	10,000
7	Electrical	LS	LS	30,000
8	Pretreatment	LS	LS	175,000
9	Treatability Testing for Ground Water	LS	LS	5,000
10	UV/Oxdidation (UV/oxidation reactor, oxidation source, system operator)	LS	LS	80,000
11	SUBTOTAL			$447,500
12	Mobilization/Demobilization, Construction Management, Site Services		10%	44,750

TABLE 4-12a (Cont.)

Item	Description	Quantity	Unit Cost	Total
13	Implementation, Design, Permits		22%	98,450
14	Contingency		50%	223,750
15	TOTAL			$814,450
			SAY	$820,000

TABLE 4-12b PRELIMINARY ESTIMATE OF OPERATION AND MAINTENANCE COSTS FOR GROUND-WATER ALTERNATIVE NO. 4: UV OXIDATION (YEARS 1-5)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	80 hours	$ 40/hr	$ 3,200
	. Analysis	16 samples	905/sample	14,480
2	Treatment Costs			
	. Pretreatment	15,770,000 gal	2.25/1,000 gal	35,483
	. VOC Treatment (oxidation, electrical)	15,770,000 gal	0.30/1,000 gal	4,731
3	System Maintenance (10% of capital equipment cost)		LS	8,000
4	TOTAL			$65,894/yr

TABLE 4-12b (Cont.) (O&M FOR YEARS 6-30)

Item	Description	Quantity	Unit Cost	Total
1	Ground-Water Monitoring			
	. Labor	20 hours	$ 40/hr	$ 800
	. Analysis	4 samples	905/sample	3,620
2	TOTAL			$4,420/yr

TOTAL 30-YEAR PRESENT WORTH O&M COSTS =
$65,894 (P/A, 8%, 5 yrs) +
$4,420 (P/A, 8%, 25 yrs) (P/F, 8%, 5 yrs) = $295,228

SAY $296,000

4.13.3 Cost Criteria

Capital costs for Ground-Water Alternative No. 4, UV Oxidation, are presented in Table 4-12a. A 50 percent contingency is applied to this action due to uncertainty associated with construction of ground-water extraction systems in fractured bedrock aquifers. This contingency would include additional aquifer characterization and additional extraction wells and piping that may be required to achieve cleanup goals. Operation and maintenance costs for Ground-Water Alternative No. 4 are presented in Table 4-12b.

5. SUMMARY AND COMPARISON OF REMEDIAL ACTION ALTERNATIVES

It is evident from the previous discussion that there are several feasible approaches to remedial action at the Marsh Run Park site. It is also evident that the final remedial action will need to include both a source-area response and a ground-water response, in order to satisfy the remedial action objectives. The remedial action objectives, previously identified in Section 2, are as follows:

1. Reduce or eliminate the chlorinated solvent contamination present in the bedrock aquifer to ground-water cleanup levels (MCLs). The cleanup standards to be achieved for volatile organic contaminants are as follows:

   trichloroethene - 5 µg/L
   cis-1,2-dichloroethene - 70 µg/L
   trans-1,2-dichloroethene - 100 µg/L
   vinyl chloride - 2 µg/L
   tetrachloroethene - 5 µg/L

2. Reduce or eliminate metals and volatile organic solvent contamination present in the shallow saturated zone to ground-water cleanup levels (MCLs). VOC cleanup levels are listed above. The cleanup standards to be achieved for inorganic contaminants are as follows:

   Arsenic - 30 µg/L
   Barium - 5,000 µg/L
   Beryllium - 0.5 µg/L
   Cadmium - 5 µg/L
   Chromium - 100 µg/L
   Copper - 1,300 µg/L
   Cyanide - 200 µg/L
   Lead - 5 µg/L
   Mercury - 2 µg/L

3. Reduce or eliminate the threat to future ground-water contamination by containment, treatment, or removal of the solvent contamination source area within the landfill, as identified based on the RI and the VOSS, and refined during design phase activities.

4. Reduce or eliminate future contaminant releases to Marsh Run Creek and the Susquehanna River through surface water or sediment pathways.

5. Reduce or eliminate future contaminant releases to Marsh Run and the Susquehanna River through ground-water pathways.

The selected ground-water alternative must address remedial objectives 1, 2, and 5. The selected source-area alternative must address remedial objectives 3, 4, and 5.

Pursuant to Section 300.430(e)(9)(iii) of EPA's revised National Contingency Plan, the remedial action to be implemented should be selected based upon consideration of nine evaluation criteria. Specifically, remedial actions should address the following:

1. Overall protection of human health and environment
2. Compliance with ARARs
3. Long-term effectiveness and performance
4. Reduction of toxicity, mobility, or volume of contamination
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

Since all of the feasible ground-water alternatives are a variant of "pump and treat," and since ground-water extraction and treatment must be a component of the final selected remedial action, the final remedial alternative will be selected based upon the most appropriate source area response. For this assessment, the "No Action" alternative may still be appropriate, if it is combined with a ground-water "pump and treat" process. "No Action" without ground-water extraction and treatment will not achieve the ARARs. Table 5-1 lists the combined alternatives that are examined in the comparative assessment. Table 5-2 summarizes key points related to alternative selection. It is understood that ground-water extraction and treatment will be included as a component of the final selected remedial action. The specific treatment process for removal of the VOCs from the ground water may be activated carbon, countercurrent air stripping, UV oxidation, or biological treatment. Biological treatment should only be used in conjunction with the *in situ* biodegradation alternative for source area remediation.

The following sections provide a brief review and comparison of the remedial actions in accordance with EPA's evaluation criteria. Table 5-3 summarizes the comparative evaluation information presented herein.

5.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

All of the alternatives, except Alternative No. 1A (no action - no ground-water action) provide adequate protection of human health and the environment. Risk through ground-water ingestion is reduced to cancer risk levels less than 1×10^{-6} applying all alternatives except Alternative No. 1A. Alternative Nos. 1B and 2 do not provide source area treatment, although Alternative No. 2 (capping) provides source area containment. The baseline risk assessment did not indicate that the source area represents human health or environmental risk in excess of 10^{-6}, therefore source area remediation is not specifically necessary from the perspective of protection of human health and the environment.

Results of the volatile organics source survey indicate that the source area is contributing to continued contamination of the bedrock aquifer. Therefore, alternatives that treat or remove the source area contamination will increase the effectiveness of the ground-water extraction/treatment component of the remedial action. Alternative Nos. 3A, 3B, and 7 (excavation/incineration options) are source area removal actions. Alternative Nos. 4 through 6 (soil venting, bioremediation, and vitrification) are in situ treatment actions. It is estimated that ground-water treatment could be achieved in less than 5 years with source area extraction and treatment. Ground-water treatment would require more than 10 years to reach health-based cleanup levels without source area extraction or treatment, and could require significantly longer depending on the volume of contaminant actually remaining within the source area.

The primary advantage to removal actions over treatment actions is that the source of contamination is permanently removed. Significant disadvantages of removal actions are that offsite disposal will probably require incineration due to concentrations of metals and VOCs in the wastes; permitted disposal facilities are not proximate to the site; and the metals content of wastes will still require RCRA-permitted disposal of ash. Alternative Nos. 4 through 6 (soil vapor venting, soil flushing/bioremediation, and vitrification) could all be effective in removing VOCs from the source area. Pilot testing should be conducted. Bioremediation may require 3-5 years to reduce contaminants to health-based levels. Bioremediation would need to be conducted in conjunction with an onsite aerobic bioreactor for VOC treatment of ground water. Soil venting could be completed in less than 1 year. Vitrification could be completed in 6 months or less.

5.2 COMPLIANCE WITH ARARs

The evaluation of the ability of the alternatives to comply with ARARs included a review of chemical-specific and action-specific ARARs that was presented in Section 2. Location-specific ARARs pertaining to wetlands

TABLE 5-1 SUMMARY OF COMBINED REMEDIAL ACTION ALTERNATIVES, MARSH RUN PARK, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Alternative No.	Description
1A	No Action with Site Controls
1B	No Action with Site Controls and[a] Ground-Water Extraction/Treatment
2	Capping with Surface Water and Gas Venting[a] Controls and Ground-Water Extraction/ Treatment
3A	Excavation, Offsite Incineration, and[a] Ground-Water Extraction/Treatment
3B	Excavation, Onsite Incineration, and[a] Ground-Water Extraction/Treatment
4	*In Situ* Soil Venting and Ground-Water[a] Extraction/Treatment
5	*In Situ* Soil Flushing/Bioremediation and[b] Ground-Water Extraction/Treatment
6	*In Situ* Vitrification and Ground-Water[a] Extraction/Treatment
7	Selective Excavation, Offsite Disposal,[a] and Ground-Water Extraction/Treatment

(a) Ground-water extraction/treatment will include pumping and pre-treatment with air stripping, activated carbon, or UV oxidation (Ground-Water Alternative Nos. 1, 2, and 4) for VOC treatment.

(b) Ground-water extraction/treatment will include pumping and pre-treatment with aerobic bioreactor treatment for VOC removal (Ground-Water Alternative No. 3).

TABLE 5-2 COMPARISON OF FEASIBLE REMEDIAL ALTERNATIVES, MARSH RUN PARK, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Alternative No.		Type of Action	Performance Period	Innovative Technology	Subject to LDRs	Requires Offsite Transport/Disposal	Capital Cost ($ x 10^6)	Present Worth O&M Cost ($ x 10^6)	Total Cost ($ x 10^6)
SOURCE AREA									
1	No Action with Site Control	No Action	N/A	No	No	No	0.05	0.85	0.9
2	Capping	Containment	6 months	No	No	No	1.4	0.5	1.9
3A	Excavation/Offsite Incineration	Removal	6 months	No	No	Yes	115.0	0.4	115.4
3B	Excavation/Onsite Incineration	Onsite Treatment	5 years	Yes	Yes	Yes	47.0	0.4	47.4
4	Soil Venting	In Situ Treatment	9-12 months	Yes	No	No	3.9	0.4	4.3
5	Soil Flushing/ Bioremediation	In Situ Treatment	3-5 years	Yes	No	No	1.65	0.4	2.05
6	Vitrification	In Situ Treatment	6 months	Yes	No	No	50.65	0.4	51.05
7	Selective Excavation	Removal	6 months	No	Yes	Yes	43.1	0.4	43.5

Alternative No.		Type of Action	Performance Period	Innovative Technology	Air Discharge	NPDES Discharge	Capital Cost ($ x 10^6)	Present Worth O&M Cost ($ x 10^6)	Total Cost ($ x 10^6)
GROUND WATER									
1	Activated Carbon	Treatment/ Discharge	3-5 years (a) >10 years (b)	No	No	Yes	0.78	0.46 0.75	1.24 1.53
2	Air Stripping	Treatment/ Discharge	3-5 years (a) >10 years (b)	No	Yes	Yes	0.61	0.36 0.57	0.97 1.18
3	Aerobic Bioreactor	Treatment/ Recycle	3-5 years >10 years	Yes	Yes	Yes	0.55	0.32 0.48	0.87 1.03
4	UV Oxidation	Treatment/ Discharge	3-5 years >10 years	Yes	Yes	Yes	0.59	0.30 0.46	0.89 1.05

(a) Ground-water pump and treat is expected to achieve cleanup levels within 5 years for Source-Area Alternative Nos. 3A-7.
(b) Ground-water pump and treat is expected to require a minimum of 10 years to achieve cleanup levels for Source-Area Alternative Nos. 1 and 2.

TABLE 5-3 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES, MARSH RUN PARK LANDFILL, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
OVERALL PROTECTIVENESS					
Human Health Protection					
- Direct Contact/ Soil Ingestion	Existing conditions indicated risk $<1 \times 10^{-6}$. No action required. Fencing reduces potential for direct contact.	See Alternative No. 1A.	See Alternative No. 1A.	Source area contamination permanently removed from site and destroyed.	See Alternative No. 3A.
- Ground-Water Ingestion for Existing Users	No existing users directly impacted by ground-water contamination.	See Alternative No. 1A	See Alternative No. 1A.	See Alternative No. 1B.	See Alternative No. 1B.
- Ground-Water Ingestion for Future Users	No significant reduction in risk Some reduction in potential for access through deed restrictions.	Reduction of risk to less than 10^{-6} by pump and treat.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B
Environmental Protection	Allows continued contamination of surficial and bedrock aquifers.	Source area is not remediated. Migration of contaminated ground water is curtailed by pump and treat.	Source area is not remediated. Leachate production is minimized through capping. Migration of contaminated ground water is curtailed by pump and treat.	Source area contaminated soils and wastes permanently removed from site. Migration of contaminated ground water is curtailed by pump and treat.	See Alternative No. 3A.
COMPLIANCE WITH ARARs					
Chemical-Specific ARARs	Does not meet ground-water standards past the site boundary.	Would meet MCLs at waste boundary in more than 10 years.	Would meet MCLs at the waste boundary in more than 10 years.	Would meet MCLs at the waste boundary in 3-5 years.	See Alternative No. 3A.

(a) VOC treatment for contaminated ground water may be air stripping, activated carbon, or UV oxidation.

TABLE 5-3 EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
OVERALL PROTECTIVENESS				
Human Health Protection				
- Direct Contact/ Soil Ingestion	Source area VOC contamination removed and treated.	TCE degradation is not consistently accomplished.	Source area VOC contamination removed/ destroyed. Source area inorganics stabilized into non-leachable matrix.	See Alternative No. 3A.
- Ground-Water Ingestion for Existing Users	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.
- Ground-Water Ingestion for Future Users	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.
Environmental Protection	Continued source area VOC contamination is curtailed by soil vapor extraction. Migration of contaminated ground water is curtailed by pump and treat.	Continued source area VOC contamination is likely degraded by enhanced bioremediation. Migration of contaminated ground water is curtailed by pump and treat.	Source area VOC contamination destroyed by vitrification. Migration of contaminated ground water is curtailed by pump and treat.	Most highly contaminated source area soils and wastes permanently removed from site. Migration of contaminated ground water curtailed by pump and treat.
COMPLIANCE WITH ARARs				
Chemical-Specific ARARs	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
Location-Specific ARARs	Would not impact wetlands or flood-plain at the site.	See Alternative No. 1A.	Would need wetlands permit and floodplain requirements.	See Alternative No. 2.	See Alternative No. 2.
Action-Specific ARARs	Would not meet any ARARs since there would be no action.	Would meet NPDES requirements. Would meet air release standards if air stripping or UV oxidation is used.	Capping would meet RCRA landfill closure requirements. Ground-water treatment would meet NPDES requirements and air release standards.	Would meet regulations concerning incineration. Would meet RCRA and DOT transportation and offsite disposal requirements. Ground-water treatment would meet NPDES requirements and air release standards.	See Alternative No. 3A. Would meet RCRA LDRs for onsite placement of incinerator ash.
Other Criteria and Guidance	Would not totally restrict ingestion of ground water exceeding 1×10^{-6}.	Protects against ground-water ingestion above 10^{-6} risk level.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.
LONG-TERM EFFECTIVENESS AND PERMANENCE					
Magnitude of Residual Risk					
- Direct Contact/ Soil Ingestion	Existing conditions indicate risk $<1 \times 10^{-6}$. No action required.	See Alternative No. 1A.	See Alternative No. 1A.	Excavation, incineration totally removes contaminated soils/wastes from the site.	See Alternative No. 3A.
- Ground-Water Ingestion for Existing Users	Future risk greater as plume migrates toward Susquehanna River; however, direction of plume movement is not toward any existing users.	Risk eliminated by extracting ground water exceeding 10^{-6}. Safe drinking water achieved in more than 10 years.	See Alternative No. 1B.	Risk eliminated by extracting ground water exceeding 10^{-6}. Safe drinking water achieved in 3-5 years.	See Alternative No. 3A.

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
Location-Specific ARARs	See Alternative No. 2.	See Alternative No. 2.	See Alternative No. 2.	See Alternative No. 2.
Action-Specific ARARs	Ground-water treatment would meet NPDES requirements and air release standards. Would meet air release standards for vapor extraction system.	Ground-water treatment would meet NPDES levels. Infiltration basin would meet air discharge levels.	Ground-water treatment would meet NPDES levels. Vitrification would meet air discharge levels.	See Alternative No. 3A.
Other Criteria and Guidance	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.
LONG-TERM EFFECTIVENESS AND PERMANENCE				
Magnitude of Residual Risk				
- Direct Contact/ Soil Ingestion	Soil vapor venting removes VOC contamination from source area. Existing conditions indicate risk $<1 \times 10^{-6}$.	Bioremediation degrades VOC contamination in source area. Existing conditions indicate risk is $<10^{-6}$.	Vitrification totally destroys VOC contamination and immobilizes inorganic contamination in source area.	See Alternative No. 3A.
- Ground-Water Ingestion for Existing Users	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
- Ground-Water Ingestion for Future Users	Risk greater as area of contamination increases. Lack of source area treatment does not restrict continuing source area contribution to contamination.	Risk eliminated by extracting ground water exceeding 10^{-6}. Safe drinking water achieved in more than 10 years.	See Alternative No. 1B.	Risk eliminated by extracting ground water exceeding 10^{-6}. Safe drinking water achieved in 3-5 years.	See Alternative No. 3A.
Adequacy and Reliability of Controls	No controls over remaining contamination. No reliability.	Ground-water pump and treat adequately controls ground-water contamination. Lack of source area treatment does not control future source of contaminants. Ground-water pump and treat is reliable and proven.	Ground-water pump and treat adequately controls ground-water contamination. Capping controls against generation of leachate, but does not control future source area contribution to ground-water contamination. Ground-water pump and treat is reliable and proven. Capping is reliable if regularly inspected and maintained.	Ground-water pump and treat adequately controls ground-water contamination. Excavation/incineration removes source area contamination. Incinerator ash may require RCRA waste disposal, due to metal concentrations. Incineration is very reliable since material is destroyed. Ground-water pump and treat is reliable and proven.	See Alternative No. 3A.
Need for Annual Review	Review would be required to ensure adequate protection and human health is maintained.	See Alternative No. 1A. Source area VOCs and metals would remain onsite.	See Alternative No. 1B.	See Alternative No. 1A. Ground-water contamination would require long-term monitoring.	See Alternative No. 3A.

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
- Ground-Water Ingestion for Future Users	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.
Adequacy and Reliability of Controls	Ground-water pump and treat adequately controls ground-water contamination. Soil vapor extraction is proven technology for removal of VOC contamination from surficial soil. Ground-water pump and treat is reliable and proven. Reliability of vapor extraction is high since no long-term operation and maintenance is required.	Ground-water pump and treat adequately controls contamination. Biodegradation of TCE and other chlorinated solvents subject to site conditions and toxic inhibition. Ground-water pump and treat is reliable and proven. Bioremediation is reliable under proper site conditions for certain contaminants. Treatability testing is essential.	Ground-water pump and treat adequately controls contamination. Vitrification can volatilize and destroy all organics and immobilize inorganics. Ground-water pump and treat is reliable and proven. Vitrification is very reliable because VOC contaminants are destroyed.	See Alternative No. 3A.
Need for Annual Review	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.	See Alternative No. 3A.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT					
Treatment Process Used	None	Ground-water pretreatment and VOC treatment[a]	See Alternative No. 1B	Incineration of source area wastes/soils, ground-water pretreatment, and VOC treatment[a]	See Alternative No. 3A.
Amount Destroyed or Treated	None	Over 98% of volatiles in ground water removed and subsequently destroyed.	See Alternative No. 1B.	>99% of source area contaminants destroyed offsite. Over 98% of VOCs in ground water removed and subsequently destroyed.	See Alternative No. 3A.
Reduction of Toxicity, Mobility, or Volume	None	Reduced volume and toxicity of contaminated ground water. Mobility of source area contaminants is not addressed.	Reduced volume and toxicity of contaminated ground water. Mobility of source area contamination is limited by capping. Toxicity and volume of source area not addressed.	Reduced volume and toxicity of contaminated ground water. Reduced volume/toxicity of source area contamination since 48,000 yd^3 of material removed from site and destroyed.	Reduced volume and toxicity of ground water. Incineration reduces toxicity of source area soils/wastes. Volume reduction of 12,500 yd^3 achieved.
Irreversible Treatment	None	Ground-water VOC treatment is irreversible.	Ground-water VOC treatment/destruction is irreversible.	Incineration is irreversible. Ground-water VOC treatment/destruction is irreversible.	See Alternative No. 3A.
Type and Quantity of Residuals Remaining After Treatment	None	Using activated carbon, spent carbon requires regeneration. Using air stripping, spent vapor phase carbon requires regeneration.	See Alternative No. 1B for ground water.	See Alternative No. 1B for ground water. Incinerated soils (17,500 yd^3) and wastes (15,000 yd^3) would be disposed offsite.	See Alternative No. 1B for ground water. Incinerated soils (17,500 yd^3) and wastes (15,000 yd^3) would require onsite or offsite disposal subject to LDRs.

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT				
Treatment Process Used	Vapor extraction of VOCs from source area. Ground-water pretreatment and VOC treatment[a]	Biological degradation of VOCs. Biological treatment of ground water[b]	Thermal destruction of VOCs. Stabilization of inorganics. Ground-water pretreatment and VOC treatment[a]	See Alternative No. 3A.
Amount Destroyed or Treated	>99% of VOCs removed from source area. Over 98% of VOCs in ground water removed and subsequently destroyed.	See Alternative No. 4; however, TCE degradation is not consistently demonstrated.	See Alternative No. 4.	>99% of source area contaminants from designated "hot spots" destroyed offsite. Over 98% of VOCs in ground water removed and subsequently destroyed.
Reduction of Toxicity, Mobility, or Volume	Reduced volume and toxicity of ground water. Reduced toxicity and mobility of source area contaminants.	See Alternative No. 4.	See Alternative No. 4.	Reduced volume and toxicity of contaminated ground water. 4,000 yd^3 of waste and 14,000 yd^3 of contaminated soil removed and disposed offsite.
Irreversible Treatment	Soil vapor extraction and ground-water VOC treatment/destruction are irreversible.	Yes.	Yes.	See Alternative No. 3A.
Type and Quantity of Residuals Remaining After Treatment	See Alternative No. 1B for ground water. No detectable residuals in source area.	See Alternative No. 1B.	See Alternative No. 1B for ground water.	See Alternative No. 1B for ground water. 26,000 yd^3 of waste and 3,500 yd^3 of contaminated soil are not treated.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
Statutory Preference for Treatment	Does not satisfy.	Source area action does not satisfy. Ground-water action satisfies.	Capping does not satisfy. Ground-water treatment satisfies.	Satisfies.	Satisfies.
SHORT-TERM EFFECTIVENESS					
Community Protection	Risk to community not increased by remedy implementation.	See Alternative No. 1A.	Temporary increase in dust production through cap installation. Contaminated materials undisturbed.	Excavation would release dust and odors, could potentially release hazardous contaminants.	Excavation would release dust and odors, could potentially release hazardous air contaminants. Storage of excavated contaminated materials may present hazards.
Worker Protection	No significant risk to workers.	Dermal protection required during construction/operation of ground-water treatment system.	Dermal protection required during cap installation. Dermal protection required during construction/operation of ground-water treatment system.	Potential hazards associated with containerizing wastes. Dermal and respiratory PPE required during excavation and construction activities.	See Alternative No. 3A.
Environmental Impacts	Continued impact from existing conditions.	Local aquifer drawdown could be expected during ground-water extraction.	See Alternative No. 1B.	See Alternative No. 1B. Excavation activities could adversely affect surrounding environment, will produce odors and dust.	See Alternative No. 3A. Incineration may impact air quality, produce odors, although it will meet emission standards.
Time Unit Action is Complete	Not applicable.	Ground-water treatment system would require more than 10 years to meet MCLs.	See Alternative No 1B.	Ground-water treatment system would require 3-5 years to meet MCLs.	Onsite incineration would require at least 5 years after construction. Ground-water treatment could take 3-5 years.

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
Statutory Preference for Treatment	Satisfies.	Satisfies.	Satisfies.	Satisfies.
SHORT-TERM EFFECTIVENESS				
Community Protection	No significant risks to public during system implementation. Possible release of dust/ odors during construction.	Infiltration basin will be exposed. Potential for release of odors and insect generation.	Potential for odors during VOC destruction.	See Alternative No. 3A.
Worker Protection	Dermal protection required during construction of soil venting and ground-water extraction/ treatment systems. Respiratory protection may be required for soil venting system installation.	Dermal protection required during construction/operation of ground water and source area biological treatment processes.	Respiratory and dermal protection required during vitrification activities.	See Alternative No. 3A.
Environmental Impacts	Vapor extraction may impact air quality and odors, although it will meet emission standards. Local aquifer drawdown expected during ground-water extraction.	Bioremediation will affect air quality and produce odors, although it will meet emission standards.	Potential for odors and air quality impact, although it will meet emission standards.	See Alternative No. 3A.
Time Unit Action is Complete	Soil venting could be completed in less than 1 year. Ground-water treatment could take 3-5 years.	3-5 years would be required to achieve ground-water MCLs, pursuant to satisfactory results of treatability study.	Vitrification would take 6 months or less. 3-5 years would be required to achieve MCLs in ground water.	See Alternative No. 3A.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
IMPLEMENTABILITY					
Ability to Construct and Operate	No construction or operation.	Onsite ground-water treatment system requires operation over system lifetime.	See Alternative No. 1B for ground-water considerations. Cap construction would require about 40,000 yd^3 of cover soil. Capping is relatively standard construction activity.	See Alternative No. 1B for ground-water considerations. Excavation will require specialty contractor to excavate landfill wastes.	See Alternative No. 1B for ground-water considerations. Excavation requires specialty contractor to excavate landfill wastes. Onsite mobile incineration system must be provided, constructed, operated. Incineration difficult to operate.
Ease of Doing More Action if Needed	If monitoring indicates additional action required, may need to go through the FS/ROD process again.	Additional extraction wells or pretreatment units could be provided.	See Alternative No. 1B.	See Alternative No. 1B.	System can handle varying volumes or concentrations.
Ability to Monitor Effectiveness	Additional down-gradient well constructed as an indicator of contaminant migration. Extensive existing well network.	Proposed monitoring will give notice of failure before significant exposure occurs.	See Alternative No. 1B.	See Alternative No. 1B.	See Alternative No. 1B.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approval required.	Need an NPDES permit.	Need NPDES permit. Need wetlands and E&S permit.	Need NPDES, wetlands, and E&S permits. May need to include special E&S provisions during excavation.	Requires test burn and incineration permit. Requires NPDES wetlands, E&S permits.

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
IMPLEMENTABILITY				
Ability to Construct and Operate	Vapor extraction requires some operation, is relatively straightforward to construct. See Alternative No. 1B for ground-water water considerations	See Alternative No. 1B for ground-water considerations. In situ bioremediation relatively simple to construct but requires attention during operation.	See Alternative No. 1B for ground water considerations. Vitrification is very specialized and difficult during operation.	See Alternative No. 3A.
Ease of Doing More Action if Needed	Simple to expand soil venting system and ground-water treatment system.	Simple to expand bio-treatment area and upgrade water treatment processes.	System can handle varying volumes or concentrations.	See Alternative No. 1B.
Ability to Monitor Effectiveness	See Alternative No. 1B.	May be difficult to determine effectiveness of source area remediation.	See Alternative No. 1B.	See Alternative No. 1B.
Ability to Obtain Approvals and Coordinate with Other Agencies	Need onsite treatment period. Need NPDES, wetlands, E&S permits.	Onsite treatment permit will be required. Stormwater/E&S provisions essential. NPDES, wetlands permits required.	Onsite treatment permit required. NPDES, wetlands, E&S permits needed.	See Alternative No. 3A.

TABLE 5-3 (Cont.)

Criteria	Alternative No. 1A No Action with Site Control	Alternative No. 1B No Action, Site Control, Ground-Water Pump and Treat	Alternative No. 2 Capping with Surface/Gas Controls, and Ground-Water Pump and Treat	Alternative No. 3A Excavation, Offsite Incineration, and Ground-Water Pump and Treat	Alternative No. 3B Excavation, Onsite Incineration, and Ground-Water Pump and Treat
Availability of Services and Capacities	No services or capacities required.	See Alternative No. 1A.	See Alternative No. 1A.	Need offsite RCRA incineration. Closest facility is more than 200 mi from site.	Need mobile incinerator.
Availability of Equipment, Specialists, and Materials	Needs legal assistance to establish deed restrictions.	Needs treatment system operators.	Need ground-water treatment system operators. No special equipment or materials needed for capping. Liner installation specialists required. Cap materials available within 50 mi.	Need ground-water treatment system operators. Need specialty excavation contractors.	Need ground-water treatment system and incinerator operators. Need specialized excavation contractors.
Availability of Technologies	None required.	Ground-water treatment technology readily available. Treatability testing required.	Capping and pump and treat technology readily available. Treatability testing required.	Pump and treat technology readily available. Treatability testing required. Incineration sources well developed and available although not locally available.	Incineration and ground-water pump/treat well developed. Will require pilot testing.
COST					
Capital Cost	$50,000	$870,000	$2,220,000	$115,820,000	$47,820,000
Present Worth O&M Cost	$900,000	$1,360,000	$860,000	$700,000	$700,000
Total Present Worth Cost	$950,000	$2,230,000	$3,080,000	$116,520,000	$48,520,000

TABLE 5-3 (Cont.) EXTENDED

Criteria	Alternative No. 4 In Situ Soil Venting, Ground-Water Pump and Treat	Alternative No. 5 In Situ Soil Flushing/ Bioremediation, Ground-Water Pump and Treat	Alternative No. 6 In Situ Vitrification, Ground-Water Pump and Treat	Alternative No. 7 Selective Excavation Offsite Disposal, Ground-Water Pump and Treat
Availability of Services and Capacities	No services or capacities required.	Specialized biotreatment technology/ equipment required.	Specialized vitrification equipment required.	See Alternative No. 3A.
Availability of Equipment, Specialists, and Materials	Need ground-water treatment system operators. Needs readily available specialists to install and monitor vapor extraction system.	Specialized operators required for ground-water and in situ biotreatment.	Highly specialized technology. Requires experts to implement/operate.	See Alternative No. 3A.
Availability of Technologies	Vapor extraction and ground-water pump/ treat well developed. Will require pilot testing.	Relatively few vendors have demonstrated experience in biologically degrading TCE. Pilot testing is required.	Only one commercial vendor of this technology. Pilot testing required.	See Alternative No. 3A.
COST				
Capital Cost	$4,720,000	$2,420,000	$51,470,000	$43,920,000
Present Worth O&M Cost	$700,000	$720,000	$700,000	$700,000
Total Present Worth Cost	$5,420,000	$3,140,000	$52,170,00	$44,620,00

and floodplains were also considered. All alternatives will meet their respective ARARs except for Alternative No. 1A (no action).

5.3 LONG-TERM EFFECTIVENESS AND PERFORMANCE

All alternatives (except No. 1A) are equally effective with respect to ground-water treatment actions. The excavation/incineration alternatives (Nos. 3A, 3B, and 7) and the in situ treatment alternatives (Nos. 4, 5, and 6) afford the highest degree of long-term effectiveness and performance, because these alternatives use treatment processes to reduce hazards posed by all known wastes at the site. The primary differences among the alternatives are the approach to removing VOC contamination from the source area.

Alternative Nos. 3A, 3B, and 7 are excavation/incineration alternatives. All of these options require that contaminated material be excavated and removed from the designated source area. In Alternative No. 3A, waste is taken to a RCRA-permitted offsite facility. In Alternative No. 3B, waste is incinerated onsite and any resultant ash that cannot be replaced due to RCRA Land Ban restrictions is taken to a RCRA-permitted ash disposal facility. Alternative No. 7 includes excavation and offsite incineration similar to Alternative No. 3A, except that the extent of source area waste removed is limited. All of these alternatives provide for permanent removal of the source of VOC contamination from the site.

Alternative No. 4 uses in situ soil venting to remove VOC contamination from the source area. Soil venting is a proven technology that has demonstrated effectiveness in remediation of sites contaminated with TCE and TCE-breakdown products (i.e., DCE, vinyl chloride). This technology would provide for permanent removal of source area VOC contamination. The depth to ground water within the waste matrix may impact system performance.

Alternative No. 5 applies soil flushing and enhanced bioremediation to degrade VOC contamination within the source area. Bioremediation is an innovative treatment technology that has been demonstrated to be effective in degrading certain organic contaminants. TCE and related solvents have been successfully degraded under certain conditions but has not been consistenly demonstrated effective for TCE degradation. Treatability testing and pilot testing are essential to assess the viability of this technology for conditions at the Marsh Run Park site.

In situ vitrification (ISV) (Alternative No. 6) provides for permanent removal of VOCs and for stabilization of metals and other inorganics. ISV has not been applied for large-scale projects, but has been highly effective in treatment and stabilization of high levels of contaminants in small areas. ISV may be adversely affected by the presence of inclusions (i.e., metal, wood, organic debris, water) within the waste matrix at Marsh Run Park.

The remaining alternatives (Nos. 1A, 1B, and 2) do not provide as great a degree of permanence since source area contaminants are not removed or treated.

Alternative No. 1A (no action) does not provide any reduction of contamination. Therefore, long-term effectiveness and permanence is not applicable to this alternative. Alternative No. 1B is similar to No. 1A except that it does provide for effective, long-term control of ground-water contamination.

Alternative No. 2 (capping) provides an impermeable barrier to prevent rainfall and surface infiltration. This barrier should effectively minimize leachate generation from the source area. Capping is an effective long-term action provided that regular inspection and maintenance is conducted. Ground-water monitoring is a significant component of this alternative. The primary disadvantage of capping in comparison to removal or treatment actions is that the time required to achieve ground-water cleanup to health-based levels will be longer (>10 years

vs. <5 years). [An estimate of time required for cleanup without source area removal or treatment is very difficult to predict since it is not known with any degree of certainty how much contamination remains within the source area.]

5.4 REDUCTION OF TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

Alternative Nos. 3A and 3B provide the highest reduction of toxicity, mobility, and volume, since these alternatives provide for removal and destruction of contaminated soils and wastes, and treatment of contaminated liquids. Alternative Nos. 4, 5, and 6 do not provide for complete removal of source area wastes, but provide for reduction of source area toxicity through removal of VOC contamination within the source area. Alternative Nos. 4 through 6 also provide for treatment and destruction of VOC contamination from the bedrock aquifer.

Alternative No. 4 (soil venting) is the most proven technology for site conditions at Marsh Run Park. Off-gas treatment (activated carbon or catalytic oxidation) will provide for removal/destruction of contaminants. Alternative No. 5 (bioremediation) should be effective but will require a much longer time frame for remediation. Alternative No. 6 (vitrification) will provide treatment of VOCs and stabilization of metals.

Alternative No. 7 (selective excavation/incineration) is similar to Nos. 3A and 3B except that it does not address the entire source area. A total of approximately 18,000 of the 47,500 yd^3 of identified source area are removed and treated under this alternative.

Alternative Nos. 1B (no action/ground-water treatment) and 2 (capping) provide for reduction of the volume and toxicity of contaminated ground water. Alternative No. 1A does not apply any treatment technologies and does not provide for reduction of toxicity, mobility, or volume of contaminants from the site.

5.5 SHORT-TERM EFFECTIVENESS

Alternative No. 1B (no action and ground-water pump and treat) and No. 2 (capping) are anticipated to have the greatest short-term effectiveness. These alternatives present the least amount of risk to workers, the community, and the environment. Some particulate emissions from cap installation (Alternative No. 2) is anticipated during implementation; however, dust control methods should reduce this risk. Construction of this alternative could be completed in a short time period (6 months or less). Alternative No. 1B could be completed in a comparable time period. The entire time required for completion of remedial action under these alternatives, however, would be in excess of 10 years, since the source area contamination is not removed or treated.

The *in situ* treatment actions (Alternative Nos. 4 through 6) also provide good short-term effectiveness. Alternative No. 4 (soil venting) provides the best short-term effectiveness of the *in situ* treatment alternatives. This action requires minimal exposure to contaminants for workers, the surrounding community, and the environment. It can be completed in 9-12 months, and it does not require significant site disturbance to implement. Bioremediation (Alternative No. 5) requires a longer time period for source area treatment (3-5 years) and it presents more potential for exposure through the infiltration basin. Bioremediation does not require source area disturbance and minimizes contaminant exposure. Vitrification (Alternative No. 6) could be completed within 6 months. With proper controls, vitrification provides good protection to the community and environment. Risk to workers is not significant, but is greater than for soil venting.

Total remedial action performance time (including ground-water actions) for *in situ* treatment methods is expected to be 5 years or less.

The excavation/incineration alternatives (Nos. 3A, 3B, and 7) present the greatest short-term risks to site workers, the public, and the environment. Releases of volatile contaminants during excavation will be very

difficult to control. Workers will be directly exposed to dermal and respiratory hazards during excavation, materials separation, and drumming of wastes. Hazards associated with offsite transport of hazardous wastes must be considered. Alternative Nos. 3A and 7 could be completed within 6 months. Alternative No. 3B would require at least 5 years. Another short-term risk associated with Alternative No. 3B is storage of excavated wastes prior to incineration.

Total remedial action performance time (including ground-water actions) for excavation/incineration alternatives is expected to be about 5 years.

5.6 IMPLEMENTABILITY

Alternative No. 1B (no action with ground-water pump and treat) would be the simplest to construct and operate. Alternative No. 1B requires only the ground-water extraction and treatment system. A system operator would be required. This alternative would include long-term monitoring to assess performance. Additional wells or system components could easily be provided if operating conditions warranted.

Alternative No. 2 (capping) would also be relatively simple to construct and operate. Alternative No. 2 includes the ground-water considerations described for No. 1B and also includes construction of an impermeable cap in conformance with RCRA closure requirements. This activity is not a difficult construction practice and does not require specialized expertise, except for liner installation. Long-term monitoring and maintenance is an essential component of this alternative.

Alternative No. 4 (soil venting) is another alternative that is relatively easily implemented. Soil venting is proven for remediation of chlorinated organic solvents. Treatability and pilot testing would be required. Effectiveness can be monitored through sampling of soils and ground water, during the remedial action process. Specialized equipment or materials are not required. A system operator is required. Ground-water considerations are as indicated for Alternative No. 1B.

Alternative No. 5 (bioremediation) is more complex than Alternative Nos. 1B, 2, or 4, but is still relatively simple to implement. Bioremediation of chlorinated organic solvents will, however, require close observation to optimize system performance. This alternative may be subject to toxic inhibition due to metals concentrations within the source area, and will require optimization of the liquid recycling rate, microbe concentration, nutrient concentration, and oxygen concentration. Treatability and pilot testing is essential. Ground-water considerations are as indicated for Alternative No. 1B.

In situ vitrification (Alternative No. 6) is more complex than alternatives previously discussed, particularly due to the inhomogeneity of the waste area and the presence of inclusions (metal, wood, organic debris, water) within the waste matrix. Sufficient electrical supply will be required to generate the large energy demand necessary for this alternative. Treatability testing is required. Ground-water considerations are as indicated for Alternative No. 1B.

Alternative Nos. 3A and 7 (excavation/offsite incineration) present significant difficulties during excavation and handling of waste materials. Excavation of a former landfill with a shallow ground-water level of 4-10 ft below ground surface will present construction-related and health-related concerns. Transport and offsite disposal of hazardous materials will require permitting and coordination with other states and the RCRA-permitted facility. Distance to a RCRA-permitted facility is a concern since no facilities are located less than 200 mi from the site.

Alternative No. 3B (onsite incineration) presents the most difficulties in implementation. Excavation and materials handling concerns described above apply to this alternative. Onsite incineration will also result in ash with concentrated metals levels. A trial burn and permitting would be required. Onsite incineration is susceptible to frequent down time due to mechanical complexities. Provisions for storage of excavated wastes would be required.

Ground-water considerations for all excavation/incineration alternatives are as indicated for Alternative No. 1B.

5.7 COST

Examination of costs indicates that the capital costs for Alternative Nos. 3A, 3B, 6, and 7 (excavation/incineration options and in situ vitrification) are one to two orders of magnitude more than the capital costs for Alternative Nos. 1A, 1B, 2, 4, and 5 (no action, capping, soil venting, and bioremediation). Operation and maintenance costs for all alternatives are fairly comparable, although the operation and maintenance costs for Alternative Nos. 1B and 2 are somewhat higher, since these alternatives include ground-water treatment but do not include source area treatment. Alternative No. 1B is a "no action" alternative, while Alternative No. 2 is a capping alternative.

The in situ treatment methods (excluding Alternative No. 6, vitrification) appear to represent the most cost-effective alternatives that address both ground-water and source-area treatment. Alternative No. 4 uses soil venting technology to remove VOCs from the source area. Alternative No. 5 uses soil flushing and enhanced biodegradation to biologically degrade VOC contamination present within the source area.

A summary of costs for each of the remedial alternatives is provided in Table 5-1. For consistency in evaluation, costs for UV oxidation are used for the ground-water treatment technology. This does not mean that UV oxidation would be the selected ground-water technology. Choice of the appropriate VOC treatment technology for ground water at the Marsh Run Park site should be based upon results of treatability testing.

5.8 STATE ACCEPTANCE

To be addressed in the ROD.

5.9 COMMUNITY ACCEPTANCE

To be addressed in the ROD.

5.10 CONCLUSION

It should be emphasized at this point that the objective of a CERCLA feasibility study is not the final selection of remedial action to be implemented. The objective of the CERCLA feasibility study is to provide sufficient information about potential remedial actions so that an informed decision can be made in selecting the most appropriate remedial action. The final selection of remedial action is documented in the Record of Decision (ROD) that is developed subsequent to the public comment period for this feasibility study.

6. RECOMMENDATIONS FOR FURTHER ACTION

6.1 SELECTION OF REMEDIAL ACTION ALTERNATIVE

The primary recommendation associated with this study is that the most appropriate feasible remedial action alternative be selected and implemented at the earliest possible time. This selection should be based upon the nine evaluation criteria as specified in EPA's National Contingency Plan. Specifically, the remedial action should address the following:

1. Overall protection of human health and environment
2. Compliance with ARARs
3. Long-term effectiveness and performance
4. Reduction of toxicity, mobility, or volume of contamination
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance

This feasibility study has been prepared to examine alternatives with respect to criteria numbers 1 through 7. Review of the report by PaDER and the public meeting and public review and comment period are intended to address criteria numbers 8 and 9. A final selection should be based upon these nine criteria.

6.2 AQUIFER CHARACTERIZATION

Regardless of which source area alternative is eventually selected, the final remedial action at Marsh Run Park will need to include ground-water extraction and treatment to achieve the remedial action objectives for the site. As such, detailed aquifer characterization of the bedrock

aquifer (Gettysburg Formation) must be conducted in the pre-design phase of remedial activities. This action should be implemented as soon as reasonably possible.

Aquifer characterization is needed to provide design data for the actual number, spacing, and locations of extraction and/or injection wells; the well depths, screened intervals, and gravel pack sizing; and average and maximum achievable extraction rates. Slug test data and ground-water modeling were conducted during the RI/FS to develop a conceptual assessment of ground-water extraction at the Marsh Run Park site. These data are not sufficient to base final design of a ground-water extraction/treatment system upon. At a minimum, the following testing is recommended prior to initiating remedial design. The specific work scope for aquifer characterization will be determined prior to initiation of remedial design.

1. Drill at least two deep boreholes (100+ ft) downgradient of contaminated area to characterize bedrock between 50 and 100 ft below ground surface (see Figure 6-1).

2. Conduct downhole geophysical logging of deep borehole(s) to characterize fractures, water-bearing zones, etc.

3. Collect discrete ground-water samples from multiple depths from the two new bedrock aquifer borings to characterize the relationship between VOC contamination and fracture orientation.

4. Install 4-in. diameter monitoring wells screened in the deep aquifer at the two new deep borehole locations (WC-1 and WC-2 in Figure 4-12). Collect samples and analyze for volatile organics concentrations before initiation of pump testing.

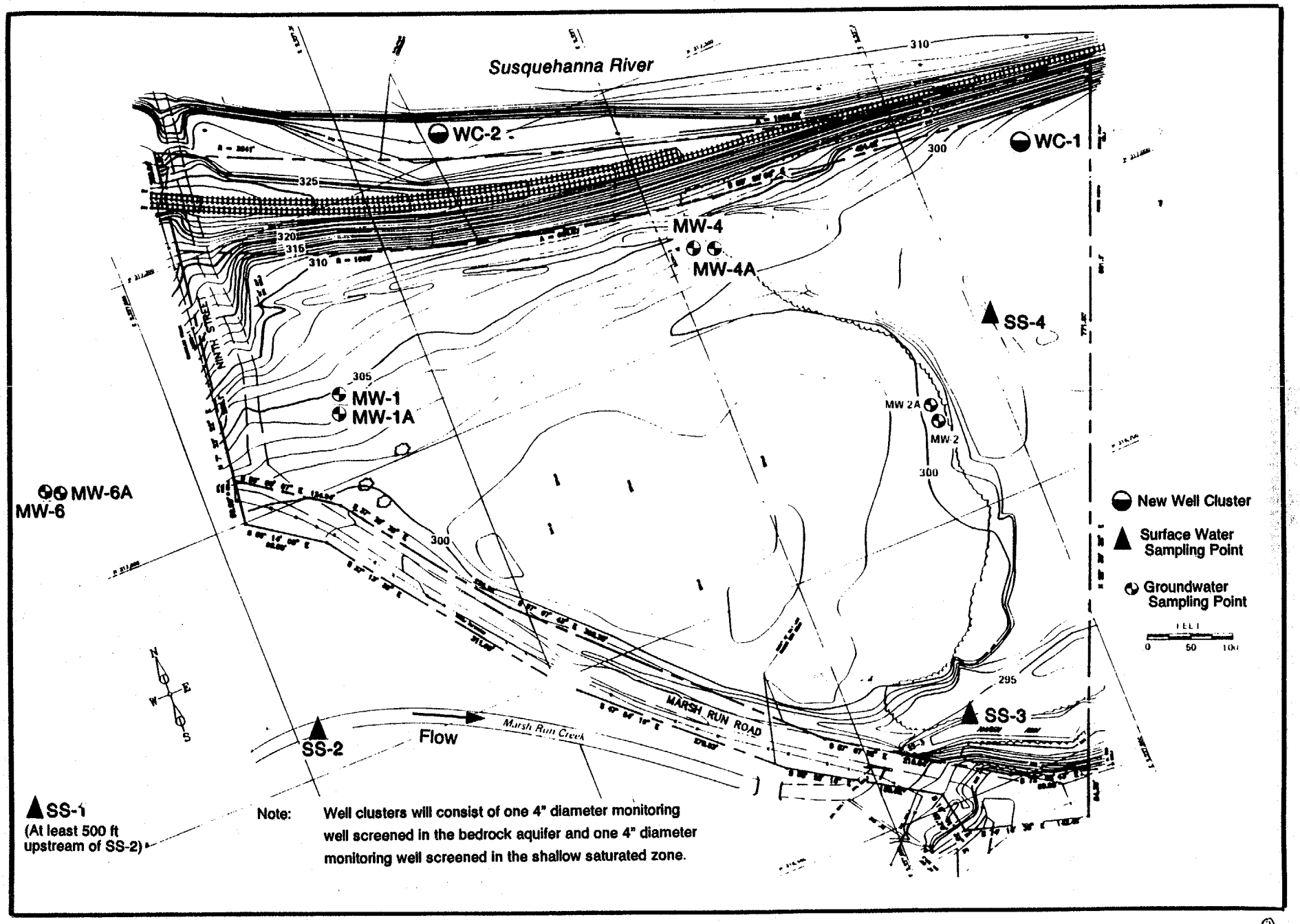

Figure 6-1. Groundwater and surface water monitoring locations.

5. Conduct long-term pump test (72-hour minimum) of bedrock aquifer to assess average and maximum extraction rates. Install additional wells to monitor drawdown as required.

6. Conduct sampling/analysis of ground-water samples for VOC contamination from pumping and observation wells before, during, and after the pump test.

6.3 TREATABILITY TESTING

Most of the source-area and ground-water treatment processes that have been examined for use at this site will required bench scale and/or pilot scale treatability testing. This testing is necessary to determine treatment effectiveness and to optimize treatment operating parameters. Treatability testing of the selected alternative should be conducted at the earliest possible time subsequent to selection of the final remedial alternative. Treatability testing should be completed prior to initiation of final design.

6.4 GROUND-WATER AND SURFACE-WATER MONITORING

Post-action monitoring of ground-water and surface-water quality should be conducted, regardless of which alternative is chosen for implementation. Post-action monitoring can be used to gauge effectiveness of the remedial action. Monitoring should be conducted at least quarterly for the first year after implementation of remedial action and at least annually thereafter for a period of 30 years. Parameters to be analyzed for will include Target Compound List (TCL) volatile organic compounds and Target Analyte List (TAL) metals.

Shallow Saturated Zone

Ground-water monitoring should consist of collecting samples from four existing wells screened in the shallow saturated zone (MW-1A, MW-2A, MW-4A, and MW-6A), and from two new wells located north of the site (WC-1

and WC-2; see Figure 6-1). Three of the existing wells and the two new wells are located downgradient of the contamination source. Monitoring well MW-6A is located upgradient of contamination and should be used as an indicator of background water quality. Water samples from the shallow saturated zone will be used as indicators of effectiveness of source area remediation.

Bedrock Aquifer

Ground-water samples should also be collected from four existing wells screened in the deep aquifer and from two new wells located north of the site (WC-1 and WC-2; see Figure 6-1). Three of the four existing wells (MW-1, MW-2, MW-4) should be downgradient of the identified source area. The two new wells are located downgradient of the site adjacent to the Susquehanna River. One existing well (MW-6) should be upgradient of contamination. Water samples from these wells will be used as indicators of effectiveness of ground-water remediation. Deep aquifer samples will be collected and analyzed quarterly throughout the period of active pumping of the aquifer and annually thereafter for a period of 30 years.

Surface Water

Surface water sampling will be conducted to assess the effectiveness of source area remediation in reducing or eliminating the contribution of the Marsh Run Park site to contamination of Marsh Run Creek and the Susquehanna River. Surface water samples will be taken from four locations along Marsh Run Creek (three on the site and one upstream of the site). Surface water samples will be collected on a quarterly basis for the first year after implementation of remedial action, and annually thereafter for a period of 30 years.

6.5 TARGET TREATMENT LEVELS

Action specific target treatment levels will be established for each of the source area treatment alternatives (Alternative Nos. 4-7). Target treatment levels will not be established for Alternative Nos. 1 and 2 since these are not treatment alternatives (Alternative No. 1 is no action and Alternative No. 2 is containment). A target treatment level will also not be established for Alternative No. 3 since it addresses excavation/removal of the entire source area. (Alternative No. 7 addresses selective excavation.)

Target treatment levels will be established to define the extent and limits of source area treatment. Target treatment levels will be action specific and will be based on the concentration of target VOCs in soil samples taken from the source area. For in situ treatment actions (soil venting and bioremediation) the target treatment level will be defined on a percent removal basis. For vitrification and selective excavation, the target treatment level will be a function of the concentration of leachable contaminants as identified using a leaching procedure such as TCLP or the California WET test. These target treatment levels will be specified in the ROD.

It should be recognized that the primary objective at this site is remediation of bedrock aquifer contamination and that source area remediation is proposed to expedite this process. No specific source area remedial action objectives related to health-based concerns have been established since it was determined in the risk assessment that contact with site soils does not represent a potential risk pathway at this site. Consequently, source area target treatment levels will be established based on technical considerations as opposed to risk considerations. Target treatment levels will be established to provide source area treatment that will reduce source area contributions to the bedrock aquifer to below SDWA MCL concentrations.

The number, location, and frequency of soil samples to assess source area remediation efficiency and progress toward achievement of target treatment levels will be determined during the pre-design phase of remedial design activities for this project.

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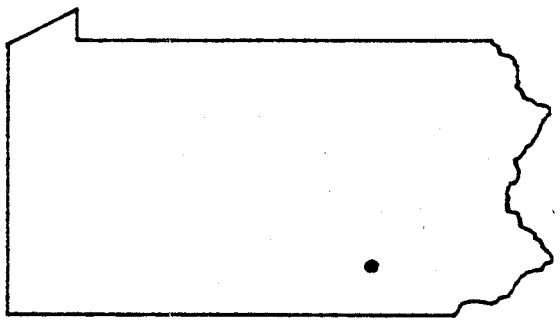
MAI
P-36

MAAR Associates, Inc.
Cultural Resource Consultants

A PHASE IA CULTURAL RESOURCES INVESTIGATION OF MARSH RUN FIELD, FAIRVIEW TOWNSHIP, YORK COUNTY, PENNSYLVANIA



SUBMITTED TO: EA ENGINEERING, SCIENCE AND TECHNOLOGY, INC.
SPARKS, MD. 21152

1989

DRAFT

A Phase IA

Cultural Resources Investigation

of Marsh Run Field,

Fairview Township, York County,

Pennsylvania

By

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August 1990

ABSTRACT

MAAR Associates, Inc. (MAI) of Newark, Delaware and Avondale, Pennsylvania conducted a Phase IA Cultural Resources Investigation of the Marsh Run Field located in the community of Marsh Run (New Cumberland Post Office), Fairview Township, York County, Pennsylvania. The investigation was undertaken in October of 1989, on behalf of EA Engineering, Science, and Technology, Inc., in order to evaluate the potential for prehistoric and/or historic cultural resources being contained within the project area which will be affected by a hazardous waste clean-up.

The Marsh Run Field site is a 13.86 acre parcel east of and adjacent to the New Cumberland Army Depot which was utilized by the Department of the Army as a landfill from the early twentieth century until 1957. Fairview Township later acquired this parcel and covered it with a clean "capping fill." The parcel was later used for recreational purposes by local residents.

This investigation, which consisted of extensive archaeological and historical background research, cartographic work, informant interviews, and a preliminary field reconnaissance, resulted in the identification of a seven-acre parcel contained within the larger 13.86 acre parcel which appears to have been extensively utilized as a landfill. Three auger tests, excavated to a maximum depth of 3 feet, could not penetrate to undisturbed natural strata. It is the considered opinion of MAAR Associates, Inc. that although the project area has the potential for containing undisturbed soils beneath and surrounding the landfill, the documented presence of hazardous wastes leaching into the soils and into the aquifer, makes any requirements for further archaeological investigations neither prudent nor feasible. It is therefore being recommended that the proposed cleanup project be given a determination of "No Effect."

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BACKGROUND

BACKGROUND

Nature of the Project

The Phase IA investigation discussed herein was undertaken on behalf of EA Engineering, Science, and Technology, Inc., which sought professional services for a cultural resources investigation at the site of the Marsh Run Field, Marsh Run (New Cumberland), York County, Pennsylvania (Figures I-1 and I-2). The project area, which will be subjected to a clean-up of hazardous waste materials, was once a part of the New Cumberland Army Depot, and was utilized as a landfill from the early twentieth century to 1957. After the township of Fairview acquired the parcel, the area was covered with a clean "capping fill," and has most recently been used as recreational fields.

Compliance Requirements

This investigation was performed in accordance with the requirements of the National Environmental Policy Act of 1969 (P.L. 91-190; 83 Stat. 852; 42 U.S.C. 4321-4347) and Section 106 of the National Historic Preservation Act of 1966 (P.L. 89-665; 80 Stat.; 915; 16 U.S.C. 470). The investigation was also carried out in compliance with the Secretary of the Interior's Standards for the conduct of professional archeological investigations and the Guidelines for Archaeological Survey in the Commonwealth of Pennsylvania, as promulgated and administered by the Bureau of Archaeology and Historic Preservation (BAHP) of the Pennsylvania Historical and Museum Commission (PHMC).

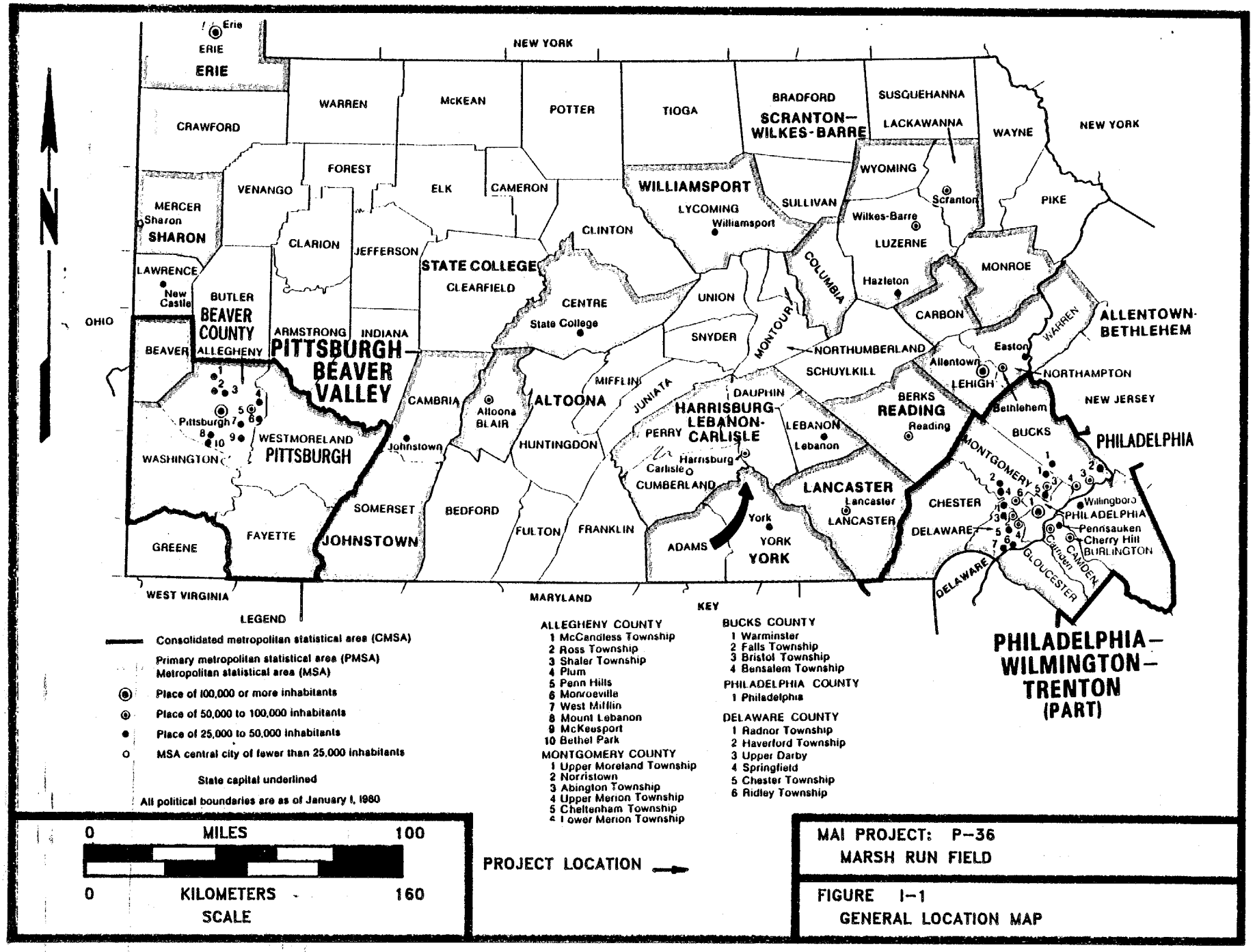
Project Personnel

Serving as Principal Investigator for the project was Betty C. Zebooker, M.A. Robert F. Hoffman was assigned as Project Manager and Kenneth M. Joire', co-author, served as Field Supervisor. Background research was conducted by Project Historian Karyn L. Zatz, co-author, and Betty C. Zebooker. Report preparation was conducted by Jessica L. Billy, Report Coordinator and Christopher B. Thomas, Graphic Illustrator.

Natural Environment

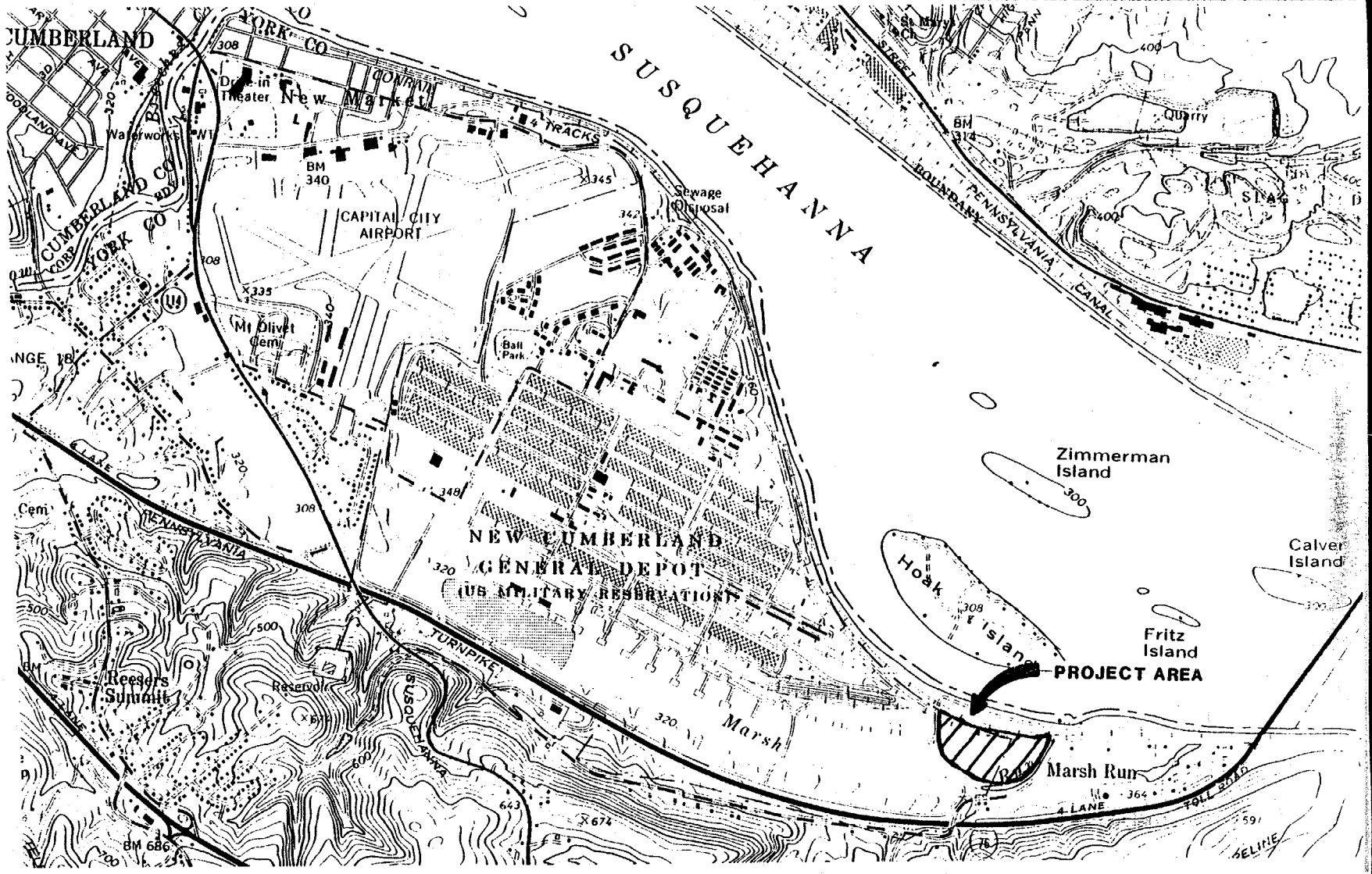
Project Location and Description

The project area is located on the USGS 7.5 Minute Series (Topographic) Steelton, Pennsylvania Quadrangle, on what most likely was a first terrace (prior to the railroad construction in the mid-nineteenth century) of the Susquehanna River near the present community of Marsh Run (New Cumberland Post Office), Fairview Township, York County, Pennsylvania (Figure I-2; Plates I-1 and I-2). The 13.86 acre parcel is bounded to the north by an existing Conrail railroad right-of-way paralleling the Susquehanna River, to the south by Marsh Run Road, to the east by a former fenceline, and to the west by the New Cumberland Army Depot (Figures I-2 and I-3).



MAI PROJECT: P–36
MARSH RUN FIELD

FIGURE I–1
GENERAL LOCATION MAP



SOURCE: 1987 U.S.G.S QUADRANGLE

0 FEET 5000

0 METERS 1500

SCALE

MAAR PROJECT: P-36
MARSH RUN FIELD

FIGURE I-2

PROJECT AREA - 1987

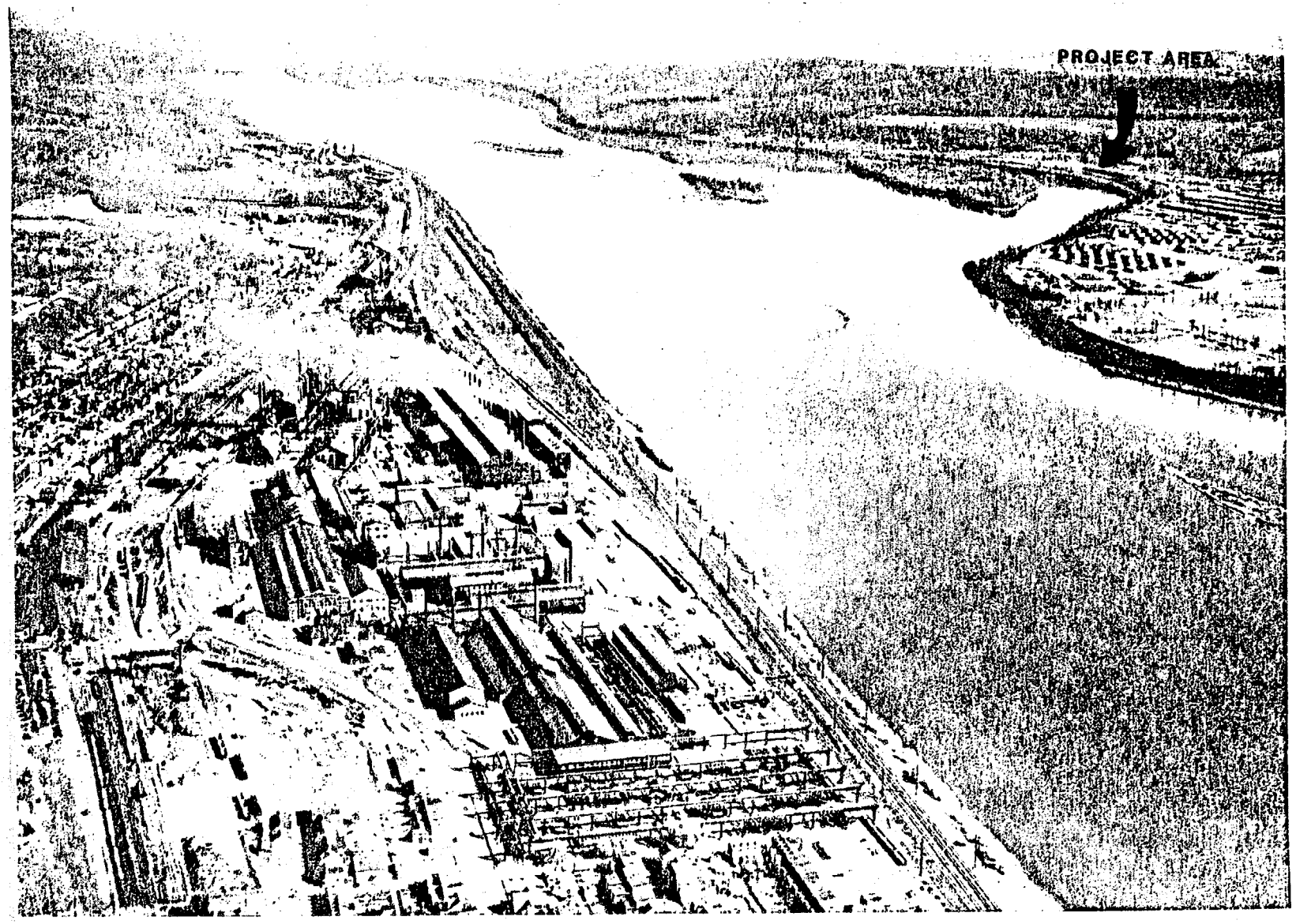


PLATE I-1: 1950 Aerial View of Project Area, From Steelton (Singmaster 1950)

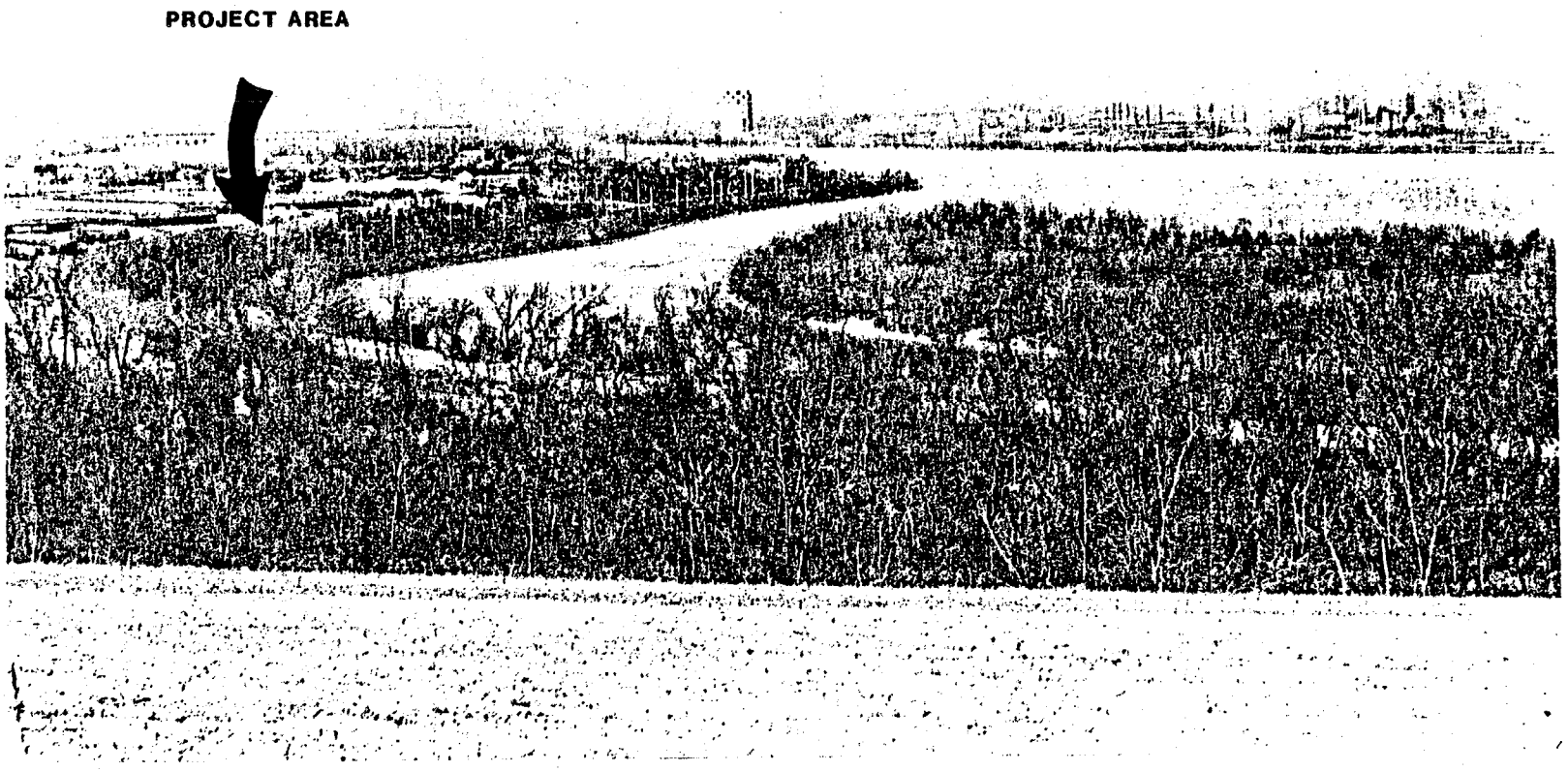
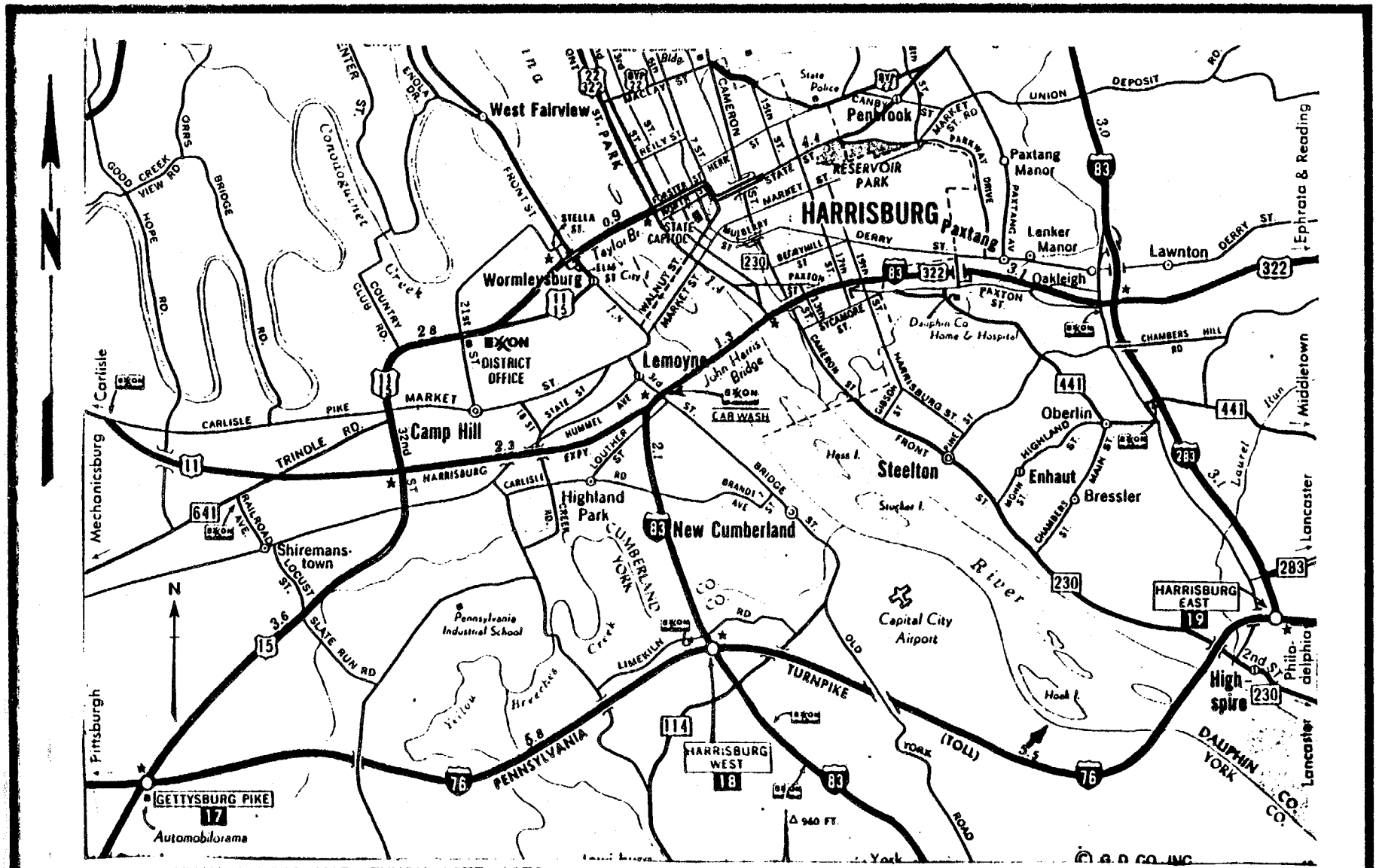


PLATE I-2: 1950 View of Project Area, From Hill Above Marsh Run (Singmaster 1950)



SOURCE: PENNSYLVANIA ROAD MAP, EXXON 1975–1976

PROJECT LOCATION →

MAI PROJECT: P-36
MARSH RUN FIELD

FIGURE I-3
STUDY UNIT

Presently, the project area consists of a relatively level (graded), fallow and wooded lot, dotted with as many as seven deep wells used for monitoring and chemical testing of the natural underground aquifers (Plate I-3). The entire parcel measures 13.86 acres, with 1.87 acres allotted as railroad right-of-way. These railroad tracks are elevated approximately 10 - 15 feet above the fallow portion of the project area (Plate I-4). Approximately 7 acres appear to have been utilized directly as landfill, evidenced by a three to six foot rise in elevation in comparison to what appears to be natural grade in the eastern and southern sections of the parcel. These areas of lower elevation comprise the remainder of the project area and consist of Marsh Run and poorly drained woods (Plate I-5). Severe leaching of heavy metals and hazardous chemicals has been documented over the entire parcel and in the underground aquifers (Gregory Johnson, E. A. Engineering, personal communication).

Soils

The eastern portion of the project area is situated on soils of the Bowmansville silt loam series (Figure I-4). These deep, poorly drained soils are a part of the Flagerstown-Duffield Soil Association, defined as deep, nearly level to moderately steep soils underlain by limestone. The western portion of the project area is comprised of made land of both the Wheeling and Sciotoville series and the Penn and Lansdale series, strongly sloping.

Geographic Characteristics

Geologically, the project area is located in the Triassic Basin of the Piedmont Uplands Physiographic Province (Socolow 1980; Raber et al. 1985). The entire project area is underlain by the Gettysburg, Hammer Creek, and Brunswick Formations, undivided, which are characterized as red to brown fine to coarse-grained quartzose sandstone with red shale interbeds (Chester County Planning Commission 1973: 5-6).

Prehistoric Overview

The following brief discussion is intended to aid in the interpretation of any cultural resources that might be located within the project area. Kent et al. (1971) formulated a chronology (Table I-1), thus providing a framework for the interpretation of prehistoric resources in Pennsylvania.

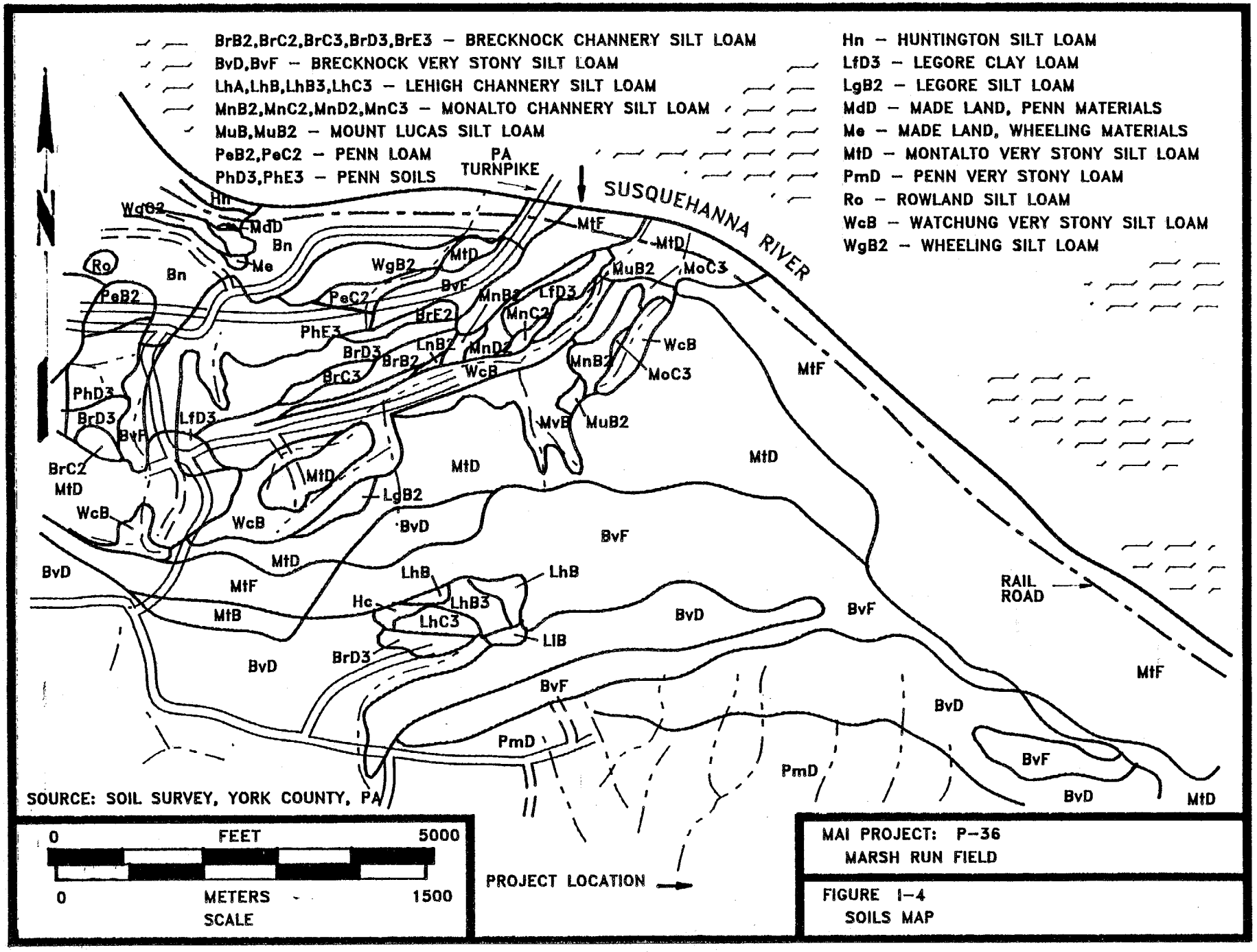
Paleo-Indian Period (11,000 to 9,000 B.C.)

It is not known when the first humans entered the New World, but it is generally recognized that these early people had spread throughout the present-day Americas by 11,000 B.C. The Paleo-Indian Period was a time of dramatic environmental change during which the final glacial advance of the Wisconsin reached its maximum range and began a rapid retreat. The forests were boreal and some areas were covered by tundra. The fauna included such now-extinct mammals as mammoth, mastodon, giant beaver, and saber-toothed tiger.

PLATE I-3: Overview of Project Area From Railroad Tracks Above Survey Monument Number 2, View to Southwest

PLATE I-4: Overview of Project Area From South Side of Marsh Run Road, View to North

PLATE I-5: View of Marsh Run From Marsh Run Road, View to East



MAI PROJECT: P-36
MARSH RUN FIELD

FIGURE I-4
SOILS MAP

TABLE I-1: PENNSYLVANIA PREHISTORY CHART

Chronological Chart of Pennsylvania Prehistory.

Culture Periods	Dates	Settlement and Subsistence Patterns	Characteristic Artifacts		Major Components and Distributions West	Central	East
Late Woodland	1550 A.D.	Seasonally sedentary tribes; villages and hamlets (some stockaded villages); horticulture, hunting and gathering.	Cord-marked and/or incised decorated pottery; triangular projectile points; bow and arrow; elbow and vasiform pipes; celts; various bone tools and ornaments.	North	McFate Monongahela Owasco	Proto-Susquehannock Chance-Wyoming Shenks Ferry Kelso Clemson's Is. Owasco	Chance-Munsee Kelso Owasco
	1000 A.D.			South	Monongahela	Shenks Ferry Clemson's Is.	Overpeck
Middle Woodland	1000 A.D.	Incipient tribal village life in western Pa., supported by horticulture, hunting and gathering; bands in eastern Pa. living in scattered hamlets, practicing hunting and gathering.	Diversification of cord- and net-impressed pottery; side-, corner-, and basal-notched spearpoints; platform pipes; elbow pipes; celts; burial mound complexes.	North	Mahoning Diluted Hopewell	Kipp Is.	Bushkill Point Peninsula
					Various local developments throughout		
	500 B.C.			South	Watson Diluted Hopewell	Radford Accokeek Cr.	Abbott
Early Woodland	500 B.C.	Bands of family units living in scattered households; persistence of hunting and gathering, with a possible shift in some areas to semi-sedentary settlement due to a more stable economic base.	Interior-exterior cord-marked pottery; plain flat-bottomed vessels; side-notched and expanded stemmed points; tubular stone pipes; adzes; bar weights; birdstones; gorgets.	North	Middlesex or Local Adena	Meadowood Local Adena	Meadowood Middlesex
					Various local developments throughout		
	1000 B.C.			South	Local Adena Half-Moon	Marcey Cr. Half-Moon	Marcey Cr.
Transitional	800 B.C.	Far ranging bands of hunters and gatherers, occupying temporary hamlets; heavy dependence on riverine resources.	Fishtail and broad spearpoints; soapstone cooking vessels.	North	Ashtabula Susquehanna Influence	Orient-like Susquehanna	Orient Perkiomen Lehigh
	1800 B.C.			South	Ashtabula Susquehanna Influence	Orient-like Susquehanna Perkiomen	Orient Perkiomen Lehigh
Archaic	1000 B.C.	Bands of hunters and gatherers, following patterns of restricted seasonal wandering.	Various spearpoint and knife forms; grooved axes; adzes; atlatl weights; pestles; mullers; choppers.	North	Laurentian Lamoka Proto-Laurentian	Laurentian Lamoka Piedmont	Laurentian Piedmont
					Various local developments throughout		
	7000 B.C.			South	Proto-Laurentian Panhandle	Laurentian Piedmont	Laurentian Piedmont
Paleo-Indian	10,000 B.C.	Bands of nomadic hunters.	Fluted points; scrapers; knives; gravers.		Clovis related cultures throughout; Enterline industry in central Pa.		

Present research indicates that Paleo-Indians were nomadic and relied on the game and floral resources of the late Pleistocene and early Holocene to provide food, shelter, and tools. Pennsylvania game, in addition to those listed above, would have included the elk, moose, bear, and musk ox, among others. The recoverable artifacts associated with Paleo-Indian peoples are, for the most part, flaked tools of high quality cryptocrystalline quartz. The associated flake tool kit consists of fluted projectile points, bifacial chopping tools, hammers and abraders, scrapers, gravers, and burins. Evidence of the Paleo-Indian Period recorded in central Pennsylvania include the Shoop Site and the Wilhelm Site, both within the Susquehanna River Drainage (Witthoft 1952).

Archaic Period (9,000 to 1,000 B.C.)

During the Early Archaic (9,000 to 7,000 B.C.), rapid environmental changes continued to take place. Much of the big game was gone from central Pennsylvania, and the forests were changing from boreal to northern hardwoods in response to a general climatic warming trend. These environmental changes did not allow for cultural stability, but forced the populations of the area to continually adjust by undergoing constant change. Population density seemed to change little during the period, but it is possible that the population actually declined in number from the previous Paleo-Indian Period. Indeed, Salwen (1975) thinks this was the case during a long portion of the Archaic period in most areas of the Northeast. Projectile points used during the Early Archaic were corner-notched and side-notched, well-made, and manufactured from both high and medium quality lithic materials. Except for the projectile points, the tool kits used were similar to those of the preceding peoples.

The Middle Archaic Period (7,000 to 3,500 B.C.) shows a slight population growth as evidenced by the more abundant number of projectile points known from this period and the more numerous sites associated with the Middle Archaic. Environmental fluctuations were lessening in intensity. With a relatively more stable environment, these populations were able to adapt to their surroundings and extract needed resources. A settlement pattern involving movement to seasonally available resources was established. A typical yearly seasonal round might begin with the spring fish runs up the rivers and would continue with utilization of more open flat land resources in the summer. It would then be followed by a move in the fall to prime nut-gathering areas such as would have existed on the hilltops and ridges, and would end with a move to poorly-drained areas in the winter for deer hunting (Thomas et al. 1975).

During the Late Archaic (3,500 to 2,000 B.C.), the inhabitants of what is today the eastern United States became very efficient at procuring resources from their environments. The term "Forest Efficiency" (Caldwell 1958) has been used to describe this cultural/economic pattern which reflected an increased reliance on localized resources. Populations grew as the inhabitants became better able to cope with this interstitial environment. New additions were made to the tool kits, including grooved axes, bannerstones (atlatl weights), and projectile points with straight stems and narrow blades.

The new prosperity is not only seen in the variety of new tools but also in the ability of archaeologists to define regional and localized cultural complexes. Kinsey (1971), in a survey of Archaic Period cultures of the Piedmont of Pennsylvania, has identified several "traditions" which he sees as representing differing modes of life within the same general environmental zone. Indicative of the Late Archaic is the beginning of elaboration of mortuary practices. Today, in many parts of the eastern United States, including Pennsylvania, burial practices have been used to define local cultural groups and to imply the presence of incipient status differentiation (Ritchie 1969).

A period of transition (2,000 to 1,000 B.C.) makes the break between the Archaic and the subsequent Woodland economic patterns. An introduction of new projectile point styles and raw materials can be seen. A "Broadspear" projectile point form (Witthoft 1953) was made from rhyolite and argillite, both found in southern Pennsylvania. Older forms also continued in use, further adding to the indications of economic and\or regional specialization. It is during this period that the first nonperishable bowls or containers, i.e. soapstone (steatite) vessels, were made. During this period, large numbers of artifacts are often found at single sites, suggesting a multi-seasonal use of camps and the beginning of semi-sedentary settlements.

Woodland Period (1,000 B.C. to A.D. 1,600)

The Early Woodland Period, which lasted until approximately 300 B.C., marks an increase in the manufacturing and use of ceramic vessels for food preparation and storage. It is probable that the introduction of this new artifact type does not represent a migration of ceramic-using peoples into the general area. Instead, it may have represented the adoption of a new technique for making vessels and a new life style. The idea of molding and firming clay to make vessels is an idea that probably diffused from the Southeast, but the local practice of shaping vessels into exact copies of the earlier soapstone bowl was a regional tradition. Experimentation by potters continued throughout the Early Woodland Period. Projectile points changed from the "Broadspear," manufactured from rhyolite and argillite, to smaller side-notched points made from Pennsylvania jasper and local flints, jaspers, cherts, and quartz. The settlement and economic patterns are similar to those of the Late Archaic. Mortuary practices, however, had become more elaborate and complex than those seen in earlier periods. Burial mounds, although not known from Pennsylvania, exist to the west and north and reflect a status-orientation that does appear to have been present in central or southern Pennsylvania.

The Middle Woodland (300 B.C. to A.D. 1000) was a period of little environmental change. An oak-hickory forest dominated throughout the Middle Atlantic region. The experimentation in ceramic manufacturing taking place during the Early Woodland resulted in the "Woodland Pottery Vessel," a coiled conoidal vessel with paddle malleated surfaces and no decoration. The Middle Woodland Period was a relatively conservative, stable time with only minor changes apparent in the archaeological record. It has been suggested (Kinsey 1974) that the separation of the Early and Middle Woodland is meaningless and that

a single term should be utilized to refer to the entire time span represented by this similar cultural manifestation. Kinsey (1972) uses the term Early/Middle Woodland; but others, notably Artusy (1976) and Custer (1982), suggest a separation of the Woodland into Woodland I and II.

The most noticeable change between the Early Woodland and the Middle Woodland was in the trade system, where large quantities of exotic artifacts from the Midwest and New York found their way into central and southeastern Pennsylvania. Adena influences from the Ohio Valley, for instance, have been documented (Ritchie and Dragoo 1959; Thomas 1970). Sometime during this period, or perhaps even earlier (Adovasio and Johnson 1981), horticulture began to affect the local economies.

The Late Woodland (A.D. 1000 to A.D. 1600), throughout most of Pennsylvania (Kent 1989), stands in marked contrast to the earlier cultural periods. The first sedentary villages were built based on a new subsistence pattern involving a greater reliance on cultigens, especially corn, beans, and squash. These villages were large and were located on well-drained promontories near navigable streams. Ceramics were made in a variety of shapes and were decorated with complex geomorphic designs. The bow and arrow became the dominant hunting weapon. Tribal political alliances were apparently formed; and warfare, as evidenced by the building of fortified (palisaded) villages, increased. In the eastern portion of Pennsylvania, the localized Late Woodland cultures, such as Clemson Island and Shenk's Ferry, were encompassed by peoples and ideas from the New York area, and the Susquehanna culture which became dominant.

During Contact times, the Susquehanna River Valley, including its tributary streams and their valleys, became part of the territory of the Iroquois-speaking Susquehannock peoples (Kent 1989). By ca. 1570, these Susquehannocks migrated down river into the Lower Susquehanna River Valley and were occupying the east-central portions of present day Pennsylvania. The Susquehannocks were an aggressive and expansionist people and were often involved in wars against the members of the Five Nations or Leagues of the Iroquois from New York. In 1674, the Senecas, a member of the Five Nations to the north, finally defeated the Susquehannocks, resulting in their expulsion from the region (Kent 1989). Soon after the Susquehannocks were displaced from their lands along the Susquehanna River, the Lenape, or Delaware Indians, who were also being displaced from their lands to the east, began to occupy this territory.

Two Indian paths utilized during the Contact Period have been documented as being within close proximity to the project area (Wallace 1971). One of these paths is the Conoy Path which runs from Conoy Town (on the east shore of the Susquehanna River) through York Haven, Newberrytown, and on to Carlisle (Wallace 1971:38). This path is located south of the Marsh Run Field. The second path, the Allegheny Path, went from Philadelphia to Kittanning, which is located in western Pennsylvania on the Allegheny River (Wallace 1971:19). This path crossed through present-day Harrisburg, north of the Marsh Run Field.

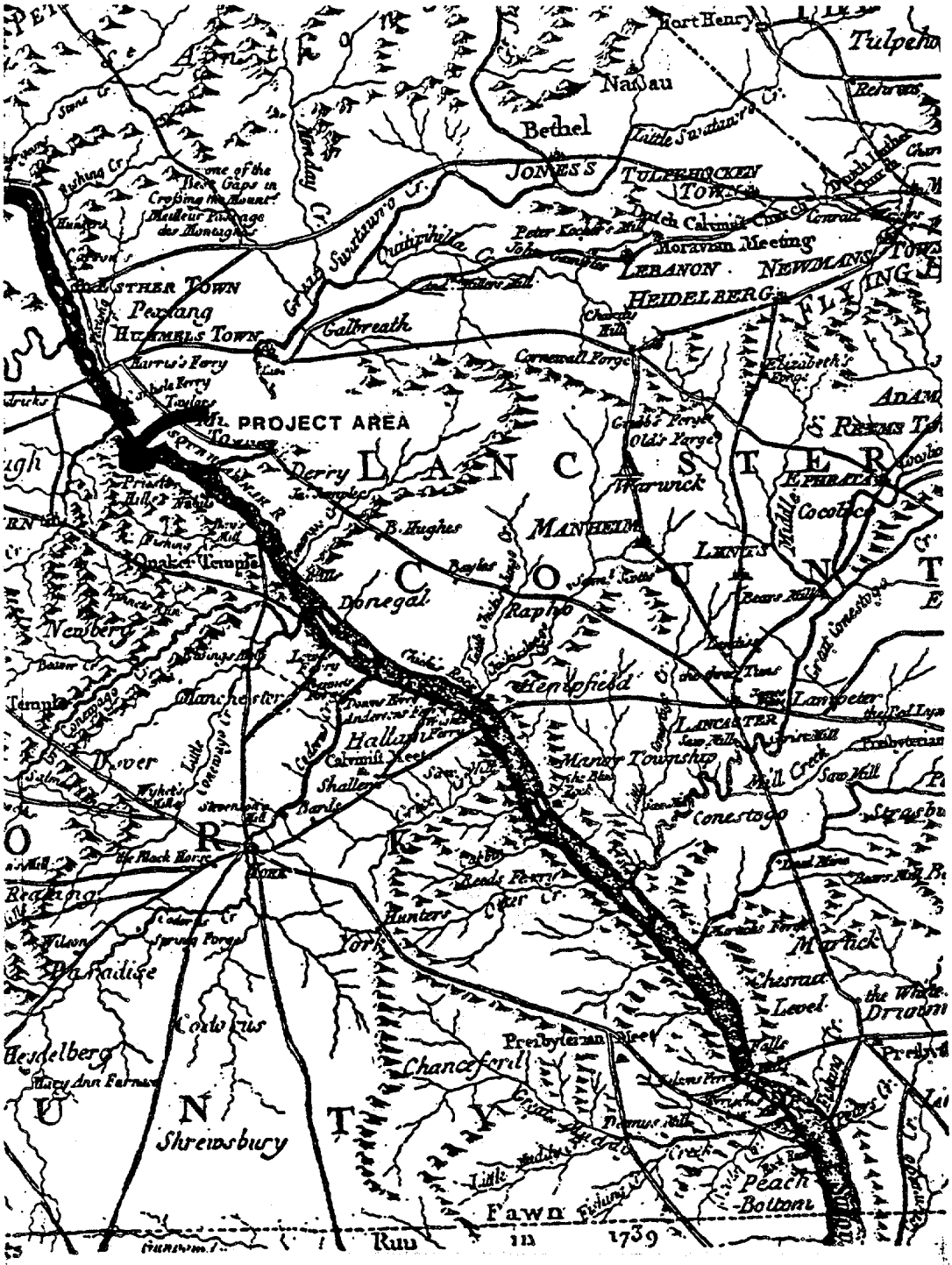
Historic Overview

The Marsh Run Field site is situated in the community of Marsh Run in Fairview Township, York County, Pennsylvania. This section of York County was initially part of the unorganized land in the western part of Chester County from which Lancaster County was created in 1729. In 1739, it was included within the bounds of Pennsborough Township, a large, sparsely settled community which encompassed nearly all of what is presently Cumberland County and portions of York County. Three years later, in 1742, the area was included within the bounds of Newberry Township in Lancaster County; and, in 1749, York County was created from the western part of Lancaster County. The area remained part of Newberry Township in York County until 1803, when Fairview Township was organized from the northern part of Newberry Township. At the present time, Marsh Run is an unincorporated hamlet in Fairview Township which utilizes the New Cumberland post office (Clint 1976:18; Prowell 1907:966; Gibson 1886:640).

Fairview Township was initially settled in the early 1730s by English Quakers from Chester County (Carter and Glossbrenner 1930:15-17). During the eighteenth century, the area which was subsequently to become Fairview Township was primarily an agricultural community with the majority of the inhabitants engaged in general farming and husbandry (Prowell 1907:970). There were no churches or meetinghouses in the area during the eighteenth century, and the principal village center during the colonial period was Lewisberry (Carter and Glossbrenner 1930:15). In 1740, a ferry was established across the Susquehanna River between what later became the community of New Market and the Marsh Run Field site. The ferry, which was operated by a succession of individuals including John Harris, Benjamin Chambers, William Chesney, and Michael Simpson, continued in operation until the mid-nineteenth century (Prowell 1907:971) at the foot of what is presently Simpson's Ferry Road. The ferry did not, however, serve as a focal point of early community development.

The initial settler in the vicinity of Marsh Run was David Priest. The wooded ridge along the Susquehanna River below Marsh Run was called Priest's Hill and is identified on the Scull Map of Pennsylvania in 1770 (Figure I-5). No development of the Marsh Run Field site appears to have been undertaken during the eighteenth or early nineteenth century. Presumably, the site either remained unoccupied or was utilized for general farming activities during this period.

In 1807, four years after the creation of Fairview Township, the community of New Market was laid out by Henry Mosser as a planned community containing one hundred twenty building lots (Prowell 1907:970). Unlike many of the speculative communities laid out in York and Lancaster County during this period (Cosans 1986:56), New Market was a successful undertaking and, during the nineteenth century, served as the principal village center for Fairview Township. Apparently, the establishment of the town of New Market had little effect on the development of the Marsh Run Field site, which appears to have remained largely undeveloped.



the late MAP of W. SCULL, *Published in* 1770.

SOURCE: DETAIL OF WM. SCULL MAP, 1770

0 MILES 15

0 KILOMETERS 24

SCALE

MAAR PROJECT: P-36

MARSH RUN FIELD

FIGURE I-5

PROJECT AREA - 1770

The York and Conewago Turnpike was completed to York Haven before 1814; and by 1838, it was extended along the west bank of the Susquehanna River to the bridge which crossed the river at Harrisburg. The turnpike road was discontinued between Goldsboro and Harrisburg in 1850 when the tracks of the York and Cumberland Railroad were constructed along the turnpike right-of-way (Prowell 1907:600). The York and Conewago Turnpike traversed the northern edge of the Marsh Run Field site and was probably situated either within or north of the present railroad right-of-way; however, no development appears to have been undertaken at the site as a result of the construction of the road along the river.

In 1848, the York and Cumberland Railroad Company was chartered and, by 1851, tracks had been completed from York to LeMoyne (formerly Bridgeport) on the west bank of the Susquehanna River opposite Harrisburg (Burgess and Kennedy 1949:131). As mentioned above, the railroad right-of-way traversed the former route of the York and Conewago Turnpike above Goldsboro. In 1854, the York and Cumberland Railroad merged with the Baltimore and Susquehanna Railroad and the York and Maryland Line Railroad Company to form the Northern Central Railway Company (Burgess and Kennedy 1949:131; Prowell 1907:612). During the 1860s, the Pennsylvania Railroad acquired most of the stock of the Northern Central Railway Company, but the operation of the two railroad companies were not merged until 1875 (Burgess and Kennedy 1949:138). During the Civil War, the Northern Central Railway was a critical line for the movement of troops and supplies. After the Civil War, the Northern Central Railway was double-tracked from Baltimore to York but it was not until 1905 that four lines of track were constructed north of York (Prowell 1907:612; Burgess and Kennedy 1949:141). The Historical Topographical Atlas of the State of Pennsylvania, compiled in 1872 (Figure I-6), shows the route of the Northern Central Railway along the west bank of the Susquehanna River. Aside from track construction, no railroad-related development could be identified at or adjacent to the Marsh Run Field site.

The hamlet of Marsh Run first appears in The Atlas of York County Pennsylvania compiled from the surveys of Beach Nichols in 1876.* This atlas map of the area shows the Marsh Run Field site as undeveloped land. The railroad traverses its present right-of-way along the river bank. The hamlet of Marsh Run is located southeast of the site and consists of several dwellings and the Marsh Run Hotel and Station. The Marsh Run School is shown at its present location on Marsh Run Road directly opposite the Marsh Run Field site. Several dwellings, including the Dotrow house, the Marsh Run Hotel and Station, and the Marsh Run School, are presently listed in the Pennsylvania Historic Sites Survey (Appendix A). No sites in the vicinity of the Marsh Run Field site are listed on the National Register of Historic Places.

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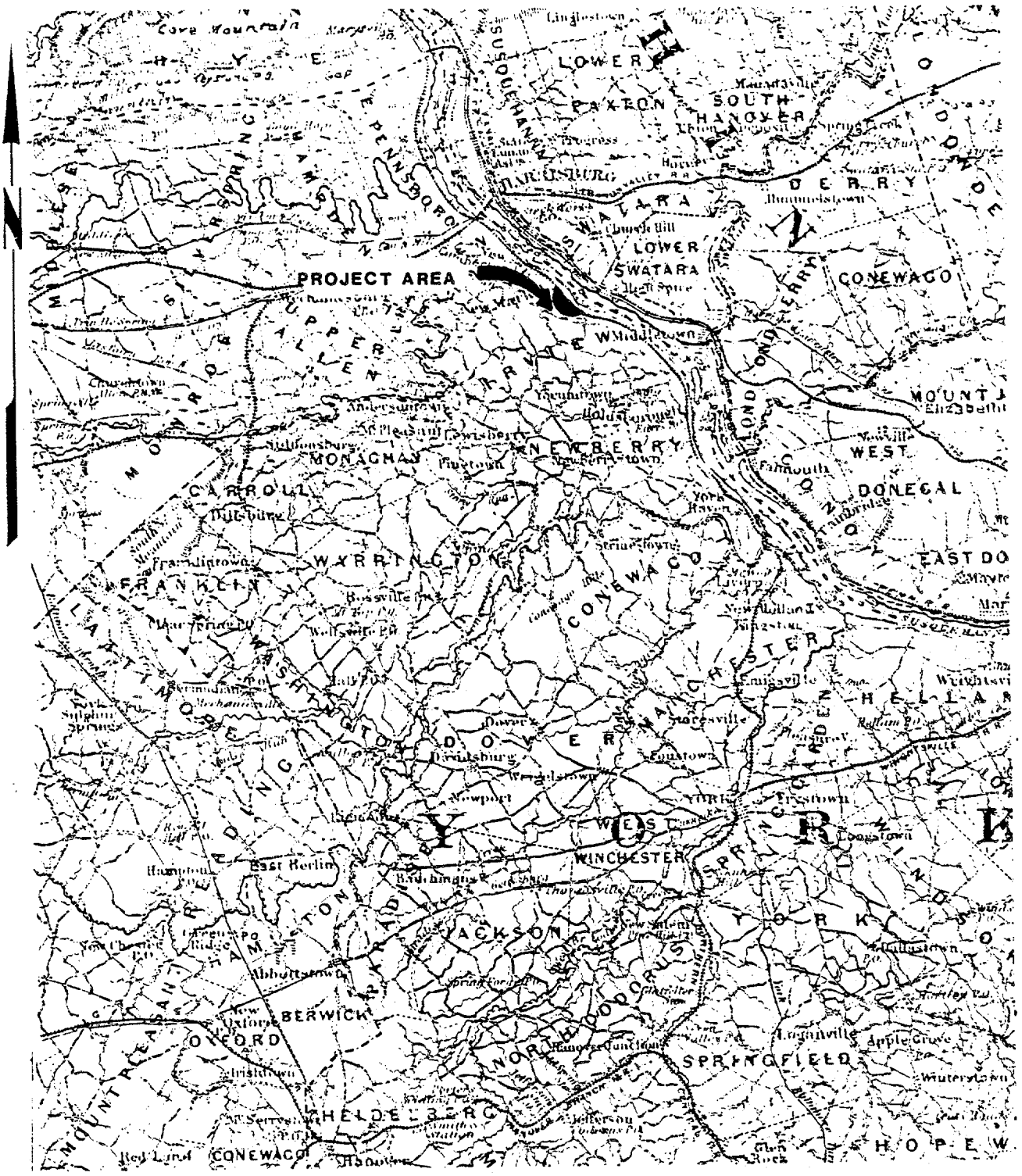
* No copies of this map were permitted to be made by the Martin Public Library in York.



SOURCE: DETAIL OF THE HISTORICAL TOPOGRAPHICAL ATLAS OF THE STATE OF PENNSYLVANIA

0 MILES 15

0 KILOMETERS 24

SCALE

MAAR PROJECT: P-36

MARSH RUN FIELD

FIGURE I-6

PROJECT AREA - 1872

In 1917, the United States Army acquired a tract of land containing 832 acres situated on the west bank of the Susquehanna River between the town of New Market and the hamlet of Marsh Run (Figure I-2). The Army Corps of Engineers constructed a supply facility called the Marsh Run Storage Depot, which was subsequently renamed the New Cumberland General Depot (Hay et al. 1984) (see Figures I-7 and I-8, indicating project area before and after construction of the New Cumberland General Depot). The Marsh Run Field site was situated within the depot bounds at the eastern end of the facility and was apparently utilized for more than half a century as a waste disposal area. Aside from utilization as a waste disposal area, no specific military structures or functions can be identified for this area.

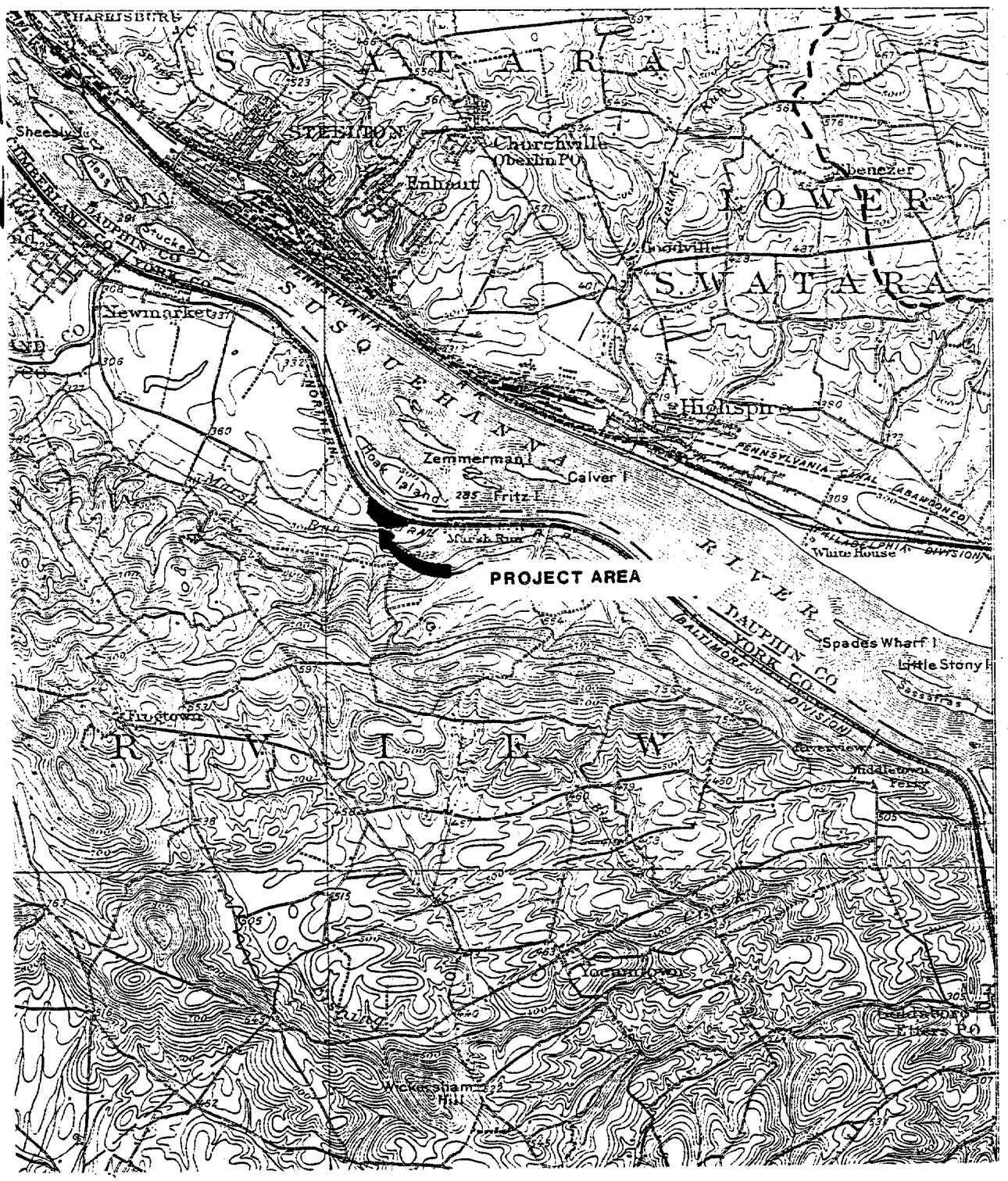
Research Strategy and Goals

Previous Investigations

No prior systematic cultural resource surveys or testing programs have been undertaken at the Marsh Run Field site. In 1984, the New Cumberland Army Depot was the subject of a Phase IA archaeological investigation to determine the probability of in situ archaeological resources within the enclosed compound to the west (Hay et al. 1984). In another unrelated survey, the standing structures adjacent to the project area were surveyed for inclusion in the Comprehensive Historic Sites Survey (Appendix A), which is maintained by the Pennsylvania Historical and Museum Commission, Office of Historic Preservation.

Goals

The primary goals of this Phase IA investigation were to identify the locations of previously known and/or recorded archaeological and historical sites, as well as the documentation of prior disturbances, if any, to the project area. Personal interviews, cartographic research, and field investigations were utilized to compile this data. Another goal of the investigation was to assess any undisturbed portions of the project area for archaeological potential and to establish prehistoric and historic contexts for cultural resources that might be discovered in the course of any subsequent field investigations.



SOURCE: 1906 U.S.G.S. QUADRANGLE

0 MILES 3

0 KILOMETERS 15

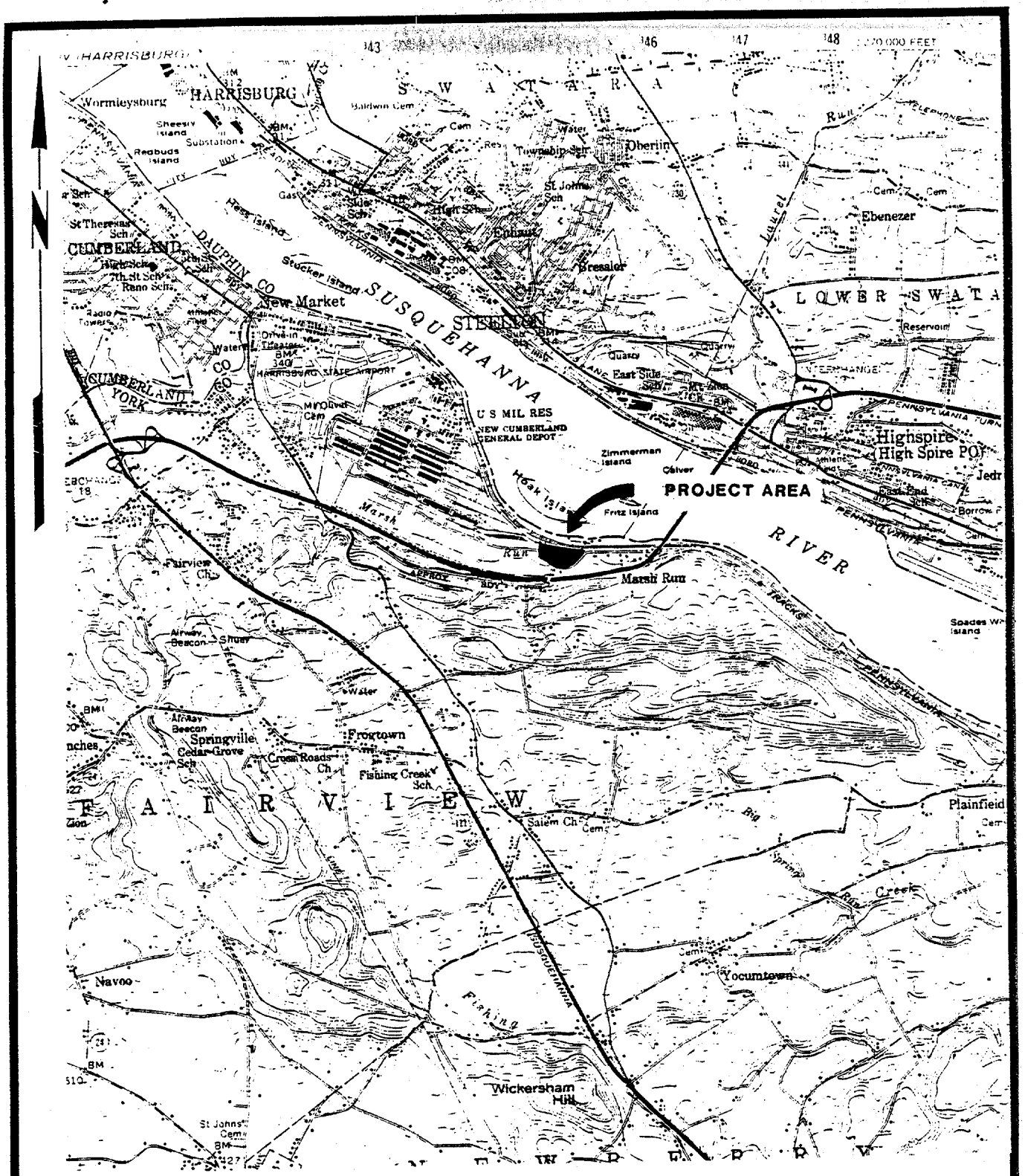
SCALE

MAAR PROJECT: P-36

MARSH RUN FIELD

FIGURE I-7

PROJECT AREA - 1906



SOURCE: 1956 U.S.G.S QUADRANGLE

0 MILES 3

0 KILOMETERS 15

SCALE

MAAR PROJECT: P-36

MARSH RUN FIELD

FIGURE I-8

PROJECT AREA - 1956

DATA BASE

DATA BASE

Data Acquisition Procedures

Members of the MAI research team visited the Bureau for Historic Preservation in Harrisburg, Pennsylvania to conduct a review of existing data concerning the project area. The list of sites pending nomination to the National Register was consulted, along with the Pennsylvania State Register for previously surveyed standing structures adjacent to the project area. The Pennsylvania Archaeological Site Survey (PASS) files and corresponding maps, housed at the Pennsylvania Historical and Museum Commission, were also examined for the presence of either prehistoric or historic sites within and/or adjacent to the project area. In particular, three prehistoric archaeological sites (36 Yo 242, 36 Yo 261, and 36 Yo 262) were noted as being previously recorded in close proximity to the project area; and three prehistoric archaeological sites (36 Da 22, 36 Da 88, and 36 Da 145) were recorded on Hoak Island directly north of the project area. No sites were previously recorded from directly within the designated project area.

Archaeological Site 36 Yo 242, the Marsh Run Site, is an extensive site located directly east of and adjacent to Marsh Run. The collection from this site consists of grooved axes from the Archaic Period and cache blades. Lithic materials collected from the surface include rhyolite and quartz. Sites 36 Yo 261 (the Channel Site) and 36 Yo 262 (the Hershberger Site) are both situated directly on a flood plain of the Susquehanna River northwest and northeast, respectively, of the project area. Untyped projectile points of rhyolite and netsinkers were recovered from the Channel Site, while a broken pestle, soapstone artifacts, and a "tomahawk" were recovered from the Hershberger Site. Both of these sites yielded pottery which dates to the Woodland Period.

Of the three sites recorded in Dauphin County, no cultural information was available for 36 Da 22 and 36 Da 88; however, 36 Da 145, the Gustin Site, produced hammerstones, drilled soapstone, and a "tomahawk." No projectile points were recovered, and thus no definitive cultural affiliation or chronological placement can be ascribed to the occupation of the site.

In order to acquire additional data relevant to the project area, the research team also consulted pertinent published and unpublished resources available at the BHP and at local archives including the Martin Library, York; the New Cumberland Public Library, New Cumberland; The Chester County Library, Exton; The Green Library at West Chester University, West Chester; the library at the University of Delaware, Newark; the reference collection of the Chester County Historical Society, West Chester; the United States Geological Survey office, Malvern, and the library housed at MAAR Associates, Inc. main office in Newark, Delaware.

Both professional and avocational archaeologists with an interest and knowledge of the area were interviewed, as well as personnel from the New Cumberland Army Depot and EA Engineering, Science and

Technology, Inc. The information provided by these individuals has been incorporated into this report.

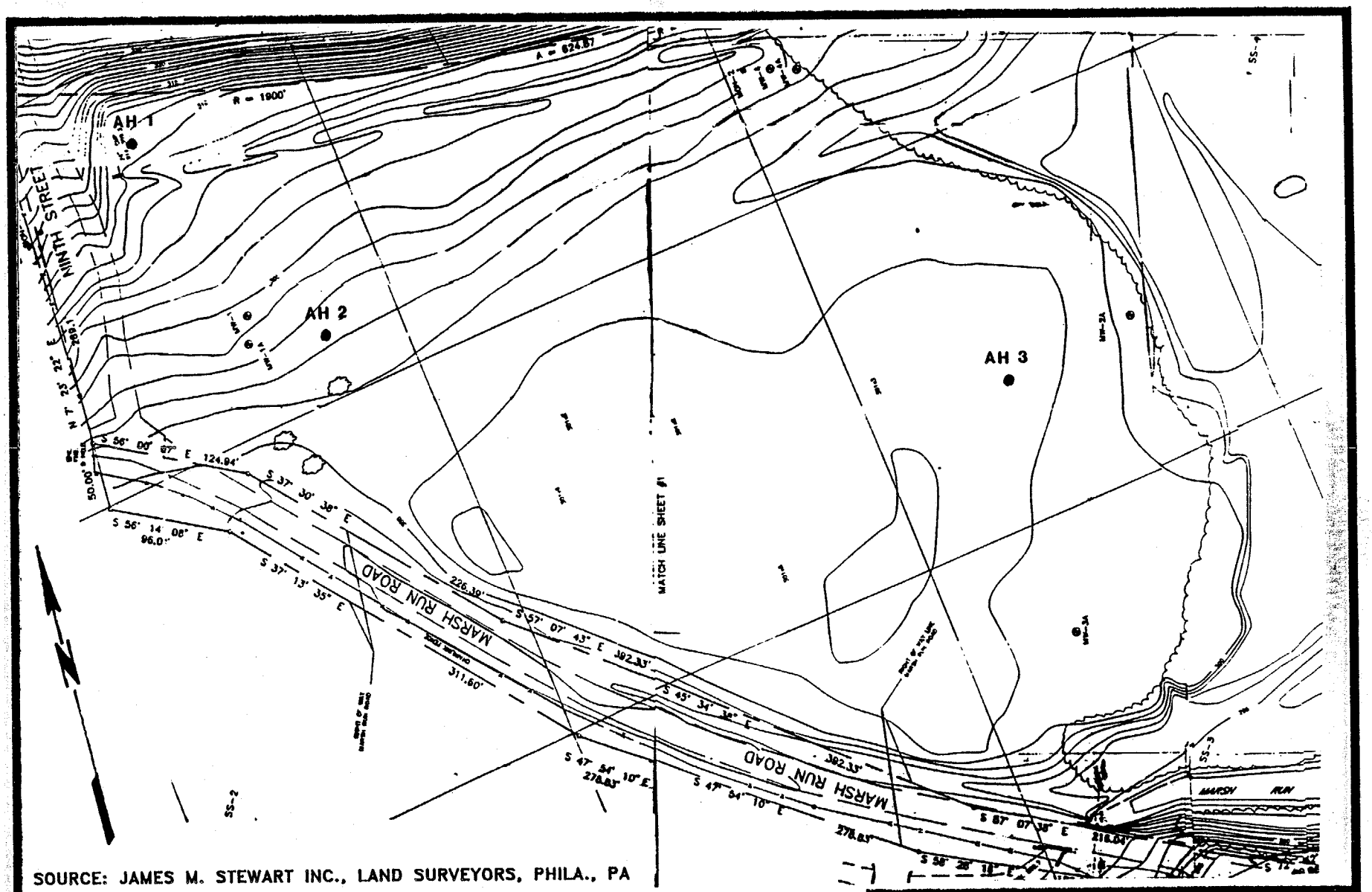
Data Description and Analysis

In the proposal submitted to EA Engineering, Science and Technology, Inc., MAAR Associates, Inc. proposed to conduct a reconnaissance survey of the project area, including a pedestrian survey of the entire project area and the subsequent excavation of no more than ten auger tests. Ground surface visibility at the Marsh Run Field site was in the 0 to 20 percent range, and no artifacts were recovered from surface proveniences. A total of three auger tests were excavated in order to confirm the area designated as landfill and to determine its depth, if possible, and to locate any undisturbed strata (Figure II-1). Each of the three auger tests were excavated in tenths of feet by stratigraphic levels, determined primarily by texture, as defined by Cornwall (1961), and color, using a Munsell Color Chart. All soils were screened through one-quarter inch hardware cloth to ensure the recovery of artifactual materials. The stratigraphic profiles encountered during the excavation of each auger test were accurately recorded, and a photographic journal was maintained.

Auger Test 1 was located in the northwest corner of the project area within the Conrail railroad easement approximately 24 feet northeast of an existing culvert and 46 feet east of Ninth Street (Figure II-1). This test, excavated to a depth of approximately 3 feet, revealed 0.3 foot of dark brown (10 YR 4/4) silt, underlain by 0.45 foot of yellowish brown (10 YR 5/4) clayey silt mottled with yellowish brown (10 YR 5/8) clayey silt. Level 3 was a 0.55 foot brown/dark brown (7.5 YR 4/4) silt level with a 0.1 foot level of strong brown (7.5 YR 5/8) sand directly below. Level 5 was a relatively thick level of brown/dark brown (10 YR 4/4) slightly sandy silt measuring 1.1 feet underlain by Level 6, 0.6 foot of brown/dark brown (10 YR 4/2) slightly sandy silt. This auger test could not be excavated below 3.1 feet. A single fragment of clear glass was recovered from Level 1, but not retained. No other cultural material was encountered in Auger Test 1.

Auger Test 2 was excavated directly in the landfill area 65.5 feet southeast of Well Number 1A and 44 feet northeast of a solitary tree in the southwest corner of the project area (Figure II-1). Three stratigraphic levels were encountered, consisting of 0.2 foot of dark brown (10 YR 3/3) silty loam with pebbles, 0.3 foot of dark brown (10 YR 3/3) silt mottled with yellowish brown (10 YR 5/4) silt with pebbles, and 0.4 foot of dark yellowish brown (10 YR 4/6) silty sand with numerous rocks and pebbles, respectively. This auger test could not penetrate through the rocks encountered at approximately 0.9 foot. No artifacts were recovered from Auger Test 2.

The final auger test was excavated 100 feet northeast of Well Number 3, in a direct line toward Well Number 2A (Figure II-1). Level 1 was 0.2 foot of sod and root mat in a matrix of dark yellowish brown (10 YR 3/4) silty loam. Level 2 was 0.3 foot of dark brown (7.5 YR 3/2) silt with pebbles and rocks underlain by Level 3, 0.7 foot of strong brown (7.5 YR 5/6) slightly clayey silt mottled with dark brown



MAI PROJECT: P-36
MARSH RUN FIELD

FIGURE II-1
SITE MAP

(10 YR 3/3) slightly clayey silt with shale, pebbles, and rocks. The final level encountered was 0.3 foot of black (2.5 YR N2.5/) ash and cinder evenly mixed with glass, shingles, and other building rubble. Dense fills were encountered at approximately 1.5 feet and could not be penetrated by this auger test.

SUMMARY & RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

Summary

The Phase IA Cultural Resources Investigation conducted within the Marsh Run Field site was designed to locate and identify any cultural resources that might be impacted by the possible future removal of hazardous waste from the parcel. Areas which had previously been disturbed or altered were also identified. Background research revealed that no significant prehistoric or historic cultural resources were previously identified within the project area, although three prehistoric archaeological sites were recorded adjacent to the parcel and several standing structures in the community of Marsh Run have been listed on the Pennsylvania Historic Sites Survey.

Background research also revealed that the area had been used as a landfill during the time it was occupied by the Department of the Army, beginning in the early 1900s. The parcel was later purchased by the Township of Fairview, covered with a clean "capping fill," leveled and graded by heavy machinery, and utilized as a recreational area by local residents.

As documented through analysis of historic and topographic maps, personal interviews, and the excavation of three auger tests, extensive grading has occurred on at least seven of the 13.86 acre parcel. It has also been determined that deep, extensive ground disturbance has occurred, in all likelihood, during the time it was occupied by the Department of the Army. Environmental testing of the parcel has exposed a high heavy metal count and the presence of hazardous chemicals in all tested soils contained in the parcel, as well as contamination of the underlying aquifers. These tests indicate that leaching has occurred even in those soils that appear not to have been directly impacted by the landfill. Results of a ground penetrating survey and chemical tests are on file at EA Engineering, Science and Technology, Inc. and at the Newark office of MAAR Associates, Inc.

Recommendations

Although the Marsh Run Field site is situated in an area with high prehistoric archaeological potential (the north end of the project area possesses moderate historical potential), it is the recommendation of MAAR Associates, Inc. that due to the presence of high levels of hazardous materials and the documented leaching of contaminants that has occurred on site, no further archaeological investigations be conducted prior to the clean-up of the site.

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REFERENCES CITED

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APPENDIX A

PENNSYLVANIA HISTORICAL and MUSEUM COMMISSION
Office of Historic Preservation
Comprehensive Historic Sites Survey Form

I. IDENTIFICATION:

Property Name _____

Location South side of Marsh Run Road at 410 Marsh Run Road

Township Fairview County York

Owners Name Mrs. Daisy M. Baker

Address 410 Marsh Run Road, New Cumberland

Telephone Number _____

II. TYPE of Structure and Approximate AGE:

Georgian

III. ARCHITECTURAL DESCRIPTION:

Exterior:

Rectangular, 2½ stories, 4 bays, symmetrical. Ashlar sandstone, quoins. Wooden lintels above windows & doors. 12-light & 4-light windows. 2-panel shutters on 1st story. Transom with handworked scalloped border above the 2 front (4-panels) doors. Wooden Dutch door in rear. Original hardware on doors. Snow-cleats on the gable roof of tin. 2 large gable-end chimneys.

Interior:

Associated Buildings:
(if appropriate)

IV. INFORMATION SHEET PREPARED BY:

Name Cynthia A. Miller

Street 304 Shuey Road

City New Cumberland County York State PA

Telephone Number 938-2180

1/4/80

COUNTY York

PROPERTY NAME

Township Fairview

CODE 133-1474

Map

V. HISTORICAL BACKGROUND:

VI. PHOTOGRAPHS:

PENNSYLVANIA HISTORICAL and MUSEUM COMMISSION
Office of Historic Preservation
Comprehensive Historic Sites Survey Form

I. IDENTIFICATION:

Property Name A. Thorley

Location south side Marsh Run Road

Township Fairview County York

Owners Name [illegible]

Address 256 Marsh Run Road, New Cumberland

Telephone Number

II. TYPE of Structure and Approximate AGE:

[redacted]

III. ARCHITECTURAL DESCRIPTION:

Exterior:

1½ stories, rectangular. Frame on sandstone foundation. Symmetrical. 2 bays. Windows have 4 lights. Paneled door. Gable roof of tin. Carved frieze. 2 gable end chimneys.

Interior:

Associated Buildings:
(if appropriate)

IV. INFORMATION SHEET PREPARED BY:

Name M. Lucreta Miller (Mrs.)

Street 473 Pleasant View Road

City New Cumberland County York State Pa.

Telephone Number 938-2889

PROPERTY NAME A. Thorley

COUNTY [illegible]

Township Fairview

CODE 133-74-78 Map

V. HISTORICAL BACKGROUND:

VI. PHOTOGRAPHS:

PENNSYLVANIA HISTORICAL and MUSEUM COMMISSION
Office of Historic Preservation
Comprehensive Historic Sites Survey Form

COUNTY York PROPERTY NAME Marsh Run School Township Fairview CODE 133-14-75 Map

I. IDENTIFICATION:

Property Name Marsh Run School

Location westside of Marsh Run Road

Township Fairview County York

Owners Name Jack Hershberger

Address Box 358, Marsh Run Road, New Cumberland

Telephone Number 774-1869

II. TYPE of Structure and Approximate AGE:

[redacted]

III. ARCHITECTURAL DESCRIPTION:

Exterior:

Frame + brick on sandstone foundation; rectangular; 1½ stories, 3 bays 1st story. Major alterations Originally the Marsh Run School, now a home.

Interior:

Associated Buildings:
(if appropriate)

IV. INFORMATION SHEET PREPARED BY:

Name M Lucreta Diller (Mrs.)

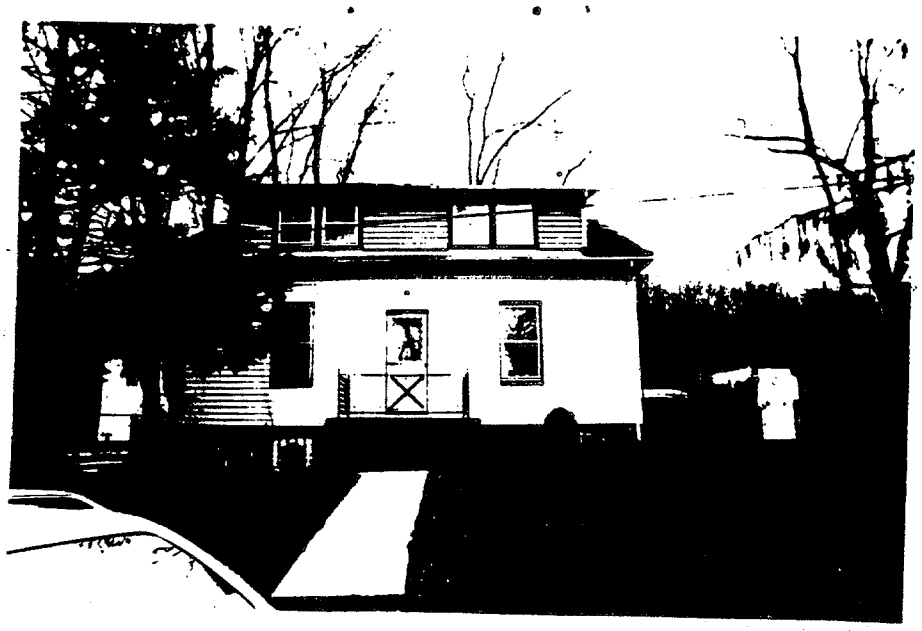
Street 473 Pleasant View Drive

City New Cumberland County York State PA

Telephone Number 938-2889

V. HISTORICAL BACKGROUND:

VI. PHOTOGRAPHS:



PENNSYLVANIA HISTORICAL and MUSEUM COMMISSION
Office of Historic Preservation
Comprehensive Historic Sites Survey Form

I. IDENTIFICATION:

Property Name Dotrow

Location to side Marsh Run Rd. along RR tracks

Township Fairview County York

Owners Name Ron Kipps

Address 4902 E. Trindle Rd, Mechanicsburg, Pa 17055

Telephone Number

II. TYPE of Structure and Approximate AGE:

[redacted]

II. ARCHITECTURAL DESCRIPTION:

Exterior:

2½ stories. Rectangular, altered to become L-Shaped now. Originally log on sandstone foundation. Major alterations on front. Windows have 4 lights. One door has 3 panels on bottom, 1 light at top. Gable roof is tin, with one small gable end. Chimney

Interior:

Associated Buildings:
(if appropriate)

IV. INFORMATION SHEET PREPARED BY:

Name Mrs. Ann T. Corby

Street 121 Bunker Hill Rd.

City New Cumberland County York State Pa. 17070

Telephone Number 774-4638

COUNTY York

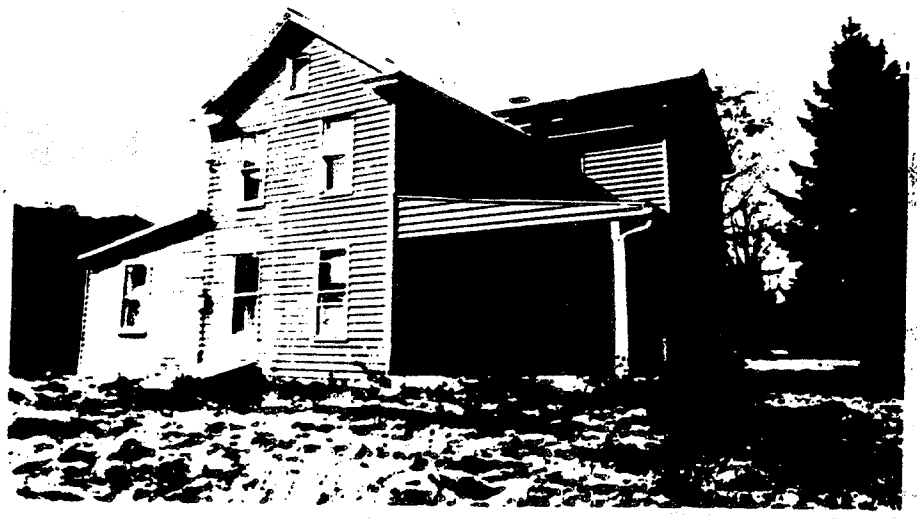
PROPERTY NAME Dotrow

Township Fairview

CODE 133-14-77 Map

V. HISTORICAL BACKGROUND:

VI. PHOTOGRAPHS:



PENNSYLVANIA HISTORICAL and MUSEUM COMMISSION
Office of Historic Preservation
Comprehensive Historic Sites Survey Form

COUNTY York PROPERTY NAME Marsh Run Hotel & Sta. Township Fairview CODE 133-14-76 Map

I. IDENTIFICATION:

Property Name Marsh Run Hotel & Sta.

Location south side of Marsh Run Road

Township Fairview County York

Owners Name James E. Hukker

Address 314 Shuey Road, New Cumberland

Telephone Number 938-4519

II. TYPE of Structure and Approximate AGE:

[redacted]

III. ARCHITECTURAL DESCRIPTION:

Exterior:

Rectangular, 2½ stories, 3 bays, symmetrical, log on sandstone foundation. 2-light transom above paneled door. 4-light windows. Gable roof of tin. 2-gable-end chimneys

Interior:

Associated Buildings:
(if appropriate)

IV. INFORMATION SHEET PREPARED BY:

Name Cynthia A. Miller

Street 304 Shuey Road

City New Cumberland County York State PA

Telephone Number 938-2180

V. HISTORICAL BACKGROUND:

The logs in this building were floated down the Susquehanna & it was erected beside the river, then moved to its present location. Originally a stagecoach stop, it was identified as the Marsh Run Hotel & Station on the 1876 atlas. It has been lived in since & has burned out the interior.

VI. PHOTOGRAPHS:

APPENDIX B

VOLATILE ORGANICS SOURCE SURVEY REPORT, EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., JULY 1990

VOLATILE ORGANICS SOURCE SURVEY
for
NCAD FORMER LANDFILL
MARSH RUN PARK
FAIRVIEW TOWNSHIP, PENNSYLVANIA

Prepared for:

U.S. Army Corps of Engineers
Omaha District

Prepared by:

EA Mid-Atlantic Regional Operations
EA Engineering, Science, and Technology, Inc.

July 1990

Report No. 10424.27

APPENDIX B

VOLATILE ORGANICS SOURCE SURVEY

B-1. INTRODUCTION

Sampling and analysis of shallow ground water for volatile organic contaminants at the Marsh Run Park landfill commenced on 16 April and finished up on 27 April 1990. A 50-ft grid was established with ninety-six locations for sampling at the site. This allowed for thorough coverage of the fill area as well as the immediate area surrounding the fill area. The purpose of the shallow ground water sampling was to provide additional characterization of the landfill and to indicate probable locations of contaminant source areas within the fill area for consideration in the feasibility study.

B-2. MATERIALS AND METHODS

Based on the need for additional site characterization and conditions of the site, it was determined that the most appropriate approach to use at Marsh Run Park landfill was to conduct the sampling on a gird system. Site dimensions and data needs dictated a 50 x 50 ft grid spacing to yield 96 sampling locations. The sampling locations are shown in Figure 1. Sampling was conducted by a two person EA team beginning on 16 April 1990 and finishing on 27 April 1990. Upon arrival at the site, the sampling gird was established by surveying in four coordinates using well point 1 (WP-1) and well point 3 (WP-3) as the baseline. Sampling locations were set off this baseline. After the grid was established, ground water samples were collected through small diameter bolt steel well point sampler.

The approach behind shallow ground water sampling at Marsh Run Park was to obtain samples at or near the base of the fill at the landfill. This corresponded roughly to a depth of 5-8 ft below the ground surface. Samples were obtained by driving the well point samplers to the appropriate depth using an electric hammerdrill. After the samplers were driven and seated, the probes were connected to the vacuum pump by dedicated hose. The ground water was purged at minimal velocity <100 ml/min. The ground water samples were collected in laboratory cleaned 40 ml VOA vials. At approximately 10 percent of the sampling locations, duplicate samples were collected for analysis in the field. Confirmatory analysis of highly contaminated samples was provided by submitting a duplicate sample for analysis by gas chromatography/mass spectrometry to EA laboratories.

All sampling equipment was steam cleaned between each use with the exception of the sampling hose. The sampling hose was dedicated to each sampling location.

Ground-water samples were collected and immediately transported to the mobile onsite laboratory for analysis. The samples were analyzed by "purge and trap/gas chromatography". A 5-ml aliquot of the samples was placed in the purging vessel. An aliquot of bromodichloromethane was injected into the samples as an internal standard. The method involved

sparging the contaminants in the samples with helium. The contaminants sparged from the sample were then absorbed onto a "Tenax" trap. The trap was a stainless steel tube approximately 24 mmly 4 mm i.d. packed with the "Tenax" polymer. The Tenax trap was then heated and backflushed, and the contaminants desorbed from the trap and injected onto the gas chromatograph (GC) for analysis. The operating parameters for the purge and trap unit are provided in Table 2.

Following injection of the sample into the GC, the individual contaminants of the sample were first separated by an analytical column. As the separated compounds eluted from the GC column, they entered the detectors where an electrical signal is produced. The signal was then amplified, integrated, and reported as a chromatographic peak.

Concurrent with compounds eluting from the GC column, the data station printed out a chromatogram, which is a continuous graph of GC detector response to the eluting compounds. Subsequently, a numerical summary of peak areas with corresponding compound identifications and concentrations was printed. Unknown peaks were quantified only by peak area.

The GC analytical system was calibrated by preparing aqueous standards and injecting a known amount of the standard on the column in the gas chromatograph. The electron capture detector (ECD) on the GC was selective for the detection of certain halogenated compounds. The flame ionization detector (FID) was utilized for the detection of certain halogenated compounds as well as hydrocarbons. One set of standards contained a mixture of hydrocarbons and certain chlorinated compounds which was used to calibrate the FID, (1,1-dichloroethylene, cis- and trans-1,2 dichloroethylene, benzene, toluene, ethylbenzene, and o-xylene). The second set of standards contained a mixture of chlorinated compounds which was used to calibrate the ECD (1,1,1 trichloroethane, carbon tetrachloride, trichloroethylene, and tetrachloroethylene). Gas chromatographic operating parameters are presented in Table 3. Compound retention time and response data were stored in the data station and subsequently used to identify and quantify the selected compounds in the samples. Essentially, a calibrated analyte (e.g., benzene) has a known retention time and known GC response to calibrating concentration; therefore, the corresponding chromatogram peak for a sample run was identified by retention time and quantified by comparison to the calibration response. Calibration standards were run each day prior to analysis. Standards were also analyzed in the middle and end of each day. Blanks were analyzed at the beginning and end of each day and one out of every 10 samples was duplicated for analysis. Also, approximately 10 percent of contaminated ground water samples were submitted to EA laboratories for analysis of volatile organic compounds by EPA Method 624.

B-3. RESULTS AND DISCUSSION

The results of the shallow ground water sampling and analysis at Marsh Run park are presented in Table 1 and Figures 1-4. Chromatograms and supporting data are provided in Appendix A. Ninety-six locations were marked for sampling at the site. Of the 96 locations, samples were obtained at 48 sampling locations. This was due to two possible factors.

The first is the depth to ground water across the site ranged from approximately 10 ft in the northern portion of the site to approximately 5 ft in the southern portion of the site. Monitoring well gauging information is provided in Table 4. Hydraulic conductivity fill/soils across the site ranged from 0.08 ft/day to 57 ft/day. Aquifer hydraulic conductivity information is provided in Table 5. Although the sampling probes were driven to various depths ranging from 3 to 11 ft, the probes may not have entered into the saturated zone. The second factor considered was that the probes were driven into the saturated zone, and that the hydraulic conductivity of the fill may have been too low to yield any sample. This was based on hydraulic conductivity data, sampling pump specifications, and radius of the sampling probe. Calculations are provided in Appendix B.

Contaminant concentrations were highest in samples obtained in the northwest portion of the site at locations 8-3 and 9-5 appears to exhibit the greatest amount of volatile contamination. Contaminant concentrations for dichloroethenes at these two locations were in the 100 ppb range. Significant volatile organic contamination was also detected at sampling location 7-5. Higher molecular weight contaminants indicative of fuel oil type contamination were detected at sampling location 7-5 also. In general, dichlorethenes and trichloroethene appear to be the most prevalent contaminants detected during this investigation. As was discussed in detail in the Remedial Investigation Report, dichlorethenes are often breakdown products of trichloroethene. Although contamination appears to be more prevalent in the northeast portion of the site, certain contaminants were detected at locations throughout the site.

Results of the confirmatory analysis by GC/MS indicate a high degree of correlation between the laboratory analysis and the field analysis.

TABLE 1 RESULTS OF SHALLOW GROUND WATER SAMPLING AND ANALYSIS FOR THE ADDITIONAL CHARACTERIZATION OF THE SUSPECTED FILL AREA AT THE FORMER NCAD MARSH RUN PARK LANDFILL, FAIRVIEW TOWNSHIP, PENNSYLVANIA

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
1-1	5.0	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5				
2-1	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
2-1(a)	5.0	<5	<5(c)	--	<5	<5	<5	<5	<5	<5	<5	<5	50	6		
2-2	9.0	No Water, No Sample														
2-3	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
2-3(a)	5.0	<5	<5(c)	--	<5	<5	<5	<5	<5	<5	<5	<5		(80,20)		
2-4	9.0	No Water, No Sample														
2-5		Sample Not Attempted														
3-1	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2		(b)		
3-2	8.0	No Water, No Sample														
3-2	10.5	No Water, No Sample														
3-3	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
3-4	9.0	No Water, No Sample														
3-5	9.0	No Water, No Sample														
3-6		Sample Not Attempted														
3-7		Sample Not Attempted														
4-1	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	2.3	<2	17.3				
4-2	5.0	<10	<10	<10	<0.1	<0.1	5.9	0.3	<2	<2	<2	<2				
4-2(a)	5.0	<5	<5(c)	--	<5	<5	6	<5	<5	<5	<5	<5			18	

(a) Duplicate laboratory analysis.
(b) Unknown compound(s) identified, quantity unknown.
(c) Total 1-2 Dichloroethenes.
(d) Duplicate field analysis.
(e) Two attempts made at depth indicated.
(f) Probe refusal at depth indicated.
(g) Concentration given at TCE and co-eluting, unresoluable unknown compound.

TABLE 1 (Cont.)

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
4-3	5.0	<10	<10	<10	0.6	0.4	3.5	0.3	<2	<2	<2	<2				
4-3(a)	5.0	<5	1(c)	--	<5	<5	3	<5	<5	<5	<5	<5			34	
4-4	9.0	No Water, No Sample														
4-5	9.0	No Water, No Sample														
4-6	9.0	No Water, No Sample														
4-7	5.0	<10	<10	<10	<0.1	<0.1	0.4	<0.1	<2	<2	<2	<2				
4-8	9.0	No Water, No Sample														
5-1	5.0	<10	<10	<10	1.6	<0.1	0.49	0.2	<2	2.3	<2	3.3				
5-2	5.0	No Water, No Sample														
5-2	8.0	No Water, No Sample														
5-3	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
5-4	5.0	No Water, No Sample														
5-4	8.0	No Water, No Sample														
5-5	5.0	<10	<10	<10	<0.1	<0.1	1.6	<0.1	<2	<2	<2	<2				
5-6	5.0	<10	<10	<10	<0.1	<0.1	0.61	<0.1	<2	<2	<2	<2				
5-7	9.0	No Water, No Sample														
5-8	5.0	<10	<10	<10	<0.1	<0.1	<0.1	0.1	<2	<2	<2	<2				
5-9	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
6-1	5.0	<10	<10	<10	2.4	0.2	0.4	1.4	<2	<2	<2	<2				
6-1(d)	5.0	<10	<10	<10	1.4	<0.1	0.3	0.2	<2	<2	<2	<2				
6-2	6.0	<10	<10	<10	0.6	<0.1	<0.1	<0.1	<2	<2	<2	<2				
6-3	5.0	<10	<10	<10	0.9	<0.1	0.3	<0.1	<2	<2	<2	<2				
6-4(e)	5.0	No Water, No Sample														
6-4	7.5	No Water, No Sample														
6-4	9.0	No Water, No Sample														
6-5	5.0	No Water, No Sample														
6-5	6.0	No Water, No Sample														
6-5	7.0	<10	<10	<10	0.5	<0.1	0.6	0.2	<2	<2	<2	<2				
6-6		No Sample, Well Point Data Available														
6-7	5.0	<10	<10	<10	<0.1	<0.1	0.4	<0.1	<2	<2	<2	<2				
6-8	5.0	<10	<10	<10	<0.1	<0.1	2.0	0.25	<2	<2	<2	<2				
6-9	5.0	<10	<10	<10	<0.1	<0.1	<0.1	0.21	<2	<2	<2	<2				
6-10	5.0	No Water, No Sample														
7-1(e)	5.0	No Water, No Sample														
7-1	6.5	No Water, No Sample														

TABLE 1 (Cont.)

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
7-1	8.0	No Water, No Sample														
7-1	10.5	No Water, No Sample														
7-2(f)	3.0	Probe Refusal, No Sample														
7-2(e)	5.5	No Water, No Sample														
7-2(e)	8.0	No Water, No Sample														
7-2	10.5	No Water, No Sample														
7-3	5.5	No Water, No Sample														
7-3	8.0	No Water, No Sample														
7-3(f)	9.5	No Water, No Sample														
7-4	5.5	No Water, No Sample														
7-4(f)	8.0	No Water, No Sample														
7-4	10.5	No Water, No Sample														
7-5	5.5	No Water, No Sample														
7-5(f)	8.0	No Water, No Sample														
7-5	10.5	<10	25	203	<0.1	<0.1	9.0	0.2	<2	<2	20	18		(b)		
7-5(a)	10.5	<25	390(c)	--	<25	<25	32	<25	<25	<25	<25					
7-6(e)	5.0	No Water, No Sample														
7-6	6.0	No Water, No Sample														
7-6	8.0	No Water, No Sample														
7-6	10.5	No Water, No Sample														
7-7(e)	6.0	<10	36	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
7-7	8.0	No Water, No Sample														
7-7	10.5	No Water, No Sample														
7-7(d)	6.0	<10	<10	<10	<0.1	<0.1	0.2	<0.1	<2	<2	<2	<2				
7-8	5.0	No Water, No Sample														
7-8	8.0	No Water, No Sample														
7-8	10.5	No Water, No Sample														
7-8	6.0	<10	<10	<10	<0.1	<0.1	1.8	0.12	<2	<2	<2	2.3				
7-8(a)	6.0	<5	<5(c)	--	<5	<5	1	3	<5	<5	<5	<5				
7-9	5.0	No Water, No Sample														
7-9	7.0	No Water, No Sample														
7-9	10.5	No Water, No Sample														
7-9(a)	6.0	<5	3(c)	--	<5	<5	4	36	<5	<5	<5	<5				
7-9	6.0	<10	<10	<10	<0.1	<0.1	3.4	9.2	<2	<2	<2	<2				
7-10(f)	1.0															
7-10	5.0	<10	<10	<10	<0.1	<0.1	<0.1	0.2	<2	<2	<2	<2				

TABLE 1 (Cont.)

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
7-11	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
8-1	5.0	No Water, No Sample														
8-1	8.0	No Water, No Sample														
8-1	10.5	<10	<10	19	0.3	<0.1	1.4	0.1	<2	<2	<2	<2				
8-2	7.0	No Water, No Sample														
8-2(e,f)	8.0	No Water, No Sample														
8-2(f)	9.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
8-3	5.5	No Water, No Sample														
8-3	8.0	<10	62	257	<0.1	<0.1	6.2	0.7	<2	<2	<2	<2				
8-3(d)	8.0	<10	61	266	<0.1	<0.1	6.4	0.6	<2	<2	<2	<2				
8-3(a)	8.0	<25	570(c)	--	<25	<25	23	<25	<25	<25	<25	<25				
8-4	5.5	No Water, No Sample														
8-4	7.0	No Water, No Sample														
8-4(e,f)	8.0	No Water, No Sample														
8-4	10.5	No Water, No Sample														
8-5	5.5	No Water, No Sample														
8-5	8.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	3	<2	<2				
8-6	5.5	<10	<10	<10	<0.1	<0.1	0.1	<0.1	<2	<2	<2	<2				
8-7	5.0	No Water, No Sample														
8-7(e)	6.0	No Water, No Sample														
8-7	7.0	No Water, No Sample														
8-7	8.0	No Water, No Sample														
8-7	9.0	No Water, No Sample														
8-8	5.0	No Water, No Sample														
8-8(e)	6.0	No Water, No Sample														
8-8(e)	8.0	No Water, No Sample														
8-8	10.0	No Water, No Sample														
8-9	3.0	No Water, No Sample														
8-9(f)	3.5	No Water, No Sample														
8-9	5.0	No Water, No Sample														
8-9	8.0	No Water, No Sample														
8-10	5.0	<10	<10	<10	<0.1	<0.1	<0.1	0.1	<2	<2	<2	<2				
8-11	5.0	<10	<10	<10	<0.1	<0.1	0.1	<0.1	<2	<2	<2	<2				
8-12		Sample Not Attempted														
9-1	5.5	No Water, No Sample														
9-1(e,f)	6.0	<10	5.3	30	<0.1	<0.1	3.9	<0.1	<2	<2	<2	<2				

TABLE 1 (Cont.)

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
9-2[e]	5.5	No Water, No Sample														
9-2[e,f]	6.5	No Water, No Sample														
9-3[e]	6.0	No Water, No Sample														
9-3[e,f]	7.0	No Water, No Sample														
9-4	6.0	No Water, No Sample														
9-4[e,f]	7.0	No Water, No Sample														
9-5	8.0	<10	99	585	<0.1	<0.1	2.4	0.3	<2	<2	<2	<2				
9-6	8.0	No Water, No Sample														
9-7	8.0	No Water, No Sample														
9-7	9.0	No Water, No Sample														
9-7	10.0	No Water, No Sample														
9-8[e]	5.0	No Water, No Sample														
9-8	6.0	No Water, No Sample														
9-8	7.0	No Water, No Sample														
9-8[e]	8.0	No Water, No Sample														
9-8	9.0	No Water, No Sample														
9-8	10.5	No Water, No Sample														
9-9	5.0	<10	<10	<10	<0.1	<0.1	<0.1	<0.1	<2	<2	<2	<2				
9-10	5.0	<10	<10	24	<0.1	<0.1	9.4	1.4	<2	<2	<2	<2				
9-10[d]	5.0	<10	<10	25	0.2	<0.1	11.1[g]	1.2	<2	<2	<2	<2				
9-10[a]	5.0	<5	73[c]	--	<5	<5	140	<5	<5	<5	<5	<5				4
9-11	6.0	No Water, No Sample														
9-11	8.0	No Water, No Sample														
9-11	9.0	<10	<10	<10	<0.1	<0.1	0.5	<0.1	<2	<2	<2	<2				
9-12[f]	0.5															
9-12[e,f]	1.0															
10-1	8.0	No Water, No Sample														
10-1[f]	9.0	<10	4.2	19	<0.1	<0.1	4.1	0.3	<2	<2	<2	4				
10-2[f]	0.5															
10-2[f]	1.0															
10-2	8.0	No Water, No Sample														
10-2[f]	9.0	<10	<10	<10	<0.1	<0.1	2.9	<0.1	<2	<2	<2	4				
10-3	8.0	<10	<10	19	<0.1	<0.1	0.1	<0.1	<2	<2	<2	11				
10-4[e]	6.0	No Water, No Sample														
10-4[e,f]	7.5	No Water, No Sample														
10-5	8.0	No Water, No Sample														
10-5	10.5	No Water, No Sample														
10-6[f]	7.0	No Water, No Sample														
10-7	8.0	No Water, No Sample														
10-7	5.0	<10	<10	29	<0.1	<0.1	2.1	0.2	<2	4.2	<2	<2				
10-8	5.0	<10	11.5	23.1	<0.1	<0.1	4.5	0.4	<2	4.9	<2	<2				
10-8[a]	5.0	<5	35[c]	--	<5	<5	3	<5	<5	<5	<5	<5				

TABLE 1 (Cont.)

Sample	Depth (ft)	1,1-Dichloroethene (µg/L)	Trans 1,2-Dichloroethene (µg/L)	Cis 1,2-Dichloroethene (µg/L)	1,1,1-Trichloroethane (µg/L)	Carbon Tetrachloride (µg/L)	Trichloroethylene (µg/L)	Tetrachloroethylene (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl Benzene (µg/L)	o-Xylene (µg/L)	Unknown Dichlorobenzene (µg/L)	Unknown (µg/L)	Acetone (µg/L)	Vinyl Chloride (µg/L)
10-9	8.0	<10	<10	<10	<0.1	<0.1	3.5	<0.1	<2	<2	<2	<2				
10-10[e]	8.0	No Water, No Sample														
10-10	10.5	No Water, No Sample														
11-0[e]	5.0	No Water, No Sample														
11-0[f]	7.0	No Water, No Sample														
11-1	5.0	No Water, No Sample														
11-1	10.5	No Water, No Sample														
11-2	8.0	No Water, No Sample														
11-2	10.5	No Water, No Sample														
11-3	8.0	No Water, No Sample														
11-3	10.5	No Water, No Sample														
11-4	8.0	No Water, No Sample														
11-4	10.5	No Water, No Sample														
11-5[e]	10.0	<10	<10	<10	<0.1	<0.1	0.4	0.2	<2	2.1	<2	<2				
11-6[f]	7.0	No Water, No Sample														
11-7[f]	5.0	No Water, No Sample														
11-7[f]	7.0	No Water, No Sample														
11-8[f]	9.0	No Water, No Sample														
11-8[f]	10.0	No Water, No Sample														
11-9[f]	10.5	No Water, No Sample														
11-9[f]	11.0	No Water, No Sample														
11-10[e]	8.0	<10	<10	<10	1	<0.1	1.1	0.1	<2	<2	<2	<2				
11-10	10.5	No Water, No Sample														
11-10[a]	8.0	<5	3[c]	--	<5	<5	<5	<5	<5	<5	<5	<5			28	

TABLE 2 PURGE AND TRAP OPERATING PARAMETERS

P&T Model:	Tekmar
Trap Packing:	Tenax
Vessel Capacity:	5 ml
Purge Gas:	Helium at 40 mL/min
Purge Temperature:	30 c
Purge Time Total:	11 min (8 min sample purge)
Dry Purge Time:	3 min
Desorb Temperature:	180 c
Desorb Time:	4 min
Bake-out Temperature:	220 c
Bake-out Time:	5 min

TABLE 3 GAS CHROMATOGRAPHIC OPERATING PARAMETERS

GC Model: Varian 3300

Column/Detector Configuration:

Column(s) used:

Column: Altech AT-624 0.53mm x 30m fused silica capillary

carrier gas: Helium
carrier flow rate 5mL/min
(or 5 psi capillary column pressure) at 40°C

Column 1 connected to ECD/FID detector(s)

Make-up Gas:

40 mL/min of Nitrogen gas into ECD detector
40 mL/min of Nitrogen gas into FID detector

Detector Sensitivity Settings:

Range 10, ECD Detector set at GC attn: = 8, int/comp attn: 256
Range 11, FID Detector set at GC attn: = 8, int/comp attn: 4

Injection Port temperature: 190

Detector Temperature: 250

Oven temperature program: 40°C hold 10 min, 4°C/min to 180°C hold 60 min

Standards	Concentration µg/L
1,1 Dichloroethene	122
Cis-1,2 Dichloroethene	128
Trans-1,2 Dichloroethene	126
Benzene	87.8
Toluene	86.7
Ethylbenzene	86.7
O-Xylene	88.0
1,1,1 Trichloroethane	5.32
Carbon Tetrachloride	3.18
Trichloroethene	5.84
Tetrachloroethene	3.24
Bromodichloromethane (Internal Std)	1.6

TABLE 4 STATIC WATER LEVELS IN MONITORING WELLS AT MARSH RUN PARK LANDFILL, 18 APRIL 1990

Monitoring Well	Depth to Water
MW 1A	10′ - 6½"
MW 2A	5′ - 11"
MW 3A	5′ - 11½"
MW 4A	9′ - 2"
MW 5A	5′ - 3½"

TABLE 5 SUMMARY OF AQUIFER HYDRAULIC CONDUCTIVITY AT MARSH RUN PARK DETERMINED FROM SLUG TEST CONDUCTED ON SITE MONITORING WELLS 9 FEBRUARY AND 17 AUGUST 1989

Well No.	Aquifer Interval Tested	Hydraulic Conductivity (cm/sec)	Hydraulic Conductivity (ft/day)
MW-1	Shallow bedrock	8.6×10^{-4}	2.4
MW-4	Shallow bedrock	6.8×10^{-4}	1.9
MW-5	Shallow bedrock	1.79×10^{-5}	0.05
MW-4A	Unconsolidated overburden	2.8×10^{-5}	0.08
MW-5A	Unconsolidated overburden	1.3×10^{-4}	0.37
MW-2	Shallow bedrock	1.3×10^{-3}	3.6
MW-6	Shallow bedrock	2.5×10^{-5}	0.07
MW-6A	Unconsolidated overburden	4.3×10^{-5}	0.12
MW-7	Shallow bedrock	1.5×10^{-3}	4.32
MW-7A	Unconsolidated overburden	5.5×10^{-5}	0.14
WP-1	Landfill waste/fill	$>1 \times 10^{-2}$ (a)	>28.3
MW-3A (b)	Landfill fill	4.5×10^{-3}	13
MW-2A (b)	Landfill fill	7×10^{-4}	1.98
MW-1A (b)	Reworked fill	2×10^{-2}	57

(a) No recorded change in initial water level WP-1 due to introduction of slug suggests high hydraulic conductivity in excess of 1×10^{-2} cm/sec (i.e., water level equilibrium reached in less than 0.1 minute).

(b) Hydraulic conductivity values reported by Woodward-Clyde Consultants.

APPENDIX A

CHROMATOGRAMS GENERATED AT MARSH RUN PARK, 16 APRIL TO 27 APRIL 1990

APPENDIX B

GROUND-WATER SAMPLING YIELD CALCULATIONS

Project NCAD
Subject effect of conductivity variation on probe water extraction rates.
Computed by SMD Date 20 July 90 Checked by _____ Date _____
Project No. _____ Sheet No. ____ of ____ Drawing No. _____

Compare the impact of varying material hydraulic conductivity on extraction rate of 3/4" pipe in fill.

Known conditions

- Vapor probe = 3/4" = .0325 ft radius (r_2)
- shallow water zone ± 5 ft (y_1)
- hydraulic conductivity fill material: (K), Per RI

MW-1A	57 f/d
MW-2A	1.98 f/d
MW-4A	.08 f/d (fill material)

Unknown conditions

- draw down depth during sampling
- radius of influence during sampling

assume these conditions for comparison purposes as:

$r_1 = 1$ ft
$y_2 = 4$ ft (5-1)

Druit EQ

$$Q = \frac{\pi K (y_1^2 - y_2^2)}{86{,}400 \cdot \ln(r_1/r_2)}$$

Substituting y_1, y_2, r_1, r_2 at different K values yields the following:

K	Qcfs	Qgpm
57 f/d	.00538	2.4
1.98 f/d	.000187	.084
.08 f/d	.0000075	.0034

Since site material conductivity could have possably varied by as much as 7/2 it is feasable that water samples could not be sampled with site equipment at all locations.

EA 0289B 7/13/89

APPENDIX C

SAFE DRINKING WATER ACT
MCLs, MCLGs, HEALTH ADVISORIES, AND SMCLs
AS OF MARCH 1989

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Acifluorofen [4] (5094-66-6)	2,000	200	100	400	NA	NA					1.0	B_2	
Acrylamide (79-06-1)	300	300	20	70	NA	NA	[5] 0		[5] TT		0.01	B_2	NA
Alachlor[4] (15972-60-8)	100	100			NA	NA	[5] 0		[5] 2		0.40	B_2	2
Aldicarb (116-06-3)	10	10	10	40	40	10	[5] 10		[5] 10		NA	D	
Aldicarb Sulfoxide [4]	10	10	10	40	40	10	[5] 10		[5] 10		NA	D	
Aldicarb Sulfone [4]	60	60	60	200	200	40	[5] 40		[5] 40		NA	D	
Ametryn (834-12-8)	9,000	9,000	900	3,000	300	60					NA	D	
Ammonium Sulfamate (7773-06-0)	20,000	20,000	20,000	80,000	8,000	2,000					NA	D	
Arsenic (7440-38-2)					35		[5] 0			50	0.03	A	5
Asbestos (long fibers > 10 um) (12001-29-5)					NA	NA	[1,5] 7.0 MFL		[1,5] 7.0 MFL		[1] 7.0 MFL	C/A	
Atrazine[4] (1912-24-9)	100	100	50	200	200	3	3		3		NA	C	1
Barium (14798-08-4)	5,000	5,000	5,000	5,000		5,000	[5] 5,000		[5] 5,000	1,000	NA	D	150
Baygon (114-26-1)	40	40	40	100	100	3					NA	C	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Bentazon[4] (25057-89-0)	300	300	300	900	90	20					NA	D	
Benzene[4] (71-43-2)	200	200			NA	NA		0	5	5	1.0	A	5
Benzo (a) pyrene (50-32-8)												B_2	
Bromacil[4] (314-40-9)	5,000	5,000	3,000	9,000	5,000	90					NA	C	
Bromobenzene (108-86-1)													5
Bromodichloromethane (75-27-4)					70					[3] 100			5
Bromoform (75-2-2)					700					[3] 100			5
Bromomethane (74-83-9)													5
Butylate (2008-41-5)	2,000	2,000	1,000	1,000	4,000	700					NA	D	
Cadmium[4] (7440-43-9)	40	40	5	20	20	5	[5] 5		[5] 5	10	NA	D/B	5
Carbaryl (63-25-2)	1,000	1,000	1,000	1,000	4,000	700					NA	D	
Carbofuran (1553-66-2)	50	50	50	200	200	40	[5] 40		[5] 40		NA	E	7
Carbon Tetrachloride[4] (56-23-5)	4,000	200	70	300	NA	NA		0	5	5	0.30	B_2	5

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Carboxin (5234-68-4)	1,000	1,000	1,000	4,000	4,000	700					NA	D	
Chloramben[4] (133-90-4)	3,000	3,000	200	500	500	100					NA	D	
Chlordane[4] (57-74-9)	60	60	0.50	0.50	NA	NA	[5] 0		[5] 2		0.03	B_2	2
Chlorobenzene (mono)[4] (108-90-7)	2,000	2,000	2,000	7,000	700	100	[5] 100		[5] 100		NA	D	5
Chlorodibromomethane (124-48-1)					70					[3] 100			5
Chloroethane (75-00-3)													5
Chloroform[4] (67-66-3)					350					[3] 100	6.0	B_2	5
Chloromethane (74-87-3)													5
2-Chlorophenol[4] (95-57-8)					200	40					NA	D	
2,4-Chlorophenol[4] (120-83-2)					100	20					NA	D	
2,4,6-Chlorophenol[4] (88-06-2)											3.0	B_2	
o-Chlorotoluene[4] (95-49-8)					700	140					NA	D	5
p-Chlorotoluene[4] (106-43-4)					4	0.8					NA	D	5

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Chlorothalonil [4] (1897-45-6)	200	200	200	500	NA	NA					2.0	B_2	
Chromium (total) (7440-47-3)	1,000	1,000	200	800	200	100	[5] 100		[5] 100	50	NA	D/A	10
Cyanazine (21725-46-2)	100	100	20	70	70	10					NA	D	
Cyanide [4] (57-12-5)	200	200	200	800	800	200					NA	D	
Dacthal [4] (1861-32-1)	80,000	80,000	5,000	20,000	20,000	4,000					NA	D	
Dalapon [4] (75-99-0)	4,000	4,000	300	900	900	200					NA	D	
Diazinon [4] (333-41-5)	20	20	5	20	3.0	0.6					NA	E	
1,2-Dibromo-3-Chloropropane (DBCP) (96-12-8)	200	50			NA	NA	[5] 0		[5] 0.20		0.03	B_2	0.20
Dibrombomethane (74-95-3)											NA	D	5
Dicamba (1918-00-0)	300	300	300	1,000	1,000	200					NA	D	
m-Dichlorobenzene [4] (541-73-1)	9,000	9,000	9,000	30,000	3,000	600	[4] 600		[4] 600		NA	D	5
o-Dichlorobenzene [4] (95-50-1)	9,000	9,000	9,000	30,000	3,000	600	[5] 600		[5] 600		NA	D	5
p-Dichlorobenzene [4] (106-46-7)	10,000	10,000	10,000	40,000	4,000	75		75		75	NA	C	5
1,1-Dichloroethane (75-34-3)						938					NA	C	5

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
1,2-Dichloroethane [4] (107-06-2)	700	700	700	2,600	NA	NA		0		5	0.4	B_2	5
1,1-Dichloroethylene (75-35-4)	2,000	1,000	1,000	4,000	400	7		7		7	NA	C	5
cis-1,2-Dichloroethylene (156-59-2)	4,000	1,000	1,000	1,000	400	70	[5] 70		[5] 70		NA	D	5
trans-1,2-Dichloroethylene [4] (156-60-5)	20,000	2,000	2,000	6,000		100	100		100		NA	D	5
Dichloromethane (75-09-2)	10,000	2,000			NA	NA					5	B_2	5
2,4-Dichlorophenoxyacetic Acid (94-75-7)	1,000	300	100		400	70	[5] 70		[5] 70	100	NA	D	1
1,2-Dichloropropane (78-87-5)		90					[5] 0		[5] 5		0.6	B_2	5
1,3-Dichloropropane (142-28-9)													5
2,2-Dichloropropane (590-20-7)													5
1,1-Dichloropropene (563-58-6)													5
1,3-Dichloropropene (542-75-6)	30	30	30	100	NA	NA					0.2	B_2	5
Dieldrin [4] (60-57-1)	0.5	0.5	0.5	2	NA	NA					0.002	B_2	
Dimethrin (67239-16-1)	10,000	10,000	10,000	40,000	10,000	2,000					NA	D	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Dinoseb [4] (88-85-7)	300	300	10	40	40	7					NA	D	
p-Dioxane (123-91-1)	4,000	400			NA	NA					7	B_2	
Diphenamid (957-51-7)	300	300	300	1,000	1,000	200					NA	D	
Disulfoton (298-04-4)	10	10	3	9	1	0.3					NA	E	
Diuron [4] (330-54-1)	1,000	1,000	300	900	70	10					NA	D	
Endothall [4] (145-73-3)	800	800	200	200	700	100					NA	D	
Endrin [4] (72-20-8)	20	5	5	20	2	0.3				0.2	NA	E	
Epichlorohydrin [4] (106-89-8)	100	100	70	70	NA	NA	[5] 0		[5] TT		4.0	B_2	NA
Ethylbenzene (100-41-4)	30,000	3,000	1,000	3,000	3,000	700	[5] 700		[5] 700		NA	D	5
Ethylene Dibromide (EDB) (106-93-4)	8	8			NA	NA	[5] 0		[5] 0.05		0.0004	B_2	0.05
Ethylene Glycol [4] (107-21-1)	20,000	6,000	6,000	20,000	40,000	7,000					NA	D	
Ethylene Thiourea [4] (96-45-7)	300	300	100	400	NA	NA					0.20	B_2	
Fenamiphos [4] (22224-92-6)	9	9	5	20	9	2					NA	D	
Fluometuron [4] (2164-17-2)	2,000	2,000	2,000	5,000	400	90					NA	D	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Fonofos[4] (944-22-9)	20	20	20	70	70	10					NA	D	
Glyphosate (1071-83-6)	20,000	20,000	1,000	1,000	4,000	700					NA	D	
Heptachlor[4] (76-44-8)	10	10	5	5	NA	NA	[5]0		[5]0.4		0.008	B_2	0.4
Heptachlor Epoxide[4] (1024-57-3)	10		0.10	0.10	NA	NA	[5]0		[5]0.2		0.004	B_2	0.2
Hexachlorobenzene (118-74-1)	50	50	50	200	NA	NA					0.02	B_2	
n-Hexane[4] (110-54-3)	10,000	4,000	4,000	10,000							NA	D	
Hexazinone[4] (51235-04-2)	3,000	3,000	3,000	9,000	1,000	200					NA	D	
Lead (entering distribution system) (7439-92-1)							[5]0		[5]5	50	NA	B_2	5
Lead (at tap) (7439-92-1)							[5]0		[5]TT	50	NA	B_2	5
Lindane (58-89-9)	1,000	1,000	30	100	10	0.2	[5]0.2		[5]0.2	4	NA	C	0.2
Maleic Hydrazide (123-33-1)	10,000	10,000	5,000	20,000	20,000	4,000					NA	D	
Mercury[4] (7439-97-6)					10	2	[5]2		[5]2	2	NA	D	0.5
Metolachlor (51218-45-2)	2,000	2,000	2,000	5,000	5,000	100					NA	C	
Methomyl[4] (16752-77-5)	300	300	300	300	900	200					NA	D	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Methoxychlor (72-43-5)	6,000	2,000	500	2,000	2,000	400	[5] 400		[5] 400	100	NA	D	1
Methylchlorophenoxyacetic Acid (MCPA) (94-74-9)	100	100	100	400	20	4					NA	D	
Methyl Ethyl Ketone [4] (78-93-3)	80,000	8,000	3,000	9,000	900	200					NA	D	
Methyl Parathion (298-00-0)	300	300	30	100	9	2					NA	D	
Metribuzin [4] (21087-64-9)	5,000	5,000	300	900	900	200					NA	D	
Nickel [4] (7440-02-0)	1,000	1,000	200	700	700	200					NA	D/B	
Nitrate-Nitrogen plus Nitrite-Nitrogen (total) (14797-55-88 and 14797-65-0)							[5] 10,000		[5] 10,000		NA	D	400
Nitrate-Nitrogen (14797-55-88)	[2] 10,000	[2] 10,000	[2] 10,000	[2] 10,000	[2] 10,000	[2] 10,000	[2] 10,000			10,000	NA	D	400
Nitrite-Nitrogen (14797-65-0)	[2] 1,000	[2] 1,000	[2] 1,000	[2] 1,000	[2] 1,000	[2] 1,000	[5] 1,000		[5] 1,000		NA	D	400
Oxamyl (Vydate) [4] (23135-22-0)	200	200	200	900	900	200					NA	E	
Paraquat [4] (1910-42-5)	100	100	50	200	200	30					NA	E	
Pentachlorophenol (87-86-5)	1,000	300	300	1,000	1,000	0/200	[5] 0/200		[5] 200				
Phenol [4] (108-95-2)					21,000						NA	D	
Pichloram [4] (1918-02-01)	20,000	20,000	700	2,000	2,000	500					NA	D	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Polychlorinated Biphenyls (PCBs)[4] (1336-36-3)			1	4	NA	NA	[5]0		[5]0.5		0.005	B_2	0.5
Prometon (1610-18-0)	200	200	200	500	500	100					NA	D	
Pronamide[4] (23950-58-5)	800	800	800	3,000	3,000	50					NA	C	
Propachlor[4] (1918-16-7)	500	500	100	500	500	90					NA	D	
Propazine[4] (139-40-2)	1,000	1,000	500	2,000	700	10					NA	C	
Propaham[4] (122-42-9)	5,000	5,000	5,000	20,000	600	100					NA	D	
Selenium							[5]50		[5]50	10			10
Simazine (122-34-9)	500	500	50	200	200	4					NA	C	
Styrene[4] (100-42-5)	20,000	2,000	2,000	7,000	NA	NA	[5]0		[5]5		0.01	B_2	5
Tebuthiuron[4] (34014-18-1)	3,000	3,000	700	2,000	2,000	500					NA	D	
Terbacil[4] (5902-51-2)	300	300	300	900	400	90					NA	E	
Terbufos[4] (13071-79-9)	5	5	1	5	5	0.9					NA	D	
2,3,7,8-Tetrachlorodibenzo-p-Dioxin (1746-01-6)	0.001	0.0001	0.00001	0.00004	NA	NA					2.0×10^{-7}	B_2	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-4} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
1,1,1,2-Tetrachloroethane[4] (630-20-6)					1,050						NA	D	5
1,1,2,2-Tetrachloroethane[4] (79-34-5)											NA	C	5
Tetrachloroethylene[4] (127-18-4)	2,000	2,000	1,000	5,000	NA	NA	[5]0		[5]5		0.7	B_2	5
Toluene[4] (108-88-3)	20,000	3,000	3,000	10,000	10,000	2,000	[5]2,000		[5]2,000		NA	D	5
Toxaphene (8001-35-2)	500	40			NA	NA	[5]0		[5]5	5	0.03	B_2	5
1,1,1-Trichloroethane[4] (71-55-6)	100,000	40,000	40,000	100,000	1,000	200		200	200	200	NA	D	5
1,1,2-Trichloroethane[4] (79-00-5)					1,050						NA	C	5
Trichloroethylene[4] (79-01-6)					NA	NA		0	5	5	3	B_2	5
2,4,5 Trichlorophenoxyacetic Acid (93-76-5)	800	800	800	1,000	350	70					NA	D	
2,4,5-Trichlorophenoxy-propionic Acid (Silvex) (93-72-1)	200	200	70	70	300	50	[5]50		[5]50	10	NA	D	0.2
1,2,3-Trichloropropane[4] (96-18-4)					210						NA	D	5
Trifluralin (1582-09-8)	30	30	30	30	100	2					NA	C	

CONTAMINANT SUMMARY TABLE

CHEMICAL (CAS Number)	NON-CARCINOGENIC ADVISORIES (µg/l)						REGULATORY LEVELS				CARCINOGENIC POTENTIAL		PQL (µg/l)
	ONE-DAY	TEN-DAY	LONGER-TERM		LIFETIME		MCLG (µg/l)		MCL (µg/l)		EPA 10^{-6} Cancer Risk (µg/l)	EPA Carcinogen Group	
			10 kg Child	70 kg Adult	DWEL	RSC Applied	Proposed	Final	Proposed	Final			
Vinyl Chloride[4] (75-01-4)	3,000	3,000	10	50	NA	NA		0	2	2	0.015	A	3
Vydate (Oxamyl)[4] (23135-22-0)	200	200	200	900	900	**200**					NA	E	
Xylenes (Total)[4] (1330-20-7)	40,000	40,000	40,000	10,000	60,000	10,000	[5] 10,000		[5] **10,000**		NA	D	5

Notes:
- CAS = Chemical Abstracts Service
- DW = Drinking Water
- NA = Not Appropriate
- PQL = Practical Quantitation Level
- RSC = Relative Source Contribution
- TT = Treatment Technique

1 Million fibers per liter (MFL)
2 Based on 4 kg infant
3 Based on TTHM MCL of 100 ug/l total for 4 THMS
4 EPA Region 3 (update) list - December 1988
5 Draft Phase II Federal Register Notice - March 1988

Where more than one EPA carcinogen group is indicated for a contaminant, (i.e., D/B) the first is based on ingestion (usually the basis for regulation) and the second on inhalation.

The source of all numbers, with the exception of those footnoted, is the published draft EPA Health Advisories. Where a footnote appears next to a chemical name, all numbers in that row correspond to the footnoted source unless another footnote appears next to a number in that row.

THE MAXIMUM UNREGULATED CONTAMINANT CONCENTRATION (IF APPLICABLE) IS LISTED IN LARGER BOLD PRINT FOR AS MANY UNREGULATED CONTAMINANTS AS POSSIBLE.

SECONDARY MAXIMUM CONTAMINANT LEVELS

Chemicals	Status*	SMCLs (mg/l)
Aluminum	P	0.05
Chloride	F	250
Color	F	15 color units
Copper	F	1
Corrosivity	F	non-corrosive
Dichlorobenzene -o	P	0.01
Dichlorobenzene -p	P	0.005
Ethylbenzene	P	0.03
Fluoride	F	2
Foaming Agents	F	0.5
Hexachlorocyclopentadiene		0.008
Iron	F	0.3
Manganese	F	0.05
Odor	F	3 threshold odor numbers
Pentachlorophenol	P	0.03
pH	F	6.5 - 8.5
Silver	P	0.09
Sulfate	F	250
Toluene	P	0.04
Total Dissolved Solids (TD)	F	500
Xylene	P	0.02
Zinc	F	5

* Status Codes: P - proposed, F - final

APPENDIX D

CLEAN WATER ACT
WATER QUALITY CRITERIA
AS OF JANUARY 1990

Appendix A

Water Quality Criteria for Toxic Substances

Table 1 lists the human health and aquatic life criteria for toxic substances which the Department will use in development of effluent limits in NPDES permits. The human health criteria are further defined as to the specific effect (that is, carcinogenicity, taste and odor, general health). For those aquatic life criteria which are hardness related and specified as a formula, such as several of the heavy metals, criteria for hardness values of 50, 100 and 200 are provided as examples. The Department will use the specific hardness of the receiving stream in calculating criteria on a case-by-case basis for these substances. The parameters are grouped according to chemical/analytical properties and denoted alphanumerically: M = Metals; A = Acid Soluble; V = Volatile; B = Base Neutral; and P = Pesticide. Some of these criteria may be superseded for Drainage Lists W (Ohio River Basin) and X (Lake Erie Basin) under interstate and international compact agreements with Ohio River Valley Sanitation Commission and International Joint Commission, respectively. See Section 93.9 (relating to designated water uses and water quality criteria) for specific parameters and criteria.

Acronyms and Footnotes to Table 1

H	=	Threshold effect human health criterion.
CRL	=	Cancer risk level criterion at 1×10^{-6}.
T&O	=	Taste and odor criterion.
1nH	=	Natural logarithm of the hardness of stream as mg/l $CaCO_3$.
N/A	=	Insufficient data to develop criterion.
b	=	Criterion is for total of halomethanes (5V + 8V + 12V + 20V + 21V) present.
c	=	Criterion is for total dichlorobenzenes (20B + 21B + 22B) present.
d	=	Criterion is for total PCBs (18P + 19P + 20P + 21P + 22P + 23P + 24P).

See 25 Pa. Code Chapter 16 for specific details.

Refer to 25 Pa. Code Chapter 93 for other specific Water Quality Standards.

APPENDIX A
Potential Chemical - Specific Applicable or Relevant/Appropriate Requirements

Table 1
Water Quality Criteria for Toxic Substances

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
1M	Antimony	07440360	219	1095	145	H
2M	Arsenic	07440382	190 (As3 +)	360 (As3 +)	50	H
3M	Beryllium	07440417	0.01 x 96Hr LC50	0.05 x 96hr LC50	0.007	CRL
4M	Cadmium	07440439	Exp (0.7852[1nH] - 3.490) @H = 50 100 200 Crit = 0.66 1.1 2.0	Exp (1.128[1nH] - 3.828) @H = 50 100 200 Crit = 1.8 3.9 8.6	10	H
5M	Chromium, Total	07440473	11 + Exp (0.8190[1nH] + 1.561) @H = 50 100 200 Crit = 131 221 381	16 + Exp (0.8190[1nH] + 3.688) @H = 50 100 200 Crit = 996 1716 3116	170,050	H
5M	Chromium, VI	07440473	11	16	50	H
6M	Copper	07440508	Exp (0.8545[1nH] - 1.465) @H = 50 100 200 Crit = 6.5 12 21	Exp (0.9422[1nH] - 1.464) @H = 50 100 200 Crit = 9.2 18 34	1,000	T&O
7M	Lead	07439921	Exp (1.266[1nH] - 4.661) @H = 50 100 200 Crit = 1.3 3.2 7.7	Exp (1.266[1nH] - 1.416) @H = 50 100 200 Crit = 34 82 200	50	H
8M	Mercury	07439976	0.012	2.4	0.144	H
9M	Nickel	07440020	Exp (0.8460[1nH] + 1.1645) @H = 50 100 200 Crit = 88 160 280	Exp (0.8460[1nH] + 3.3612) @H = 50 100 200 Crit = 790 1,400 2,500	632	H

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
10M	Selenium	07782492	5	20	10	H
11M	Silver	07440224	0.2	Exp (1.72[lnH] - 6.52) @H = 50 100 200 Crit = 1.2 4.1 1.3	50	H
12M	Thallium	07440280	18	90	13	H
13M	Zinc	07440666	Exp (0.8473[lnH] + 0.7614) @H = 50 100 200 Crit = 59 110 190	Exp (0.8473[lnH] + 0.8604) @H = 50 100 200 Crit = 65 120 210	5,000	T&O
14M	Cyanide, Free	00057125	5	22	200	H
15M	Phenolics (Total Phenols)	---	20	100	5 (at water supply intake)	T&O
1A	2-Chlorophenol	00095578	20	100	0.1	T&O
2A	2,4-Dichlorophenol	00120832	337	1685	0.3	T&O
3A	2,4-Dimethylphenol	00105679	132	660	400	T&O
4A	4,6-Dinitro-o-Cresol	00534521	16	80	13.4	H
5A	2,4-Dinitrophenol	00051285	131	655	70	H
6A	2-Nitrophenol	00088755	20	100	N/A	-
7A	4-Nitrophenol	00100027	467	2335	N/A	-
8A	p-Chloro-m-Cresol	00059507	31	155	3,000	T&O
9A	Pentachlorophenol	00087865	Exp (1.005[pH] - 5.290) @pH = 6.5 7.8 9.0 Crit = 3.5 13 43	Exp (1.005[pH] - 4.830) @pH = 6.5 7.8 9.0 Crit = 5.5 20 68	30	T&O

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
10A	Phenol	00108952	20	100	300	T&O
11A	2,4,6-Trichlorophenol	00088062	91	455	1	CRL
1V	Acrolein	00107028	1	5	320	H
2V	Acrylonitrile	00107131	129	645	0.06	CRL
3V	Benzene	00071432	128	640	1	CRL
4V	(Deleted)					
5V	Bromoform	00075252	365	1,825	0.2(b)	CRL
6V	Carbon Tetrachloride	00056235	556	2,780	0.3	CRL
7V	Chlorobenzene	00108907	236	1,180	20	T&O
8V	Chlorodibromomethane	00124481	N/A	N/A	0.2(b)	CRL
9V	Chloroethane	00075003	N/A	N/A	N/A	-
10V	2-Chloroethyle Vinyl Ether	00110758	3,500	17,500	N/A	-
11V	Chloroform	00067663	389	1,945	0.2	CRL
12V	Dichlorobromomethane	00075274	N/A	N/A	0.2(b)	CRL
14V	1,1-Dichloroethane	00075343	N/A	N/A	N/A	-
15V	1.2-Dichloroethane	00107062	3,088	15,440	0.4	CRL
16V	1,1-Dichloroethylene	00075354	1,492	7,460	0.06	CRL
17V	1,2-Dichloropropane	00078875	2,165	10,825	N/A	-
18V	1,3-Dichloropropylene	00542756	61	305	87	H

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
19V	Ethylbenzene	00100414	580	2,900	1,400	H
20V	Methyl Bromide	00074839	110	550	0.2(b)	CRL
21V	Methyl Chloride	00074873	5,500	27,500	0.2(b)	CRL
22V	Methylene Chloride	00075092	2,368	11,840	5	CRL
23V	1,1,2,2-Tetrachloroethane	00079345	208	1,040	0.2	CRL
24V	Tetrachloroethylene	00127184	139	695	0.7	CRL
25V	Toluene	00108883	330	1,650	14,300	H
26V	1,2-trans-Dichloroethylene	00156605	1,350	6,750	350	H
27V	1,1,1-Trichloroethane	00071556	605	3,025	1,000	H
28V	1,1,2-Trichloroethane	00079005	678	3,390	0.6	CRL
29V	Trichloroethylene	00079016	450	2,250	3	CRL
30V	(Deleted)					
31V	Vinyl Chloride	00075014	N/A	N/A	0.02	CRL
1B	Acenaphthene	00083329	17	85	20	T&O
2B	Acenaphthylene	00208968	N/A	N/A	0.003	CRL
3B	Anthracene	00120127	N/A	N/A	0.003	CRL
4B	Benzidine	00092875	59	295	0.0001	CRL
5B	Benzo(a)Anthracene	00056553	0.1	0.5	0.003	CRL
6B	Benzo(a)Pyrene	00050328	N/A	N/A	0.003	CRL

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
7B	3,4-Benzofluoranthene	00205992	N/A	N/A	0.003	CRL
8B	Benzo(ghi)Perylene	00191242	N/A	N/A	0.003	CRL
9B	Benzo(k)Fluoranthene	00207089	N/A	N/A	0.003	CRL
10B	Bis(2-Chloroethoxy) Methane	00111911	N/A	N/A	N/A	-
11B	Bis(2-Chloroethyl) Ether	00111444	6,000	30,000	0.03	CRL
12B	Bis(2-Chloroisopropyl) Ether	00108601	N/A	N/A	34.7	H
13B	Bis(2-Ethtlhexyl) Phthalate	00117817	909	4,545	15,000	H
14B	4-Bromophenyl Phenyl Ether	00101553	54	270	N/A	-
15B	Butylbenzyl Phthalate	00085687	35	140	N/A	-
16B	2-Chloronaphthalene	00091587	N/A	N/A	N/A	-
17B	4-Chlorophenyl Phenyl Ether	07005723	N/A	N/A	N/A	-
18B	Chrysene	00218019	N/A	N/A	0.003	CRL
19B	Dibenzo (a,h) Anthracene	00053703	N/A	N/A	0.003	CRL
20B	1,2-Dichlorobenzene	00095501	164	820	400(c)	H
21B	1,3-Dichlorobenzene	00541731	69	345	400(c)	H
22B	1,4-Dichlorobenzene	00106467	146	730	400(c)	H
23B	3,3'-Dichlorobenzidine	00091941	N/A	N/A	0.01	CRL

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
24B	Diethyl Phthalate	00084662	800	4,000	350,000	H
25B	Dimethyl Phthalate	00131113	495	2,475	313,000	H
26B	Di-n-Butyl Phthalate	00084742	21	105	34,000	H
27B	2,4-Dinitrotoluene	00121142	318	1,590	0.1	CRL
28B	2,6-Dinitrotoluene	00606202	198	990	N/A	-
29B	Di-n-Octyl Phthalate	00117840	N/A	N/A	N/A	-
30B	1,2-Diphenylhydrazine	00122667	3	15	0.04	CRL
31B	Fluoranthene	00206440	40	200	42	H
32B	Fluorene	00086737	N/A	N/A	0.003	CRL
33B	Hexachlorobenzene	00118741	N/A	N/A	0.0007	CRL
34B	Hexachlorobutadiene	00087683	2	10	0.5	CRL
35B	Hexachlorocyclopentadiene	00077474	1	5	1	T&O
36B	Hexachloroethane	00067721	12	60	2	CRL
37B	Indeno (1,2,3-cd) Pyrene	00193395	N/A	N/A	0.003	CRL
38B	Isophorone	00078591	2,080	10,400	5,200	H
39B	Naphthalene	00091203	43	135	10	T&O
40B	Nitrobenzene	00098953	808	4,040	30	T&O

Table 1 (Continued)

PP No.	Chemical Name	CAS Number	Fish and Aquatic Life Criteria		Human Health Criteria (ug/l)	
			Criteria Continuous Concentrations (ug/l)	Criteria Maximum Concentrations (ug/l)		
41B	N-Nitrosodimethylamine	00062759	3,420	17,100	0.001	CRL
42B	N-Nitrosodi-n-Propylamine	00621647	N/A	N/A	0.0008	CRL
43B	N-Nitrosodiphenylamine	00086306	59	295	5	CRL
44B	Phenanthrene	00085018	1	5	0.003	CRL
45B	Pyrene	00129000	N/A	N/A	0.003	CRL
46B	1,2,4-Trichlorobenzene	00120821	26	130	700	H
1P	Aldrin	00309002	0.1	0.5	0.00007	CRL
2P	alpha-BHC	00319846	N/A	N/A	0.009	CRL
3P	beta-BHC	00310857	N/A	N/A	0.02	CRL
4P	gamma-BHC (Lindane)	00058899	0.08	2	0.02	CRL
5P	delta-BHC	00319868	N/A	N/A	N/A	-
6P	Chlordane	00057749	0.0043	2.4	0.0005	CRL
7P	4,4'-DDT	00050293	0.001	1.1	0.00002	CRL
8P	4,4'-DDE	00072559	0.001	1.1	N/A	-
9P	4,4'-DDD	00072548	0.001	1.1	N/A	-
10P	Dieldrin	00060571	0.0019	2.5	0.00007	CRL
11P	alpha-Endosulfan	00095988	0.056	0.22	74	H
12P	beta-Endosulfan	33212659	0.056	0.22	74	H
13P	Endosulfan Sulfate	01031078	N/A	N/A	74	-