DRAFT PROPOSED TAR REMOVAL WORK PLAN

TAR LAKE SITE
ANTRIM, MICHIGAN

Prepared for:

56th Century Antrim Iron Works
Antrim, Michigan

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August 26, 1997

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List of Acronyms

AFFF	aqueous film-forming foam
AIW	Antrim Iron Works
Btu/lb	British thermal unit per pound
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CFR	Code of Federal Regulations
CPVC	chlorinated PVC
CY	cubic yard
ft^2	square feet
gpm	gallons per minute
HASP	Health and Safety Plan
MDEQ	Michigan Department of Environmental Quality
MDOT	Michigan Department of Transportation
NCP	National Contingency Plan
NPL	National Priorities List
OSHA	Occupational Safety and Health Administration
ppb	parts per billion
PPE	Personal Protective Equipment
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SVOCs	Semivolatile organic compounds
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
μg/L	micrograms per liter
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
VOCs	Volatile organic compounds

Based on a comparison between a 1938 and a 1984 aerial photographs of the site, it appears that Tar Lake has shrunk in area by more than 50% (see Figure 1-2). Tar Lake caught fire in the 1960s and burned for an unspecified time before being extinguished by natural action. There is also evidence of ongoing natural biological degradation of tar. Specifically, the rapid decrease in groundwater constituent concentrations within a short distance of Tar Lake and an oxygen-reduced environment indicate of biological action. Both the fire and natural biodegradation may be responsible for the apparent decrease in the size of Tar Lake.

In 1982, the USEPA evaluated the site and proposed that it be included on the Superfund National Priorities List (NPL). It was placed on the list in 1983. In the 1992 Record of Decision (ROD) issued for the site, the remedy selected for the disposal of tar and impacted soil was excavation, stabilization, and isolation in onsite Resource Conservation and Recovery Act (RCRA) containment cells. Pre-design activities conducted at Tar Lake between October 1993 and June 1994 were intended to better define site information for purposes of designing the ROD-selected remedy; however, this investigation yielded data about tar management alternatives and media treatability which resulted in a reassessment of the remedial alternative. The USEPA is currently amending the ROD for the offsite recycling or reuse of the tar.

1.2 Previous Investigations

Information gathered during the pre-design investigation conducted at the Tar Lake site is summarized below:

Horizontal and Vertical Extent of the Tar

Using hand-augering techniques, the pre-design investigation refined the depth estimate in the deepest part of Tar Lake to less than 20 feet. This information, along with water table elevations developed during aquifer testing, indicate that the water table is below the bottom of Tar Lake. Further, hand augering conducted during the pre-design investigation showed that total tar depths in Tar Lake vary, and approach the water table in only one relatively small area in the central portion of the lake.

Figure 1-3 illustrates the boundary of Tar Lake, as well as the tar thicknesses defined in the pre-design investigation. This map was created using a statistical contouring package employing the Krieging method of interpolation. Tar thickness contours represent the total thickness of the tar and do not account for physical variability in tar media. Using the thickness contours, the total volume of tar in Tar Lake is approximately 24,000 cubic yards (CY).

Chemical and Physical Characteristics of the Tar

Physical data acquired during pre-design activities show that the tar ranges in moisture content from 30% to 70% and the heat content ranges between 900 and 8,000 British thermal units per pound (Btu/lb), suitable for recycling or reuse. Analytical data collected during the pre-design activities indicate that the tar is chemically homogeneous — samples obtained from physically distinct tar samples contained similar chemical constituents. Analytical data indicate that tar from Tar Lake does not exhibit any hazardous waste characteristics.

1.3 Source Control Remedy Performance Standard

At a June 24, 1997, meeting among representatives of USEPA, Michigan Department of Environmental Quality (MDEQ), 56th Century Antrim Iron Works, EnSafe, and the Township of Mancelona, the scope of the tar removal was discussed and agreed upon. The removal action will include tar and soils visibly contaminated with tar. Two forms of tar have been identified at the site: (1) tar, with little or no soils; and (2) tarry soil, where cohesion between tar and soil has occurred. Underlying soil may be stained (i.e., darker than native materials), clearly free of tar (i.e., noncohesive), and grades into clean light-brown sand over short vertical distances of several inches.

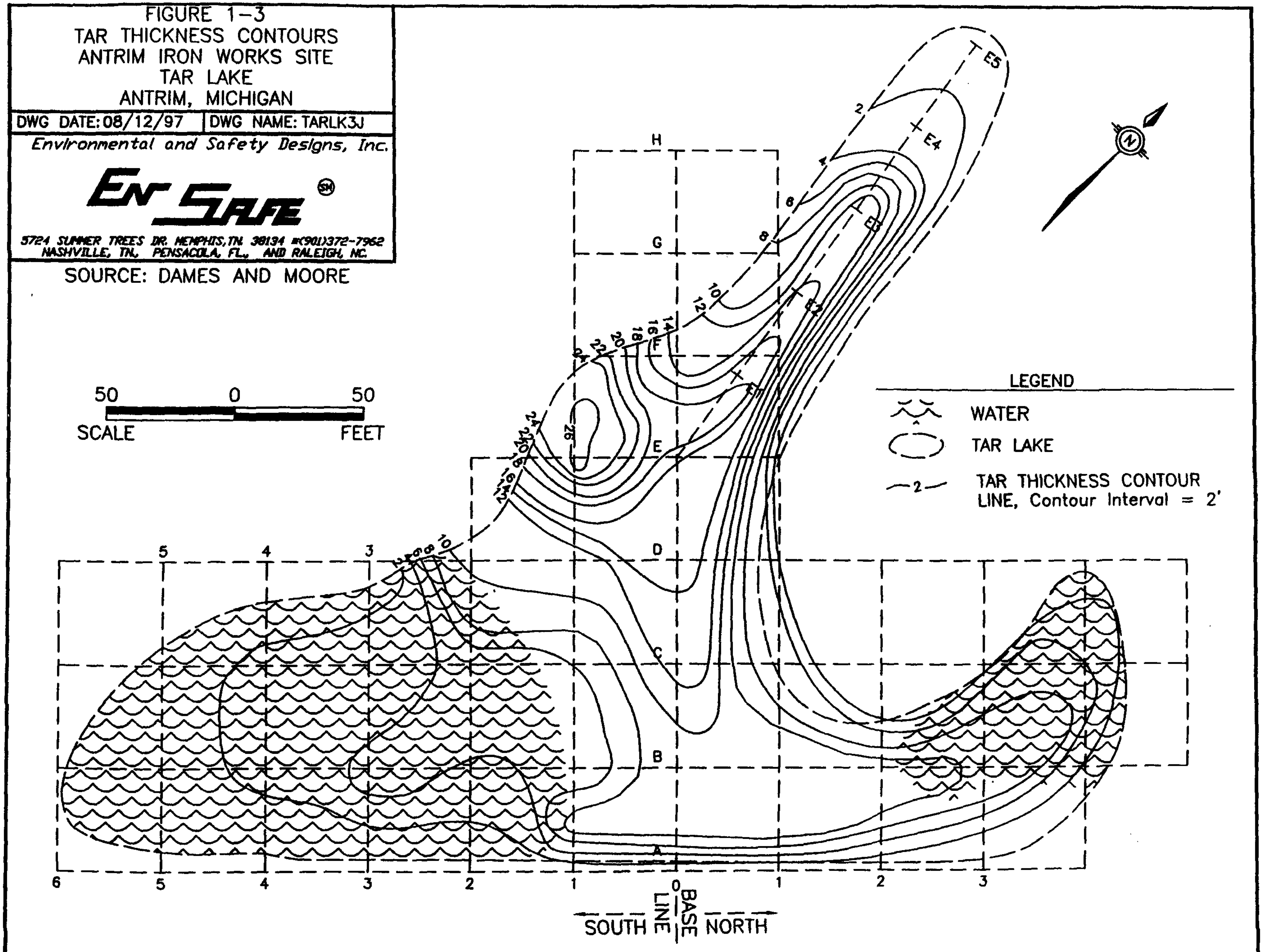


FIGURE 1-3
TAR THICKNESS CONTOURS
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN
DWG DATE: 08/12/97
DWG NAME: TARLK3J
Environmental and Safety Designs, Inc.
EnSafe
5724 SUMMER TREES DR. MEMPHIS, TN. 38134 (901)372-7962
NASHVILLE, TN., PENSACOLA, FL., AND RALEIGH, NC.
SOURCE: DAMES AND MOORE
50 0 50
SCALE FEET
LEGEND
WATER
TAR LAKE
TAR THICKNESS CONTOUR LINE, Contour Interval = 2'
SOUTH
BASE LINE
NORTH

The removal action will be limited to tar and tarry soil. A photographic log has been included as Appendix A. The samples shown in this log illustrate the distinct layers of tar and soil and are a useful tool for understanding where tar removal will stop.

1.4 Tar Disposition

The selected remedy for source control at Tar Lake includes excavating tar from the site and using it for energy recovery or material re-use processes offsite. The tar will be removed from the topographic depression onsite, pretreated if required, and transported via truck or rail to offsite facilities. Offsite processing may include dewatering, filtration, or blending with other materials to meet the facility's feedstock specifications.

An assessment of potential recycling and re-use alternatives indicated that both energy recovery and material re-use are available and viable options. Energy-recovery alternatives include: (1) fuel-blending, in which solid and liquid phases of tar are blended to obtain a uniform product suitable for energy recovery, and (2) solid fuel processing, in which tar is combined with shredded wood and sawdust to obtain a high-Btu/low-ash solid fuel. Tar used for energy recovery will be thermally destroyed.

Chemical re-use processes use tar as feedstock in commercial manufacturing processes. The tar has been identified as potential feedstock in the manufacture of roofing tar or carbon black. The tar is combined with virgin material and processed using distillation and/or cracking techniques, making it usable in commercial products. Tar used for material re-use will be incorporated into virgin feedstocks and refined using standard industry processing techniques.

Tar samples were examined by potential recyclers, who determined that the tar could be processed using developed technologies. Several vendors can remove, handle, and recycle or re-use the tar, and have submitted statements of qualification to perform that work.

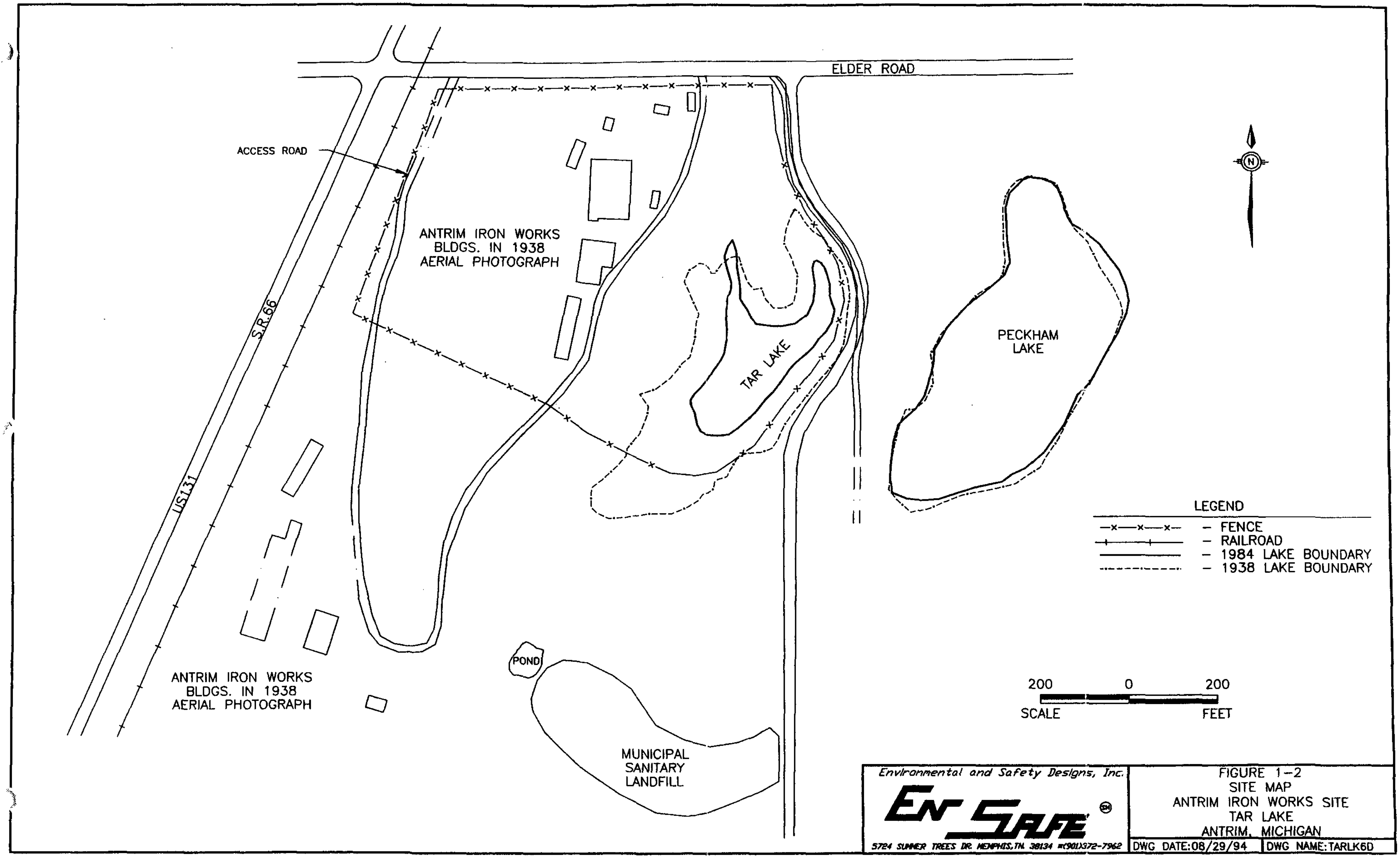


FIGURE 1-2
SITE MAP
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

DWG DATE:08/29/94 | DWG NAME:TARLK6D

1.0 INTRODUCTION

This document presents a work plan for implementing a proposed removal of tar at the Tar Lake site in Antrim, Michigan. It was prepared by EnSafe Inc. in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA §117), as amended by the Superfund Amendments and Reauthorization Act, and the National Contingency Plan (NCP; 40 Code of Federal Regulations [CFR] 300.435[c][2][ii]), and will become a part of the administrative record file, as per 40 CFR 300.825(a)(2). This work plan provides the basic information needed for tar removal planning and cost estimation purposes. This report responds to a request from the U.S. Environmental Protection Agency (USEPA) on June 24, 1997.

Section 1 discusses the site history, background information, and site conditions that were identified during pre-design activities, as described in the *Tar Lake Site Pre-Design Report* (EnSafe, 1995) . This section also establishes the tar removal performance standard and provides an overview of the prescribed removal action.

The remainder of this work plan addresses how the removal action will be conducted. Sections 2, 3, 4, and 5, address required site infrastructure improvements, the removal of tar, the treatment of process water generated from the removal action, and groundwater management during the removal action. Section 6 addresses site health and safety. A cost estimate is included in Section 7.

1.1 Site History

The following section provides and background information and a description of the site.

1.1.1 Site Description

The Antrim Iron Works (AIW) site is in Antrim County, Michigan, as shown on Figure 1-1. It formerly occupied more than 200 acres east of U.S. Highway 131, approximately one mile south

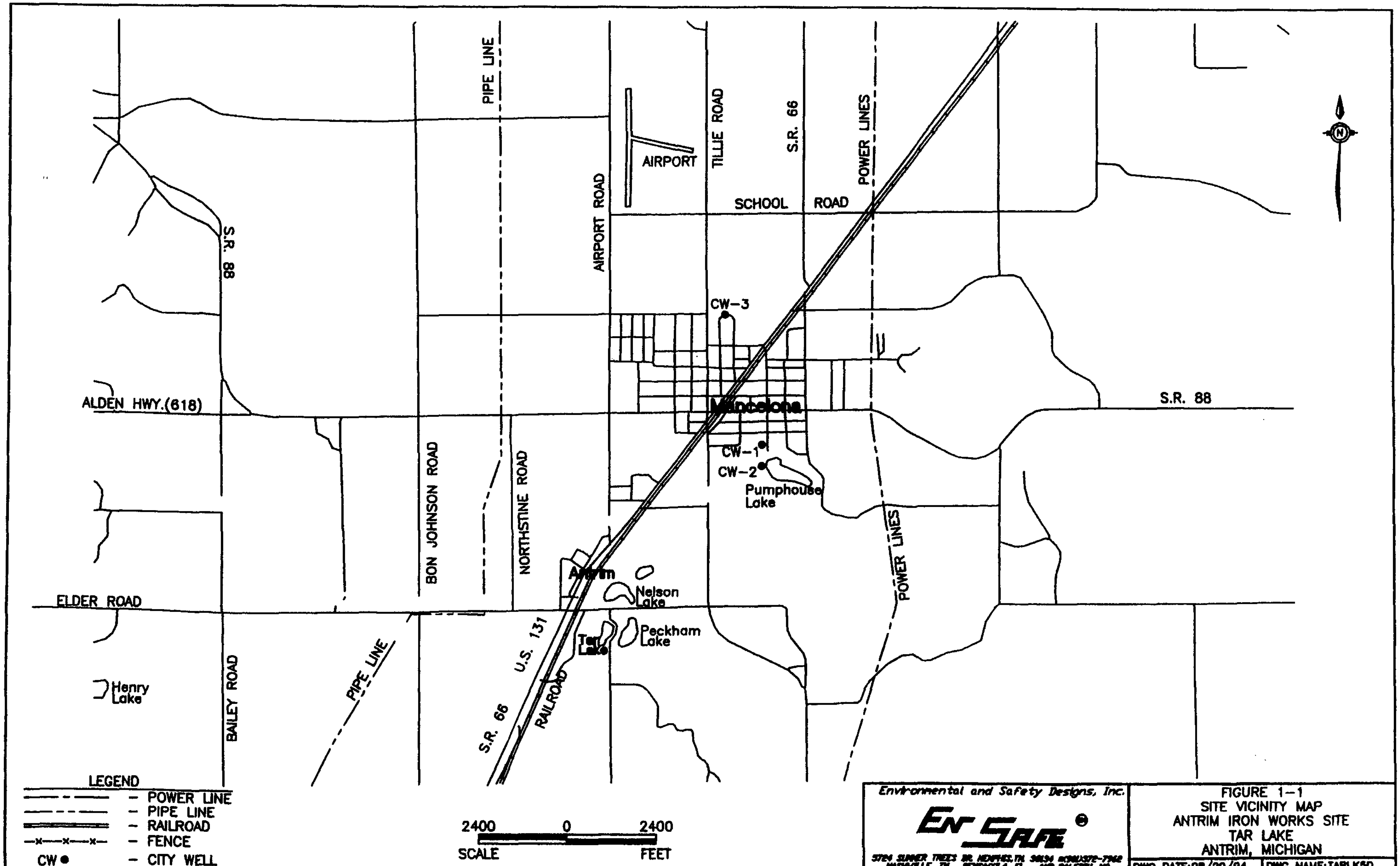


FIGURE 1-1
SITE VICINITY MAP
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

of Mancelona, Michigan. It is in a rural, undeveloped area near the Village of Antrim. The site contains a 62,000 square foot (ft^2) topographic depression containing tar and water.

1.1.2 Site Background

According to the Mancelona Centennial Commission and the July 10, 1980, *Mancelona Herald*, between 1882 and 1945 the site was a manufacturing location for companies producing iron by the charcoal method. From 1882 to 1886, the site was occupied by the John Otis Charcoal Iron Furnace Co. In 1886, AIW took over the site, and began operating a charcoal furnace in 1890. AIW produced 20,000 tons of iron per year, using hardwood charcoal made in onsite kilns. In 1910, the company began producing charcoal in sealed retorts from which crude pyroligneous liquor was recovered. This liquor was then further processed into calcium acetate, methanol, acetone, creosote oil, and wood tar. This secondary chemical manufacturing process produced a waste which was discharged into a topographic depression onsite. This depression, now referred to as "Tar Lake", received the waste still bottoms generated by the production of charcoal from 45,000 to 50,000 cords of wood per year. The furnace was closed in 1945 when the company was placed in receivership and the site equipment was salvaged. Although some of the waste tar that was generated may have been burned in an onsite boiler, Tar Lake received wood tar waste from approximately 1910 to 1944.

Figure 1-2 illustrates historic site features. The Tar Lake topographic depression is approximately 20 feet below the surrounding site property. No permanent or intermittent streams are present. Outside of Tar Lake, surface runoff drains quickly due to high-permeability soil. Other site features include slag piles, limestone piles, one sludge pile on the west side of the lake, and the remains of tank supports and cooling water ditches.

2.0 SITE PREPARATION

This section outlines the site preparation work required to allow tar-removal equipment access and tar recovery to be completed. Although some of the activities discussed below can be conducted concurrently, many can only be performed in sequence. At least two months will be required to prepare the site. Figure 2-1 illustrates the site layout with the proposed locations of the infrastructure improvements discussed below.

2.1 Site Improvements

2.1.1 Clearing and Surveying

Before clearing trees, brush, and debris from areas of the site designated as work zones or routes for the roads or railway siding, the selected oversight contractor will walk the area and survey for demolished building foundations, pipes, conduits, and other features that may make the work zone unsafe or unstable. A site layout of AIW, prepared by the Michigan Inspection Bureau in 1929, has been superimposed on a current site map as shown in Figure 2-2. While conducting the site survey and clearing the site, the location of these former structures will be investigated to determine if they are still present and/or obstructing proposed roads or work areas. If conditions in an area are unsafe or unusable, alternative work zones and routes will be established, or the area will be stabilized (e.g., building foundations will be removed or filled). Unsafe areas will be clearly marked and equipment operators will be instructed not to enter the area until further instructions have been provided by the selected oversight contractor. A plan outlining the removal or gravel filling of any building structures that impede tar removal operations will be submitted to USEPA and MDEQ, as required.

To improve access and visibility, once areas have been inspected and are considered safe, trees and brush that obstruct work areas required for tar removal will be cleared before any other site preparation activities begin. All work will be conducted using excavators and/or bulldozers. About three weeks will be required for grubbing activities. Trees and brush will be stockpiled onsite in designated areas outside the work zone.

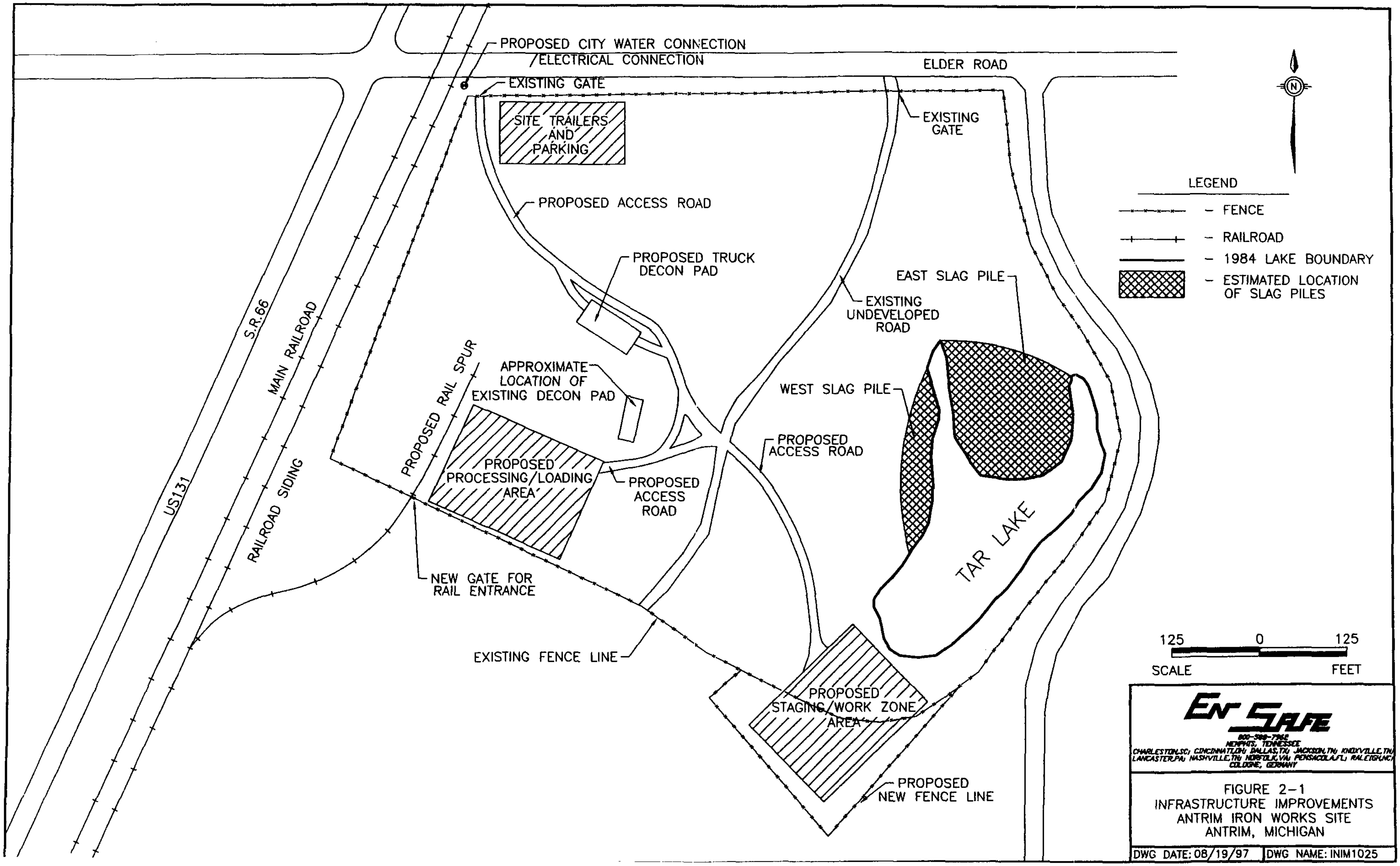
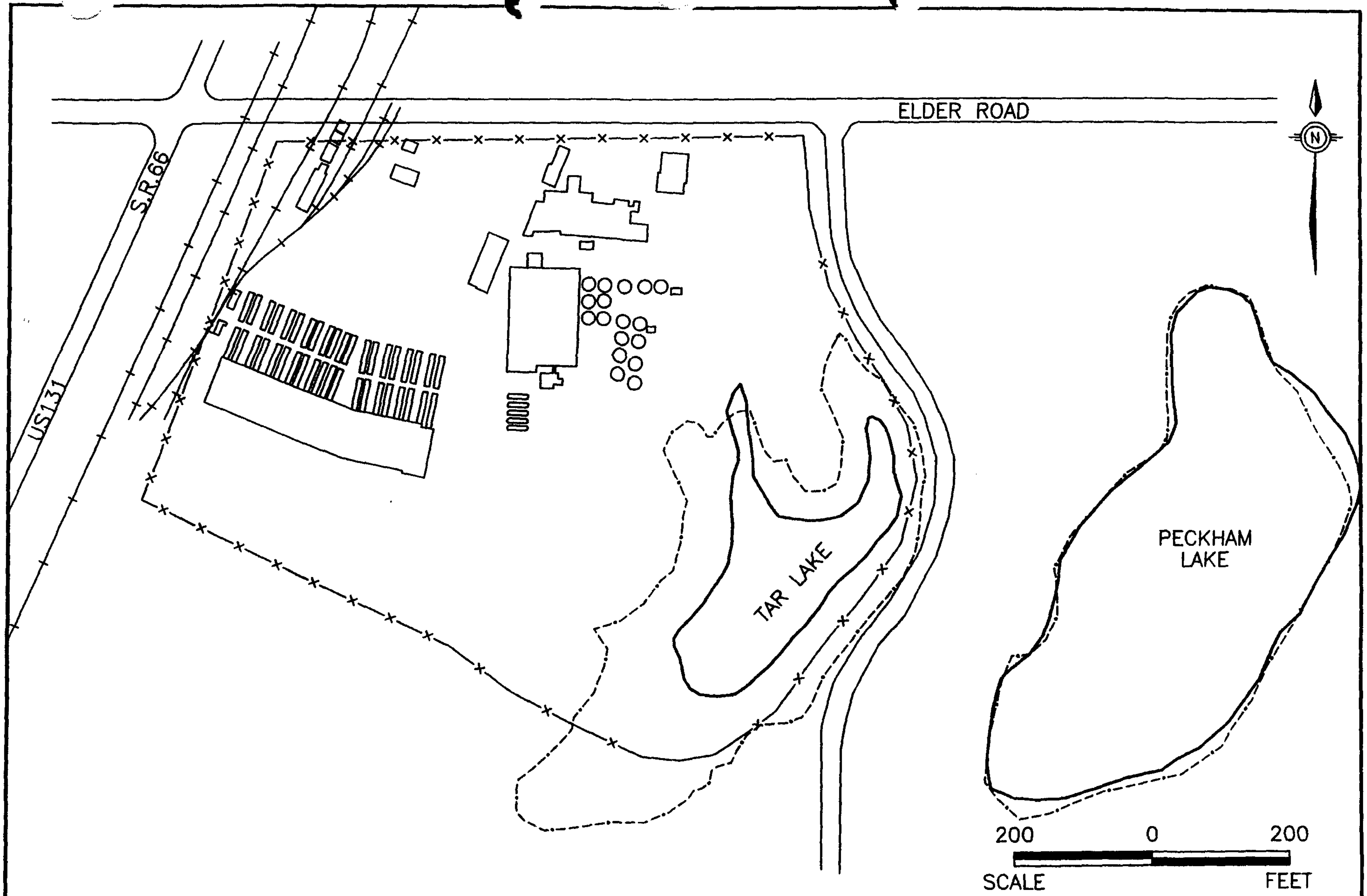


FIGURE 2-1
INFRASTRUCTURE IMPROVEMENTS
ANTRIM IRON WORKS SITE
ANTRIM, MICHIGAN

DWG DATE: 08/19/97 | DWG NAME: INIM1025



LEGEND

- FENCE
- RAILROAD
- 1984 LAKE BOUNDARY
- 1938 LAKE BOUNDARY

EnSafe
800-588-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

FIGURE 2-2
SITE MAP WITH BUILDINGS
FROM 1929 DRAWING
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

DWG DATE: 08/12/97 | DWG NAME: SMWB1025

Additionally, when the site is cleared, a Michigan-licensed surveyor will define the upper tar surface and horizontal extent of Tar Lake prior to any removal activities.

2.1.2 Site Grading

After the site is surveyed, roadways and work zones will be graded using bulldozers and/or other equipment as deemed necessary in the field. Work will be conducted using local labor or the selected remedial contractor.

2.1.3 Onsite Roads, Parking Areas, and Work Zones

To support tar removal activities, the onsite roads will be extended and improved. In addition, a work zone, decontamination zone, wastewater treatment area, and parking area will be created. At present, an access road enters the site from Elder Road along the northern boundary of the site. This road will be extended southwest across the site, connecting the areas designated as the work and decontamination zones. The proposed route is illustrated in Figure 2-1. A truck turnaround will be created at the southern end of the road. Ingress and egress will only be permitted at the Elder Road gate.

Per Michigan Department of Transportation (MDOT) regulations, an 8-inch layer of crushed stone will be placed over the graded roadbed and work zones to improve and stabilize the road surface. Additional stone will be applied should the roads deteriorate. The selected removal contractor will be required to maintain the road and work zone.

The approximately 200-foot by 150-foot staging/work zone will be created at the south end of Tar Lake to provide access to personnel and removal equipment. The approximately 200-foot by 150-foot processing/loading area will be created west of Tar Lake to allow for tar handling, loading, and decontamination. Wastewater treatment equipment, such as carbon vessels and holding tanks for treated and untreated water generated as a result of tar removal operations, will also be installed at the processing/loading area. Treated water will be tested and confirmed to be below cleanup standards, and then discharged close to Tar Lake upgradient of the proposed monitoring network discussed in Section 5. The approximate locations for the proposed work zones are on Figure 2-1.

A parking area with a capacity for up to 10 vehicles will be constructed near the field trailers by grading the area and laying crushed stone. This parking area will also be maintained until work is completed.

2.1.4 Railway

Conversations with tar removal contractors are ongoing and the method of transporting tar offsite has not yet been selected. The preferred choice to date is by rail, as discussed in Section 3. To allow for offsite transport by rail, the improvements discussed below would first be required.

The Tuscola Saginaw Bay Railway Co. Inc. in Owosso, Michigan, currently owns an active railway line that runs parallel to the Tar Lake site and services the Holnam Cement Co. in Elmira, Michigan. Also running parallel to the site is an approximately 0.75-mile siding line (Figure 2-1) that begins north of Moecke Lumber and extends north of Elder Road. According to Jim Moore and David Lewis at Tuscola Saginaw, the siding line is long enough to stage and load at least 10 railcars at a time on the Tar Lake property separate from the main Tuscola Saginaw line. On July 22, 1997, Mr. Moore inspected the line and indicated that approximately three weeks would be required to upgrade the siding to render it usable. While infrastructure improvements are being made to the site, the siding line could be upgraded and/or lengthened by Tuscola Saginaw personnel.

If the rail siding is used, it must pass a Tuscola Saginaw Railway Co. inspection. Mr. Moore and Mr. Lewis have said that an access agreement would not be required to use the line. Additionally, a spur may be installed off the siding line to load railcars onsite.

2.2 Utilities

2.2.1 Power

The site currently has one field trailer with electrical and phone supplied. Electrical power will also be required for additional trailer lighting, air conditioning, site lighting for roads and work areas, and any process equipment. Power will be of sufficient capacity and characteristic to supply proper current for use with various types of equipment. The selected contractor will be responsible for extension of said additional utilities. The utility installation contractor will be responsible for obtaining permits for electrical connections in accordance with all applicable codes and requirements.

The utility contractor will also be responsible for verifying the presence and location of underground structures and utilities to ensure conflicts are avoided when power lines are installed.

2.2.2 Telephone Service

Telephone service is currently supplied to the site by AmeriTech of Saginaw, Michigan. Arrangements will be made with AmeriTech to provide separate telephone service to each field trailer before site work begins.

2.2.3 Water Supply

Arrangements will be made with the Town of Mancelona to extend the existing 6-inch water main to the northwest corner of the site at U.S. Highway 131 and Elder Road. A trailer with a portable water tank will be kept onsite for use as needed throughout the site.

2.2.4 Sanitary Services

An adequate number of portable, prefabricated, chemical-type toilets will be mobilized to the site.

2.2.5 Field Trailers

One temporary field trailer, in addition to the current field trailer, will be mobilized to the site to be used as a field office. Separate trailers will be provided for: (1) USEPA and the MDEQ, and (2) the selected remedial subcontractors. Telephone lines, electricity, and heat will be provided to each trailer.

2.2.6 Personnel Decontamination Facility

In accordance with 29 CFR 1910.141, personnel hygiene/decontamination facilities will be provided onsite by the field trailers. Sufficient portable showers will be mobilized for the final decontamination of site workers. Each portable unit will contain two showers. The discharge water will be treated using reactivated carbon and discharged onsite into the plume of groundwater contamination.

2.2.7 Site Fencing and Access

Chainlink fencing currently surrounds the Tar Lake site. This fenceline does not designate the property line and may be moved and/or enlarged to improve access to the work space that will be used for tar removal and other associated activities.

The present Elder Road access gate will be used to allow for site ingress and egress for trucks and personnel. This gate may need to be widened to ensure 18-wheel trucks and trailers can safely pass through. All people entering the site will be required to check in and out at this main entrance to provide site control and a complete record of site entry. The gate will be locked at the end of each workday.

At present, the railway siding that runs parallel to the site is not fenced. Before the line can be used, the fenceline will be relocated to surround the track and reduce public access to the railcars. A gate wide enough for railcars will be installed in the fence where the railway siding passes. The gate will be used exclusively for railcar access and will be locked at all other times.

Temporary fencing or barricades, such as standard snow fencing or warning tape, may be erected around all active work areas for purposes of denoting the exclusion zone, and will be removed when work in that area is completed.

2.2.8 Decontamination Pad with Pole Barn

A small pad for personnel and equipment decontamination was constructed at the site before the preliminary design investigation. This concrete pad is approximately 60 feet long by 15 feet wide and slopes toward a sump used to collect wastewater. During tar removal, this pad will be used for gross decontamination of personnel and full decontamination of smaller equipment.

A large decontamination pad covered by a pole barn will be constructed at the site before tar removal begins. This pad will be large enough for decontamination of an 18-wheel truck and trailer, as well as other large equipment. The pad will be constructed at a slope that runs to a sump and with a berm that is at least 6 inches tall. Wastewater from both decontamination pads will be collected in their respective sumps, pumped into a temporary holding tank, treated through onsite carbon vessels, and tested to ensure compliance with MDEQ standards before being released from a second holding tank. Discharge will be onsite at a location to be approved by USEPA, and MDEQ. Treatment of decontamination water is further discussed in Section 4.

3.0 TAR REMOVAL AND RECYCLING/REUSE

The tar will be removed by appropriate mechanical means and/or by pumping. It will be loaded into railcars or truck trailers; free liquids may be decanted to reduce the offsite shipment of material not suitable for recycling or re-use.

The tar is not a listed RCRA hazardous waste and predesign findings indicate that it does not exhibit any RCRA hazardous waste characteristics. Thus, the Tar Lake tar differs from coal tar (K087) materials in both hazardous waste characteristics and fundamental chemical composition. Therefore, RCRA hazardous waste regulations are neither applicable nor relevant and appropriate to the Tar Lake tar.

3.1 Tar Excavation, Pumping, and Loading

Removal of the tar will begin next to the staging/work zone in the large, shallow, southern end of Tar Lake. Early removal of the southern end of Tar Lake will allow better access to the deeper areas of tar. The weathered tar will be cut through with an excavator and the pump suction lowered into the liquid tar. Tar will be pumped for as long as feasible directly into trucks. Pumping will be re-established as necessary when and where practical and safe. All nonpumpable tar and debris will be removed with large trackhoe excavators that can extend 30 to 40 feet, and, Front-end loaders will be used where accessible. The amount of tar to be removed with trackhoes will depend on the success of the tar pumping operations. Appendix A contains photographs showing the consistency of the tar within Tar Lake.

Tar removed from Tar Lake will be loaded into end-dump or tanker trucks dedicated to onsite transportation. The use of onsite dedicated transportation equipment should reduce the number of vehicles requiring decontamination and the number of drivers shuttling tar within the site boundaries. Trucks will haul the tar from the staging/work zone up the hill, an approximately 35-foot elevation change over a distance of 800 feet, to the processing/loading area northwest of

Tar Lake (see Figure 2-1). The proposed location serves two purposes: to physically separate the removal activities and processing/loading activities (to facilitate logistics, health and safety, etc.); and to provide a wide open work area accessible to the rail line, roads, and tanks for decant water.

Nonpumpable tar will be transferred into gondola railcars, while liquid tar will be pumped into tanker railcars. After a railcar is filled with tar, it will be staged for several days to allow free liquids to separate and be pumped off. An estimated 10% to 20% water is expected to decant from the tar without special processing. The advantages of decanting the tar before offsite shipment are as follows: savings in transportation and recycling or re-use costs due to the reduced volume of tar; and an increased heat content of the tar, therefore making it more attractive to the recycle/re-use facility. Section 4 details how process water will be handled.

To date, neither a removal contractor nor the method of transportation has been selected for this removal project. However, rail is the preferred method for hauling tar offsite for the following reasons: rail is more cost-effective when compared to trucking; railcars can be loaded as needed, whereas trucks need to be loaded promptly to be cost-efficient; railcars have minimal impact on local traffic patterns; railcars can serve as affordable temporary decanting tanks; and health and safety concerns are decreased and site security improved by having fewer personnel and vehicles working onsite. Trucking is still a viable transportation alternative that may be used on an intermittent basis, as needed.

3.1.1 Odor Issues

All efforts will be made to reduce the area of exposed tar at the excavation. Based on information available from past tar removals at other sites, it is thought that nuisance odors should be limited to the excavation area and will not be a concern to the surrounding areas. However, odor control methods are available, if needed. These include: (1) covering areas where tar is being removed with a 6-inch layer of water to reduce volatilization; and (2) applying aqueous-film forming foam (AFFF), a biodegradable foam that retards volatilization and excludes air from contacting the tar, but requires re-application approximately every hour. In the unlikely event that odor control is required, the preferred choice would be to use existing standing water in the southern and northeastern parts of Tar Lake during pumping or excavation activities to help suppress tar odors. Additionally, three 55-gallon drums of AFFF will be stored onsite to cover up to one-quarter of the surface area of Tar Lake, which should provide sufficient coverage since the excavation will proceed section by section. AFFF is readily available from several vendors within Michigan, so only a small quantity would need to be stored onsite.

Initial attempts at pumping liquid tar will be conducted without introducing heat. In doing so, the hardened upper crust throughout the lake would act as an odor barrier. If tar is deemed pumpable, but too viscous for flow under ambient conditions, pumping with heat will be conducted. Air emissions will be monitored by health and safety personnel downwind of the work zone for volatile compounds. If vapors from the heated tar exceed ambient air quality or site worker safety thresholds established during design and planning, heated pumping will be discontinued or the above-mentioned engineering controls applied. Odor issues will also be addressed as a public awareness and education issue before tar removal begins.

3.1.2 Process Water

Water separated from the tar will be pumped from the railcars or trucks into a water-holding tank and then pumped at a controlled flow rate through a carbon treatment system and into a second holding tank. A representative sample of the water in the second holding tank will be collected and submitted for analysis of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Following receipt of the sample analysis, if the concentrations in the water exceed the MDEQ generic industrial cleanup criteria, the water will be discharged onsite within the plume of groundwater contamination. If analysis of the water indicates the parameters of concern are above MDEQ generic industrial cleanup criteria, then the water will be recirculated through the carbon treatment system and the process repeated until the water can be discharged onsite.

3.2 Tar Recycling/Re-use

If the tar is used for energy recovery, it will be managed as a nonhazardous solid waste for offsite re-use; if the tar is used for material recovery, it will not be considered solid waste and will instead be managed as a raw material for offsite recycling. Thus, either remedy complies with applicable and relevant or appropriate requirements governing the transport and use of solid waste and hazardous raw materials. Any recovery process residuals generated at the recycle/re-use facility selected for tar recovery will be managed according to that facility's process residuals management plan.

Tar removed from Tar Lake has been proposed to be used in several different ways at various offsite recycling/re-use facilities. The costs associated with the tar removal and recycling/re-use typically consist of three elements:

- Onsite removal, loading, and treatment;
- Transportation to an offsite facility; and
- Re-use of the solid waste or recycling of the raw material at an offsite facility.

Most energy recovery re-use methods require onsite stabilization of the tar by mixing it with sawdust or coal at ratios as high as one part sawdust to one part tar by weight, before use as a solid fuel source. The disadvantages of this approach are as follows: the cost and space requirements of building an onsite staging area for the storage of sawdust or coal; the cost of labor and equipment required for increased onsite handling; the additional traffic and personnel onsite due to the delivery of raw products (e.g., sawdust or coal); and the increased transportation and re-use costs due to the larger amount of material shipped offsite (i.e., the weight of material to be shipped offsite could more than double).

Other proposed methods, such as recycling the tar as a feedstock or in chemical re-use, do not involve onsite treatment; therefore, the pumped or excavated tar could be loaded and shipped directly offsite. The disadvantage to the recycling method is the dramatically higher price for offsite recycling of the raw tar material compared to offsite reuse of the treated tar material for energy recovery. However, the increased price in offsite recycling of the raw material when there is no onsite treatment is typically more than offset by the cost savings realized by the smaller amount of material to be shipped offsite. In general, the overall cost to recycle tar, which requires no onsite treatment, versus the re-use of tar, which requires onsite treatment, is comparable.

3.3 Debris Removal and Disposal

Tar-impacted debris may also be encountered within the Tar Lake boundaries during the removal action. Debris known to be in and around the lake includes personal protective equipment (PPE), empty steel drums, piping, production and process waste from the former iron works, monitoring wells, and the gravel road with a geotextile membrane. Large debris may need to be cleaned physically (using heavy equipment or high-pressure washing) to remove only gross contamination prior to loading it in truck trailers for offsite disposal. All debris shipped offsite will be disposed of in a RCRA Subtitle D landfill such as the Waste Management Inc., landfill in Charlevoix, Michigan. The type or amount of subsurface debris that will be encountered during tar removal is unknown. Approximately 5,000 cubic yards of debris is estimated to require disposal at a RCRA Subtitle D landfill, assuming only a small portion, if any, of the gravel road built on top of Tar Lake will require offsite disposal.

Another form of debris in and around Tar Lake remaining from the former iron works facility is slag, which has been identified in two locations adjacent to the visible (aboveground) portion of

Tar Lake, as shown in Figure 2-1. During the pre-design investigation, four borings were completed in slag on Tar Lake's west side. It was determined to be 7 to 15 feet deep. Tar was not encountered in borings in the slag pile on the west side, while the slag pile adjacent to the east side of Tar Lake was unstable and the pile's slope precluded investigation. It is assumed that tar is present at the base of the slag pile on the east side of Tar Lake. Using topographic contours and information gathered from borings completed during the pre-design investigation, an estimated 1,400 CY of slag is on the west side of Tar Lake and an estimated 8,600 CY is on the east side of Tar Lake. Any amount of tar underlying the slag, is unknown; however, it is assumed that the combined 10,000 CY of slag will require relocation to ensure safe working conditions during the tar removal.

Slag encountered during the tar removal will be kept onsite if at all possible to avoid costly offsite transportation and disposal. Any slag that is removed will be relocated as short a distance as possible using trackhoes and/or bulldozers. The extent of tar/slag mixing in the slag piles can be determined once slag piles are removed to match the grade of the existing tar surface. Slag covered with tar will be removed and either decontaminated or shipped offsite for disposal in a RCRA Subtitle D Landfill. An estimated 5,000 CY of slag contaminated with tar will require offsite disposal at a RCRA Subtitle D landfill.

3.4 Tar Removal Time-Frame

Due to the uncertainty in material handling requirements, most removal contractors contacted to date have requested time for a pilot study preceding full-scale tar removal. A limited pilot study conducted in conjunction with a limited site investigation by a selected contractor would have all or several of the following objectives.

- Requirements for and the viability of pumping Tar Lake tar could be ascertained and the pumpable volume estimated.

- The site infrastructure system, specifically the access roads and loading system, could be tested on a trial basis so any inadequacies can be corrected before the full-scale removal action.

- Slag piles adjacent to Tar Lake could be partially excavated to help determine how much tar may be mixed with slag.

- The acceptability of the Tar Lake tar at the selected disposal facility could be ascertained and the mixing ratios of material with tar could be tested.

- Air emissions could be investigated and control methods tested.

Infrastructure improvements will require at least two months to complete. The tar removal alone is estimated to require two six-month periods during spring, summer, and fall. If a pilot study and limited investigation are conducted, the tar removal is still expected to require one six-month period and an additional three to four months.

3.5 Tar Removal/Management Cost

The costs associated with tar removal and its recycle/re-use consist of three main elements:

- Onsite removal, loading, and treatment;
- Transportation of the tar to an offsite facility;
- Re-use of the solid waste or recycling of the raw material at an offsite facility.

The cost estimate for Tar Lake is based on 24,000 CY of tar to be removed, an estimated 15% reduction in the volume of tar to be shipped offsite due to onsite decanting, and a tar density of 0.945 tons/CY. The volume of tar to be removed and the density of the tar were both obtained from the *Tar Lake Site Pre-Design Report*. The transportation and recycling/re-use costs will be charged by weight (e.g., dollar/ton). Therefore, for cost estimates, the cubic yard volumes were converted to tons. Also, for the re-use scenario cost estimate, the tonnage of material to be shipped offsite would be approximately double the decanted weight of tar, since the addition of sawdust would be at a rate of one ton of sawdust to one ton of tar. The calculations for the tons of tar and/or material to be used in the recycle or reuse cost estimates are as follows:

- There are 24,000 CY x 0.945 tons/CY = 22,700 tons of tar to be removed from Tar Lake for either recycling or reuse.
- If the volume of tar can be reduced by 15% through onsite decanting of liquids, then 24,000 CY x (0.85) x 0.945 tons/CY = 19,300 tons of tar for offsite shipment.
- Tar to be recycled will be used as a raw material; no onsite treatment is required so the amount of material for transport and offsite recycling is 19,300 tons.
- Tar to be reused for energy will be mixed onsite at a ratio of one ton tar to one ton sawdust, so after the onsite treatment, the amount of material for transportation and offsite re-use is 19,300 tons x 2 = 38,600 tons of material.

To calculate a cost estimate for the Tar Lake removal, several contractors' estimated costs were compared and a typical cost of each element identified. The estimated cost for tar removal, loading, and any treatment is $60/ton. The estimated cost for transportation via rail is $55/ton; via trucking, it is $75/ton. The estimated cost for offsite recycling is $180/ton. The recycling cost depends on the quality and consistency of the tar, so the stated cost is a conservative estimate. The estimated cost for offsite reuse is $60/ton. Additionally, the offsite reuse of tar will involve onsite mixing with a material such as sawdust, which will cost approximately $300,000 for 19,300 tons of sawdust. A cost comparison between the recycling and reuse options is as follows:

Recycle		
Tar removal	22,700 tons @ $ 60/ton	$1,362,000
Transportation — rail	19,300 tons @ $ 55/ton	$1,061,500
Transportation — truck	19,300 tons @ $ 75/ton	$1,447,500
Recycling Fee	19,300 tons @ $180/ton	$3,474,000
	Recycle via rail Subtotal	$5,897,500
	Recycle via truck Subtotal	$6,283,500

Reuse		
Tar removal	22,700 tons @ $ 60/ton	$1,362,000
Transportation — rail	38,600 tons @ $ 55 /ton	$2,123,000
Transportation — truck	38,600 tons @ $ 75/ton	$2,895,000
Reuse Fee	38,600 tons @ $ 60/ton	$2,316,000
Sawdust		$300,000
	Re-use via rail subtotal	$6,101,000
	Re-use via truck subtotal	$6,873,000

For cost estimates, all options are within a comparable range of uncertainty and rail would be the preferred method of transportation. By not preselecting either the recycling or re-use method, the option to use both or either would remain available and the cost estimate would not be greatly affected. For this report, the more conservative cost estimate of $6,101,000 for re-use via rail has been used in the cost estimate discussion, Section 7. Ultimately, the tar removal and recycling and reuse costs will be dictated by market conditions and the most competitive qualified bid by an end user at the time of the scheduled removal.

4.0 WASTEWATER TREATMENT

As a result of tar removal activities, water will be generated by the following sources:

- Process water
- Surface water
- Decontamination water

As determined during the preliminary design investigation, water table suppression is not expected to be required to gain access to the tar. Water generated as a result of tar removal will require treatment to below MDEQ industrial cleanup criteria prior to discharge onsite. The following section discusses how this goal will be achieved. The expected wastewater concentrations and volumes are discussed in Section 4.1, the MDEQ discharge criteria are summarized in Section 4.2. Section 4.3 presents carbon adsorption as the treatment method that will be used to attain the required effluent concentrations.

4.1 Estimated Volumes and Concentrations of Water Requiring Treatment

Dewatering Residuals

The tar removal contractor has not yet been selected; however, several contractors have said the tar would require dewatering prior to removal from the site. The following section discusses how this process water would be handled, should dewatering be necessary.

As part of the October 1993 preliminary design investigation, 11 tar samples were collected for Toxicity Characteristic Leaching Procedure (TCLP) analysis of VOCs, SVOCs, metals, and pesticides from throughout Tar Lake at the locations and depths labeled on Figure 4-1. No metals or pesticides were detected; however, the VOC benzene, and the SVOCs 2-methylphenol, 3-methylphenol, 4-methylphenol, and pyridine were detected at concentrations exceeding the detection limit. Analytical results are summarized in Table 4-1.

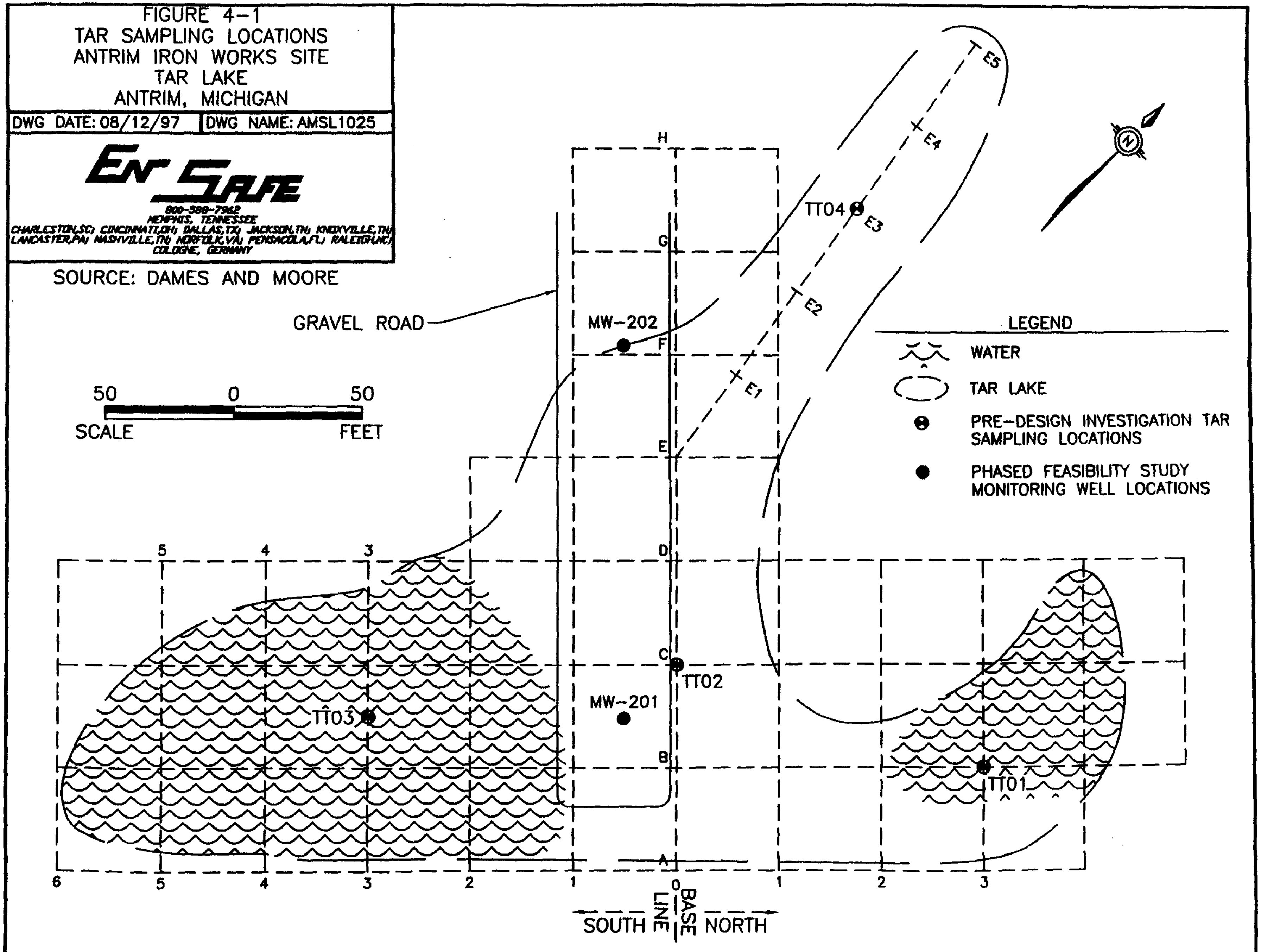


FIGURE 4-1
TAR SAMPLING LOCATIONS
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

Table 4-1
TCLP Data for Tar Samples Collected from Tar Lake in October 1993
(in mg/L)

Parameter	TT01BT	TT01MD	TT01SH	TT02BT	TT02MD	TT02SH	TT03BT	TT03SH	TT04BT	TT04MD	TT04SH	Average	Industrial[a]
TCLP VOC													
Benzene	0.46	0.27	0.05	0.12	0.11	0.17	0.3	0.21	1	0.38	NA	0.307	0.005
TCLP SVOCs													
2-Methylphenol	61	29	7.8	21	17	29	19	14	29	24	27	25.25	1.0
3-Methylphenol	51	33	8.2	12	12	19	19	16	12	13	20	19.56	1.0
4-Methylphenol	51	33	8.2	12	12	19	19	16	12	13	20	19.56	0.1
Pyridine	0.5U	0.5U	0.5U	0.26	0.36	0.31	0.5U[b]	0.5U	1.2	0.76	0.48	0.42	0.021

Notes:
mg/L = Milligrams per liter
NA = No data available
U = Not detected above method detection limit.
a = Discharge criteria are based on *Memorandum 14: Remedial Actions Plans Using Generic Industrial or Generic Commercial Cleanup Criteria* issued on June 6, 1995, by the Environmental Response Division of MDEQ.
b = Average for pyridine was calculated using half of the detection limit for sample concentrations below the method detection limit.

As a result of the TCLP analytical procedure, samples can undergo an approximately 20 fold dilution based on a dry weight basis. To approximate possible worst-case concentrations in process water after it has been separated from the tar, this dilution factor was eliminated by multiplying the TCLP concentrations by 20. These values are summarized in Table 4-2. Treatment design calculations were performed using the undiluted values to approximate the influent concentration that would require treatment.

The moisture content of the tar samples discussed above was also analyzed. The average moisture content was calculated to be 54%, with values ranging from 39% to 74%. As a result, the estimated process water concentrations are conservative because eliminating the 20-fold dilution was based on a dry weight basis. As determined during the preliminary design investigation and presented in the *Tar Lake Site Pre-Design Report*, approximately 24,000 CY of tar are to be removed.

Based on discussions with several tar removal contractors, typical water separation from tar is 10% to 20%. At 20%, approximately 960,000 gallons of water would be generated and require treatment. Assuming process water will be generated over approximately six months, the flow rate of water requiring treatment would be approximately 4 gallons per minute (gpm).

Surface Water

The *Soil Survey of Antrim County, Michigan*, (USDA, 1978), indicates average annual precipitation in the Tar Lake area has been 31.43 inches per year, as averaged between 1946 and 1975. The construction season (specifically the tar removal phase) at the site is expected to occur between April and November. On average, 24.57 inches of precipitation fall during these months. Storm water drains quickly due to high-permeability soil and as a result, no run on is expected.

Table 4-2
TCLP Data x 20 for Tar Samples Collected from Tar Lake in October 1993
(in mg/L)

Parameter	TT01BT	TT01MD	TT01SH	TT02BT	TT02MD	TT02SH	TT03BT	TT03SH	TT04BT	TT04MD	TT04SH	Average	Industrial[a]
TCLP VOC													
Benzene	9.2	5.4	1.0	2.4	2.2	3.4	6.0	4.2	20	7.6	NA	6.14	0.005
TCLP SVOCs													
2-Methylphenol	1,220	580	505	420	340	580	380	280	580	480	540	505	1.0
3-Methylphenol	1,020	660	391.2	240	240	380	380	320	240	260	400	391.2	1.0
4-Methylphenol	1,020	660	391.2	240	240	380	380	320	240	260	400	391.2	0.1
Pyridine	0.5U	0.5U	8.4	5.2	7.2	6.2	0.5U[b]	0.5U	24	15.2	9.6	8.4	0.021

Notes:
mg/L = Milligrams per liter
NA = No data available
U = Not detected above method detection limit.
a = Discharge criteria are based on *Memorandum 14: Remedial Actions Plans Using Generic Industrial or Generic Commercial Cleanup Criteria* issued on June 6, 1995, by the Environmental Response Division of MDEQ.
b = Average for pyridine was calculated using half of the detection limit for sample concentrations below the method detection limit.

With a surface area of 62,000 ft^2, and assuming zero infiltration into the tar, the estimated volume of surface water that will pond on Tar Lake and require treatment, as well as the treatment flowrates are:

Average Precipitation	Timespan	Treatment Flowrate
1.21 million gallons	12 months	2.33 gpm
950,000 gallons	8 months (April to November)	4.0 gpm

Ponded water on Tar Lake has not been sampled since 1967. For design purposes, concentrations for groundwater samples from MW-201 and MW-202, collected during the December 1989 site investigation from beneath Tar Lake, have been used to approximate worst-case scenario concentrations of ponded water that may require treatment. Monitoring well MW-201 is screened 5 feet below the tar (20 feet below Tar Lake's surface) and is near the center of Tar Lake. MW-202 is screened 7 feet below the tar (16 feet below the lake surface) at the edge of Tar Lake. The well locations are shown on Figure 4-1. Analytical results for VOCs and SVOCs are summarized in Table 4-3. Treatment design calculations were performed using surface water that had gathered over eight months from April to November.

Decontamination Water

Decontamination water refers to the liquids that will be generated when decontaminating personnel, vehicles, equipment, and debris. The VOC and SVOC concentrations in decontamination water generated during tar removal activities are not expected to exceed those detected in the groundwater samples discussed above. It is expected that approximately 1 million gallons of decontamination water will be generated over six months.

Table 4-3
Volatile and Semivolatile TCL Compounds Detected in Water Samples Collected from Immediately Below Tar Lake (in mg/L)

Compound	MW-201	MW-202	Industrial[a]
Volatile			
Benzene	**0.43**	**0.04**	0.005
Ethylbenzene	0.12	0.045	0.7
Toluene	0.62	0.16	1.0
Styrene	0.063 J	0.006	0.1
2-Butanone	1.9	0.015	38
2-Hexanone	0.91	ND	2.9
4-Methyl-2-pentanone	0.091 J	ND	1.0
Xylenes	0.91	0.14	10
Semivolatile			
Acenaphthylene	0.049 J	ND	0.075
bis(2-ethylhexyl)phthalate	ND	0.003 J	0.006
Fluorene	ND	0.005 J	2.5
Naphthalene	ND	0.038	0.75
Phenanthrene	ND	0.004 J	0.075
Dibenzofuran	ND	0.004 J	ND
2-Methylnaphthalene	0.38 J	0.017	0.75
2,4-Dimethylphenol	**29**	**3.1**	1.0
Phenol	**14**	0.29	13
2-Methylphenol	**28**	0.78	1.0
4-Methylphenol	**49**	**4.9**	0.1

Notes:
mg/L = milligrams per liter
ND = Indicates compound was below the method detection limit.
J = Estimated concentration.
a = Discharge criteria are based on *Memorandum 14: Remedial Actions Plans Using Generic Industrial or Generic Commercial Cleanup Criteria* issued on June 6, 1995, by the Environmental Response Division of the MDEQ.
Bolded values indicate concentrations that exceed the industrial cleanup criteria.

4.2 Discharge Concentrations

Water generated as a result of tar removal activities at the Tar Lake site qualifies under the exemptions adopted by MDEQ on September 19, 1996, pursuant to R323.2209(2) of the Administrative Rules of Part 31 of Act 451, as amended. A generic exemption notification form will be submitted to MDEQ for discharges within the groundwater plume. Discharges will be required to meet the industrial discharge criteria that are based on *Memorandum 14: Remedial Actions Plans Using Generic Industrial or Generic Commercial Cleanup Criteria* issued on June 6, 1995, by the Environmental Response Division of MDEQ. These cleanup standards are listed in Tables 4-1, 4-2, and 4-3.

Process water (Stream 1) generated as a result of tar removal activities will be pumped into a holding tank. Similarly, surface water and decontamination water (Stream 2) will be pumped into a separate holding tank. From here, each stream will be pumped at a regulated flow rate from the holding tank through their respective carbon treatment systems. Treated water will be stored in treated water holding tanks to allow the effluent stream to be sampled for VOCs and SVOCs by USEPA Methods 8240 and 8270, respectively, prior to discharge. Each holding tank will be 20,000 gallons, the maximum portable size that is available, to reduce the number of samples that will require collection. Treated water batches with concentrations below the industrial criteria will be released onsite. The proposed discharge location is near the north edge of Tar Lake, as labeled on Figure 2-1. Treated water batches with concentrations exceeding the industrial discharge criteria will be recirculated through the carbon units and resampled until the water is acceptable for discharge.

4.3 Design of Carbon Adsorption Treatment System

Model results for a combined process water and surface water/decontamination water stream resulted in higher treatment costs than using two separate treatment systems and would require carbon replacement every 10 days. As a result, use of a separate treatment system for each stream is preferred and has been presented below.

Process Water

Treatment design calculations for process water (Stream 1) were performed using the adjusted preliminary design investigation TCLP results for tar as the approximate influent concentration requiring treatment. These undiluted TCLP concentrations are summarized in Table 4-2. Assuming 20% water separation from tar, design calculations were based on 960,000 gallons of water requiring treatment over six months. This volume would require a treatment flow rate of approximately 4 gpm. The desired influent and effluent criteria used in design calculations are summarized in Table 4-2.

To achieve the desired effluent criteria for Stream 1, computer model results run by Carbonair Environmental Systems, Inc. of New Hope, Minnesota, recommend the use of two liquid-phase carbon adsorbers (Carbonair PC 13 vessels) operated in series, each loaded with 1,500 pounds of reactivated carbon. The influent flowrate would be 4 gpm. Using this suggested system, 3,000 pounds of carbon would require replacement every 22 days, or seven times over six months to treat 960,000 gallons of process water. The flow range of the Carbonair PC 13 vessel extends up to 90 gpm so the vessels could handle a higher flowrate, if necessary.

Surface Water and Decontamination Water

Treatment design calculations for surface water and decontamination water (Stream 2) were performed using the concentrations for groundwater samples collected in December 1989 from beneath Tar Lake as the approximate influent concentration requiring treatment. These concentrations are summarized in Table 4-3. Design calculations were based on a combined total volume of 2 million gallons of water requiring treatment over six months. This combined volume would require a treatment flow rate of approximately 6 gpm. The desired effluent criteria used in the design calculations are summarized in Table 4-3.

To achieve the desired effluent criteria for Stream 2, computer model results run by Carbonair recommend the use of two liquid-phase carbon adsorbers (Carbonair PC 13 vessels) operated in series, each loaded with 1,500 pounds of reactivated carbon. The influent flow rate would be 6 gpm. Using this suggested system, carbon replacement of 3,000 pounds would be required every 70 days, or twice over six months for treatment of a total of 2.6 million gallons of water. The flow range of the Carbonair PC 13 vessel extends up to 90 gpm so the vessels could handle a higher flowrate, if necessary.

Pumps, piping, and a discharge system are also required for each treatment system and have been included in the cost estimate.

5.0 GROUNDWATER

As discussed in previous site investigation reports and historical documents, some tar constituents have over time leached to groundwater. Hazardous substance constituents in groundwater appear to attenuate naturally within a few hundred feet of Tar lake. Trace amounts of non-hazardous alkylphenols (with very low taste and odor thresholds) result in organoleptic degradation of the top of the aquifer that extends several thousand feet beyond the property boundary. Elevated concentrations of dissolved iron are also found in downgradient groundwater due to biological breakdown of organic compounds within the aquifer.

Tar removal may change the current equilibrium between tar, meteoric water that comes in contact with tar, and affected groundwater. Without gathering additional data regarding tar and soil leachability — and without expending significant effort to model the dynamics of water flow, the planned tar removal, and the fate of constituents that leach into groundwater during removal — the magnitude of this change is difficult to project with any certainty. However, despite surface activities (e.g., the proposed removal), ongoing biological processes are expected to continue contributing significantly to contaminant attenuation via in-aquifer degradation of organic compounds within a short distance of Tar Lake.

To mitigate short-term impacts to groundwater (if any) during removal activities, the following groundwater management approach may be used:

- An updated offsite well survey will be conducted to determine the current extent of the plume, which will be used as a pre-removal "baseline".

- Additional groundwater monitoring wells will be installed onsite to monitor contaminant trends before, during, and after tar removal.

- Institutional controls will be implemented to restrict groundwater use onsite.

If remedial actions are needed to supplement groundwater management during the tar removal, a preventative air sparging system can be installed immediately downgradient of Tar Lake to enhance naturally occurring biological activity.

5.1 Potential Impacts to Groundwater

Tar removal activities and the resulting exposure of underlying soil may adversely impact groundwater through accelerated leaching. As tar and impacted soil are exposed to direct precipitation over the construction season, tar constituents may leach into groundwater.

5.1.1 TCLP Data

Rainwater leach testing of the tar and soil has not been conducted to date. However, TCLP analyses performed on the tar during predesign investigations indicated benzene, 2-methylphenol, 3-methylphenol, 4-methylphenol, and pyridine were leachable under test conditions (tar and leachate concentrations are shown in Section 4). As discussed in MDEQ Operational Memorandum #12 (Revision 2), the TCLP was developed for approximating landfill leachate, and as such likely does not simulate site conditions accurately. However, to assess gross leachability from the tar, these data were evaluated.

Tar leachate concentrations typically exceed health-based drinking water standards by two orders of magnitude for a limited number of compounds. For example, benzene leachate concentrations average 300 micrograms per liter (μg/L); benzene's health-based criterion for residential groundwater is 5 μg/L. Similarly, 4-methylphenol concentrations average 19,600 μg/L; 4-methylphenol's health based criterion is 37 μg/L.

TCLP data were used to calculate the leachability ratio of the tar. The leachability ratio is defined as:

$$\textit{leachability ratio} = \frac{\textit{leachate concentration}}{\textit{total concentration}}$$

For example, for benzene, the leachability ratio was estimated using average leachate concentrations (307 parts per billion [ppb]) and average total concentrations (21,400 ppb):

$$leachability\ ratio = \frac{307\ ppb}{21{,}400\ ppb} = 0.014$$

A leachability ratio of 0.014, or 1.4%, suggests that a very small fraction of tar compounds is removed from the source during TCLP analyses. This fraction was similar for other compounds quantified during TCLP analyses.

If the same leaching rate is applied to soil using maximum concentrations presented in the *Tar Lake Site Pre-Design Report*, leachate concentrations of benzene will be less than 1 μg/L, as shown below:

$$leachate\ concentration = soil\ concentration \times leachability\ ratio$$

$$leachate\ concentration = 40\ ppb \times 0.014 = 0.56\ ppb$$

Similarly, assuming a maximum soil concentration of 20,000 ppb, leachate concentrations of 4-methylphenol will be 280 μg/L.

Actual soil leachability characteristics are unknown. The analysis presented above assumes similar characteristics between tar and soil. This analysis may not be adequate for the following reasons:

- Underlying soil, with constituent concentrations 2 to 3 orders of magnitude less than tar, is highly permeable. The *Antrim County Soil Survey* (December 1978) cites surface soil infiltration rates of up to 6 to 20 inches per hour. It is unclear whether highly permeable soil would have adequate retention capacity to leach significant concentrations.

- During the removal action, only some subset of the tar will be newly exposed to precipitation at any given time. The precipitation volume will be significantly less than the annual volume, and contact times will be short.

- Analytical techniques applied during predesign may not adequately represent leachable fractions. Both tar and elevated-concentration soil samples were run using Contract Laboratory Program (CLP) medium level (methanol) extractions. Tar constituents may be more soluble (i.e., more easily leached) in methanol than in neutral pH water. Similarly, acidic TCLP analyses may be more aggressive than actual (field) leaching conditions.

- Source tar, although certainly containing higher concentrations of leachable constituents than soil, is much less permeable. The existing tar in Tar Lake may have acted as a "cap", retarding infiltration and thus minimizing leachate flux into the aquifer. In this case, current conditions are not necessarily representative of "worst case" conditions.

These factors make the prediction of leachate concentrations (especially leachate from exposed soil) difficult, but suggest that the leachate concentrations from soil will likely be less than those from the source tar.

5.1.2 Dilution Capacity

The contribution by leachate to overall aquifer flow beneath the site can be quantified. Comparing the average annual precipitation onto Tar Lake with the natural groundwater flow through the aquifer beneath the lake yields a factor for dilution of leachate constituents once it percolates to the water table.

To estimate the annual precipitation falling on Tar Lake, assume that 31.4 inches of precipitation fall annually in Antrim County (*Antrim County Soil Survey*, December 1978) and that the surface area of Tar Lake is 62,000 square feet. Using these values, approximately 1.2 million gallons of direct precipitation on Tar Lake can be expected annually. Assuming no evapotranspiration, 1.2 million gallons of recharge can be expected each year.

The aquifer underlying Tar Lake is highly transmissive, with estimated transmissivities of approximately 6,500 ft^2/day. Hydraulic conductivities are typically calculated using the equation:

$$\textit{hydraulic conductivity} = \frac{\textit{transmissivity}}{\textit{aquifer thickness}}$$

At the Tar Lake site, the aquifer is expected to be approximately 400 feet thick. However, aquifer tests performed onsite in 1993 suggest that due to the high transmissivities and the use of a partially penetrating extraction well, the entire aquifer was not stressed during testing. Clearly, overestimating the aquifer thickness results in underestimating the hydraulic conductivity of the aquifer system. Therefore, to estimate the conductivity of the upper portion of the aquifer, a partial aquifer thickness of 100 feet was used to account for the screened depth (to 60 feet below the water table) and a small portion of the aquifer which may have been impacted by vertical flow effects.

$$\textit{hydraulic conductivity} = \frac{6{,}500\ ft^2/day}{100\ feet} = 65\ feet/day$$

Groundwater velocity was estimated using Darcy's law:

$$velocity = \frac{(hydraulic\ conductivity) \times (hydraulic\ gradient)}{effective\ porosity}$$

Assuming an average hydraulic gradient at the site of 0.0091 feet/foot (the static gradient measured before 1993 tests), and an effective porosity of 0.25, the velocity onsite was calculated to be:

$$velocity = \frac{(65\ feet/day) \times (0.0091\ feet/foot) \times (365\ days/year)}{0.25} = 860\ feet/year$$

This velocity represents the average groundwater velocity through the upper portion of the aquifer.

To calculate the aquifer's dilution capacity, the mixing zone or dilution depth was assumed to be 10 feet. Thus flow of the aquifer through this zone was calculated assuming Tar Lake's maximum width is 600 feet. The flow is estimated as:

$$flow = (lake\ width) \times (dilutional\ depth) \times (velocity)$$

$$= (600\ feet) \times (10\ feet) \times (860\ feet/year) = 5{,}160{,}000\ cubic\ feet/year$$

Expressed in gallons, the rate of groundwater flow that can be expected to dilute leachate from tar is 38.6 million gallons per year. The large volumetric flow within this top portion of the aquifer dilutes precipitation roughly thirty-fold (38.6 million base flow plus recharge of 1.21 million gallons per year).

Given that the highly transmissive aquifer provides on average a thirty-fold dilution of incipient leachate, constituent concentrations in the aquifer downgradient of Tar Lake would be less than the soil concentrations estimated above. For example, if benzene in soil leached from a maximum soil concentration of 40 ppb to a leachate concentration of 0.6 ppb, the leachate would be diluted by a factor of 30, to 0.019 ppb. Similarly, 4-methylphenol present in soil at 20,000 ppb, leaching at a concentration of 280 ppb, would be diluted to 9.3 ppb in downgradient groundwater.

As discussed in Sections 3 and 4, rainwater and ponded water collected during the removal action will be treated using granular activated carbon to concentrations less than MDEQ industrial criteria. Treated water will be discharged onsite within the plume boundaries. Given this, infiltration of untreated leachate will be minimized.

5.1.3 Tar/Soil/Groundwater Data

Historical data collected immediately below Tar Lake (1988/1989) indicated constituent concentrations similar to those predicted above for tar leachate (i.e., part-per-million levels). Constituent concentrations in wells MW-201 and MW-202 are shown in Table 4-3. However, vertical profiling immediately downgradient (100 to 200 feet) of Tar Lake in 1993 indicated acetone, methylene chloride, toluene, ethylbenzene, and xylene at concentrations less than 20 μg/L within the aquifer; 2,4-dimethylphenol, naphthalene, 2-methylnaphthalene, and phthalates were detected at concentrations less than 35 μg/L. Additionally, historical sampling at the property boundary indicate 2,4-dimethylphenol concentrations of less than 60 μg/L and benzene, ethylbenzene, naphthalene, and 4-methylphenol concentrations of less than 10 μg/L each. Constituent concentrations at onsite downgradient monitoring wells have never exceeded health-based criteria. Data suggest that significant natural attenuation is occurring downgradient of Tar Lake.

The degree of attenuation in constituent concentrations over short distances, and secondary geochemical evidence of biodegradation (low dissolved oxygen, high dissolved iron) have been discussed in previous site documents. Various factors can account for the low concentrations quantified within the aquifer, including the age of the source and decreased leachability of exposed surfaces over time, or biotic and abiotic attenuation (dilution, dispersion, retardation, biodegradation, etc.) within the soil column and within the aquifer immediately beneath Tar Lake. While precise measurements of the effects of this natural attenuation are not available, it clearly results in significant decreases in site constituents in groundwater within a short distance of the source.

5.1.4 Organoleptic Groundwater Plume

As discussed in previous documents, an organoleptic plume extends approximately 4 miles downgradient of the site. The organoleptic plume is attributed to low concentration alkylphenols (methylphenols, etc.) migrating beyond the property boundary. Groundwater concentrations in offsite residential wells are below detectable limits (0.8 μg/L, using the specially designed Research Triangle Institute protocol in 1988) for various alkylphenol groups, but are still characterized by taste and odor. The organoleptic threshold, therefore, is below detectable concentrations.

The significant attenuation occurring within the aquifer (from part-per-billion concentrations at the property boundary to part-per-trillion levels offsite) indicates significant attenuation/retardation within the aquifer.

5.2 Offsite Well Survey

The last areal survey of the Tar Lake plume occurred in 1993. Seventeen residences indicated impacts to drinking water supply wells, including taste, odor, and iron precipitation; wells are shown in Figure 5-1.

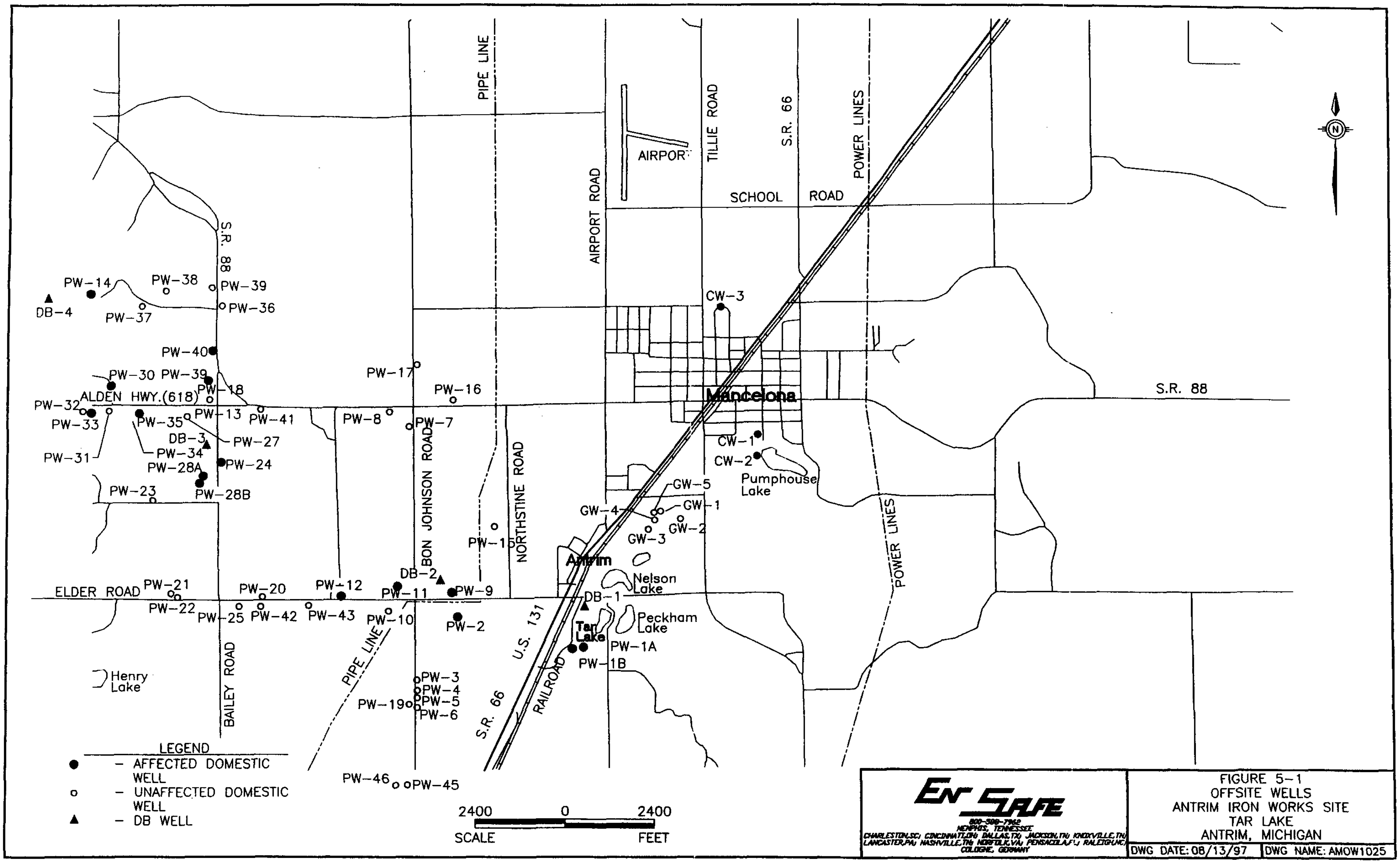


FIGURE 5-1
OFFSITE WELLS
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

Work performed in the early 1980s determined that the primary organoleptic constituents of concern were alkylphenols. No CLP VOCs or SVOCs are present above health-based thresholds offsite. Nonhazardous alkylphenols are not included in standard semivolatile analyses. The 1983 investigations of the offsite organoleptic plume used a total phenolic analysis (the 4-aminoantipyrene test) to quantify the presence or absence of phenolics in groundwater and delineate the extent of the plume. The Research Triangle Institute protocol indicated that alkylphenols were not present above detectable concentrations (0.8 ppb), but still were noticeable by taste and odor.

The proposed offsite well survey will establish current offsite conditions, indicating any changes in plume status as well as in the number of residences currently using groundwater as a potable source. The survey will be mailed to residents living in the plume area and currently listed with the Antrim County Health Department as using private wells. The survey is included in Appendix B.

5.3 Groundwater Monitoring Network

A groundwater monitoring system will be installed to monitor constituent concentrations in the aquifer during and after the tar removal action. The network will include existing, upgradient wells MW-1 and MW-16, shown on Figure 5-2, as well as new wells. Downgradient network wells will be established near Tar Lake, at the downgradient site boundary, and at intermediate locations, as shown in Figure 5-3. Where possible, if site logistics allow, existing wells will be incorporated into the monitoring network (e.g., MW-6, MW-7, PZ-2, PZ-3).

The monitoring network will allow:

- Timely detection of groundwater impacts of tar removal, if any;

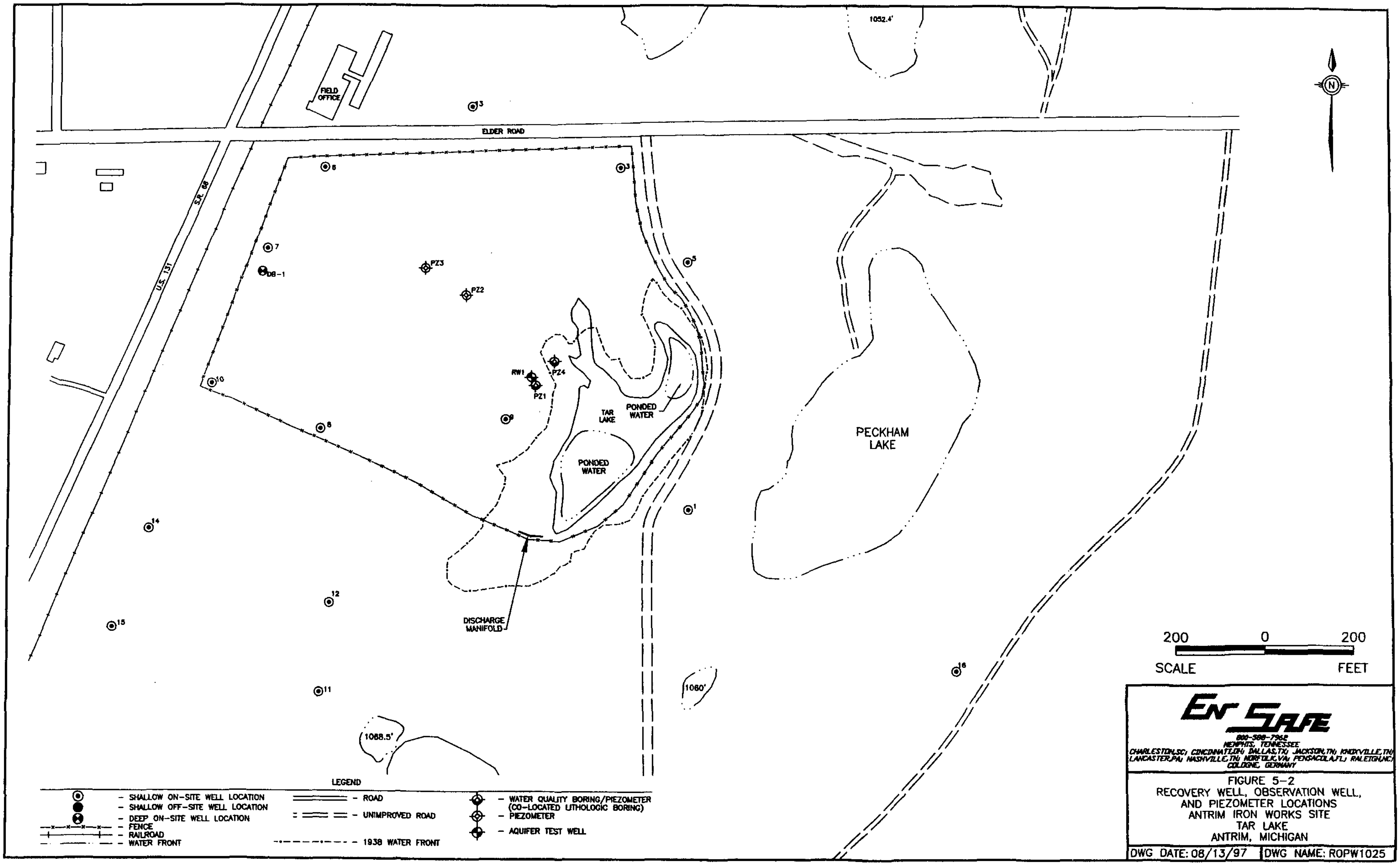


FIGURE 5-2
RECOVERY WELL, OBSERVATION WELL, AND PIEZOMETER LOCATIONS
ANTRIM IRON WORKS SITE
TAR LAKE
ANTRIM, MICHIGAN

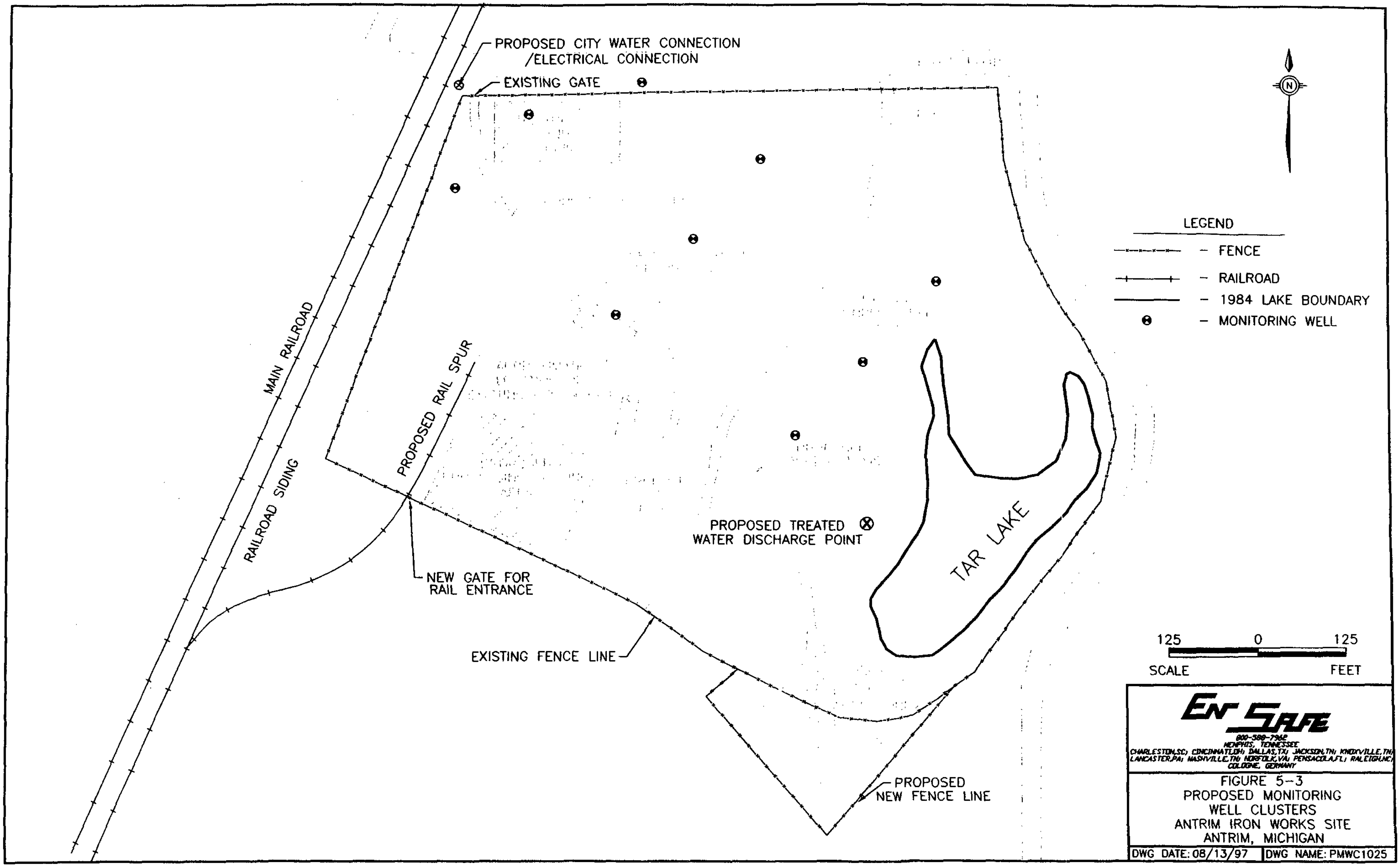


FIGURE 5-3
PROPOSED MONITORING
WELL CLUSTERS
ANTRIM IRON WORKS SITE
ANTRIM, MICHIGAN

DWG DATE: 08/13/97 | DWG NAME: PMWC1025

- An assessment of the rate of attenuation due to continued biological action and other mechanisms; and

- Early warning of potential for offsite impacts.

5.3.1 Basis of Design

The main body of Tar Lake is approximately 900 to 1,000 feet away from the northwestern property boundary of Elder Road and U.S. Highway 131. Assuming groundwater velocities of 860 feet/year (discussed in Section 5.1.2), advective transport from Tar Lake to the property boundary will take approximately 12 to 14 months — this estimate assumes no retardation (i.e., worst case conditions).

The monitoring well network shown on Figure 5-3 is placed 200 feet (Series A), 500 feet (Series B), and 800 feet (Series C) from Tar Lake to detect any impacted groundwater as it moves downgradient of Tar Lake. The first wells will intercept groundwater approximately three months after it flows beneath Tar Lake. Upgradient wells (MW-16 and MW-1) will provide background information regarding water quality and aquifer geochemistry.

This configuration will provide adequate time to implement the preventive groundwater measures if groundwater is being unacceptably impacted. Additionally, the well configuration is optimal to monitor natural attenuation at intermediate well locations.

5.3.2 Well Specifications

Groundwater monitoring points will be completed as nested wells monitoring three discrete depth intervals within the aquifer. The monitoring points will be spaced at 150-foot intervals along the northwestern perimeter of Tar Lake, 200 feet, 500 feet, and 800 feet downgradient of the removal area.

Well nests will include three 2-inch inner diameter polyvinyl chloride (PVC) monitoring wells, set 10 feet, 40 feet, and 60 feet below the water table. The 0.010 slot, PVC well screens will be 10 feet long. Because natural formation can be collapsed against the well screen, no filter pack will be emplaced.

5.3.3 Monitoring Plan

The first sampling event will assess groundwater quality up- and downgradient of the lake. The objective of the baseline event is to establish a "snapshot" of groundwater quality before the removal action begins to better assess potential impacts.

Network monitoring wells and upgradient, onsite wells MW-16 and MW-1 will be sampled and analyzed for VOCs, SVOCs, inorganics, and geochemical parameters (alkalinity, dissolved oxygen etc.). These data will be compared with health-based criteria. Groundwater will also be analyzed using the 4-aminoantipyrene analysis for total phenolics (Standard Methods 5530-C). The total phenolics concentration will be compared to CLP results. The characteristic groundwater "signature" will be used to define pre-removal groundwater conditions.

Wells will be monitored quarterly during the removal action to determine if potential leaching has caused exceedances of human health criteria. Quarterly monitoring is expected to be sufficient to monitor offsite threats given worst-case travel times (860 feet/year).

Of the 29 wells within the monitoring network, a maximum of 20 will be monitored at the beginning of the removal effort. For example, MW-16, MW-1, and Series A and B wells will be monitored first. If impacts are seen at Series B wells, Series A wells may be dropped and the B/C series may be monitored instead. Well selection will be based on previous quarters' monitoring data.

5.4 Institutional Controls

Institutional controls will be placed on groundwater use on the Tar Lake property. Installing residential or potable water supply wells on the property will be prohibited.

5.5 Community Education

Community education regarding the removal action and preventive groundwater actions will be integral to field activities. Community relations activities will conform to the requirements established in the NCP, 40 CFR 300.415(m).

Community relations during the removal action will focus on supplementing other forms of communications (such as the administrative record). Efforts will address area residents' concerns regarding the removal action, including:

- How and when the removal will occur
- Possible "impacts" from the action (e.g., odor, temporary blockage of public roadways, etc.)
- Groundwater issues, including
  - potential impacts due to the removal action
  - the groundwater monitoring program
  - additional groundwater management strategies, if required

Multiple community relations activities can be implemented to meet these concerns, including municipal involvement, fact sheets, press releases, etc. A question-and-answer forum, such as a telephone messaging center or message board, may also be used to mitigate community concerns.

5.6 Additional Groundwater Management Strategies

If additional groundwater management strategies are required, air sparging has been identified as a groundwater remedy to mitigate potential short-term impacts to groundwater quality by tar constituents released during the removal action.

5.6.1 Rationale for Technology Selection

As discussed earlier, historical data suggest significant attenuation is occurring in the aquifer within a short distance downgradient of Tar Lake. Low dissolved oxygen concentrations and high dissolved iron levels suggest that natural biological actions may be oxygen-limited. Air sparging — or, more appropriately, biosparging — can introduce air into both saturated and unsaturated zones to further enhance aerobic biodegradation. All site constituents which may pose a threat to downgradient receptors are amenable to sparging/biosparging techniques.

The air sparging system can be used in conjunction with the monitoring well network to evaluate aquifer conditions throughout the tar removal effort. Network monitoring data, sparging system operational parameters, and site observations can be integrated to manage mitigation efforts.

Feasibility analyses regarding interim groundwater actions presented in the *Tar Lake Site Pre-Design Report* concluded that in situ techniques are preferred to ex situ groundwater management due to the extremely transmissive nature of the aquifer. Because sparging wells tend to cause mounding effects in the aquifer, the hydraulic gradient immediately downgradient of Tar Lake – between the lake and the sparging fence – may flatten out or reverse. Such localized changes, under equilibrium, may reduce groundwater velocities through the treatment area, enhancing treatment effectiveness by increasing the time required for groundwater travel between Tar Lake and the property boundary.

5.6.2 Conceptual Design

At Tar Lake, the air sparging system could consist of a "fence" of sparging wells installed to a depth of 60 feet below the water table, immediately downgradient of Tar Lake, perpendicular to groundwater flow. Air could be injected into the aquifer through one or more small screened intervals in each sparging well. Groundwater flowing through the fence would be oxygenated, both stripping volatile organics and enhancing bioactivity within the aquifer.

For cost estimating purposes, the conceptual sparging system was described as follows:

- An air sparging system composed of 17 2-inch diameter air injection wells.
- 200 to 300 cubic foot per minute, 100 pound per square inch air compressor with controllers.
- 1,000 linear feet of piping.
- Temporary monitoring points.

For purposes of costing, each sparging well is assumed to have a 15-foot radius of influence; the conceptual fence would span the breadth of the plume. The actual number of wells and well locations will be determined after the site is cleared and inspected as described in Section 2.

6.0 HEALTH AND SAFETY

All site workers will be responsible for operating in accordance with the most current OSHA regulations including 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response, and 29 CFR 1926, Construction Industry Standards, as well as all other applicable safety and health regulations as outlined in the *Pre-Design Health and Safety Plan* (HASP; EnSafe 1993). Activities to be conducted onsite that are not addressed in the existing HASP will be in an amendment prepared and submitted for USEPA review and comment. Contractors will either adopt and abide by the site-specific HASP or shall develop their own site-specific plans which, at a minimum, meet the requirements of the site-specific HASP.

7.0 COST ESTIMATE

Cost estimates for infrastructure improvements, the removal and recycling or reuse of tar, process water treatment, and groundwater monitoring and contingent groundwater action are summarized in Tables 7-1 to 7-4. The overall estimated cost to complete the tar removal and all associated activities is $9,280,000, as itemized below:

Work Phase		Cost
	Infrastructure Improvements	$307,000
	Tar Removal and Recycling/Reuse	$6,385,000
	Wastewater Treatment	$191,000
	Groundwater Management	$753,000
Subtotal		$7,636,000
	Design and Oversight (8%)	$611,000
	Contingency (15%)	$1,145,000
Total Cost		$9,390,000

Table 7-1
Infrastructure Improvements

Activity	Description	Cost
Site Improvements		
Site Clearing	Tree clearing and removal from work areas.	$21,600
Site Survey	Site walk of all work areas.	$9,100
Site Grading	Grading of work area and roadways.	$14,000
Access Roads, Work Zones, and Parking	Upgrade or Installation of access roads, parking areas, and work zones.	$18,000
Railway	Upgrade of existing siding line and/or installation of onsite spur.	$50,000
Utilities		
Power	Installation of electrical power distribution.	$20,000
Telephone Service	Installation of telephone service to each field trailer.	$500
Water Supply	Tie-in to city water supply.	$32,500
Sanitary Services	Mobilization and rental of portable restroom facilities.	$8,700
Operations		
Site Fencing and Access	Relocation and/or addition of fences and gateway entrances.	$42,000
Decontamination Pad with Pole Barn	Installation of pad and pole barn sized for decontamination of 18-wheel truck and trailer.	$17,500
Field trailers	Delivery and rental of field trailers.	$6,500
Decontamination trailer	Delivery and rental of personnel decontamination showers.	$45,000
Slag Relocation	Onsite relocation of slag obstructing access to work zone or underlying tar.	$21,600
Total Costs for Infrastructure Improvements		**$307,000**

Table 7-2
Tar and Debris Removal

Activity	Description	Cost
Tar Removal, Transportation, and Recycling/Reuse		
Tar removal, treatment, and loading	Removal of 22,700 tons of tar, any onsite treatment, and loading into rail cars or trucks	$1,362,000
Transportation via rail	Offsite transportation of 38,600 tons of material to re-use facility via rail	$2,123,000
Recycling/Re-use	Offsite re-use of 38,600 tons of material	$2,316,000
Treatment materials	Purchase and delivery of 22,700 tons of sawdust	$300,000
Debris/Slag Handling and Disposal		
Debris transportation	Transportation of 500 CY of nonhazardous debris to a Class D landfill	$10,000
Debris disposal	Disposal of 500 CY of nonhazardous debris in a Class D landfill	$9,000
Slag transportation	Transportation of 5,000 CY of nonhazardous slag contaminated with tar to a Class D landfill	$100,000
Slag disposal	Disposal of 5,000 CY of nonhazardous slag contaminated with tar in a Class D landfill	$90,000
Odor Controls		
AFFF Odor Suppressant	Purchase and delivery of 20 drums of AFFF foam and application equipment	$75,000
Total Cost for Tar Removal		**$6,385,000**

Table 7-3
Wastewater Treatment

Activity	Description	Cost
Process Water		
Vessel Rental	Rental of two 1500-lb carbon units.	$4,500
Preparation charge and hose kit		$1,200
Pumps, piping, and discharge structure	Purchase, delivery, and setup.	$1,500
Carbon (first load)		$2,500
Carbon (replacements loads)		$52,500
Hose and Fittings		$300
Water Storage Tank Rental	Rental charges for two 20,000 gallon storage tanks.	$18,000
Effluent Sampling and Analysis	Analysis of 50 samples for VOCs (Methods 8240) and SVOCs (Method 8270).	$22,500
Surface Water and Decontamination Water		
Vessel Rental	Rental of two 1500-lb carbon units.	$4,500
Preparation charge and hose kit		$1,200
Pumps, piping, and discharge structure	Purchase, delivery, and setup.	$1,500
Carbon (first load)		$2,500
Carbon (replacement loads)		$15,000
Hose and Fittings		$300
Water Storage Tank Rental	Rental charges for two 20,000-gallon storage tanks.	$18,000
Effluent Sampling and Analysis	Analysis of 100 samples for VOCs (Methods 8240) and SVOCs (Method 8270).	$45,000
	Total Costs for Wastewater Treatment	**$191,000**

Table 7-4
Groundwater Management

Activity	Description	Cost
Offsite Survey		
Offsite Survey	Preparing resident survey, reviewing results, report preparation.	$10,000
Monitoring Network and Quarterly Monitoring		
Well Installation	Installation of 27 wells downgradient of Tar Lake, professional labor, travel and lodging, and equipment costs.	$101,300
Initial Sampling Event	Sampling 29 wells to develop baseline.	$35,400
Quarterly Monitoring Events — Total Cost	Analysis costs for 20 wells over 12 quarters (three years), labor for sampling personnel, travel and lodging, equipment costs, and report preparation.	$362,900
Institutional Controls		
Legal and filing fees		$10,000
Air Sparging System		
System	Sparging wells installation (17 wells).	$72,300
	Air compressor, controls, building	$63,000
	System install, startup, and optimization	$20,000
Design	Plans and specifications, performance testing (20%).	$31,100
O&M	Electricity, maintenance over two years (15% per year).	$46,600
Total Cost for Groundwater Management		**$752,600**

Appendix A

Photographic Log

Shown in this photograph is liquid tar that could be pumped from Tar Lake during the tar removal. Several contractors have indicated they would pump liquid tar first and then remove the rest of Tar Lake.

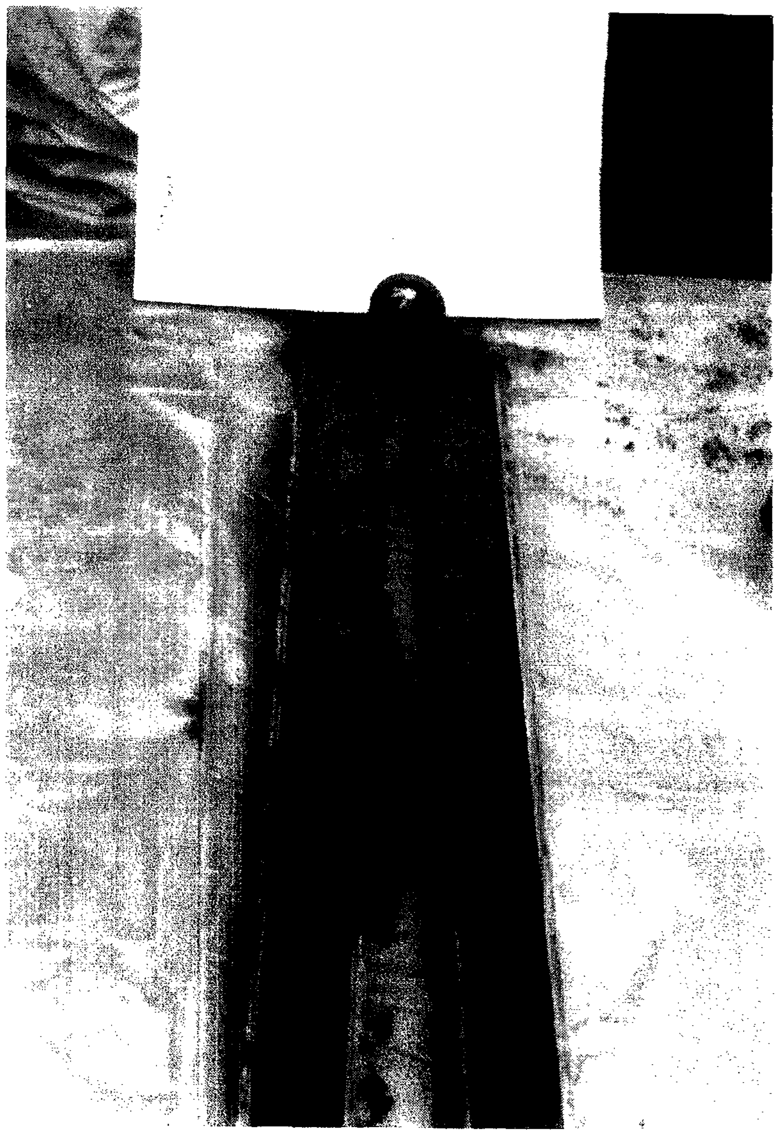
Liquid tar is shown on the end of a stainless steel spoon.

Once liquid tar is removed, the contractors have indicated the remaining tar would be removed from Tar Lake using an excavator.

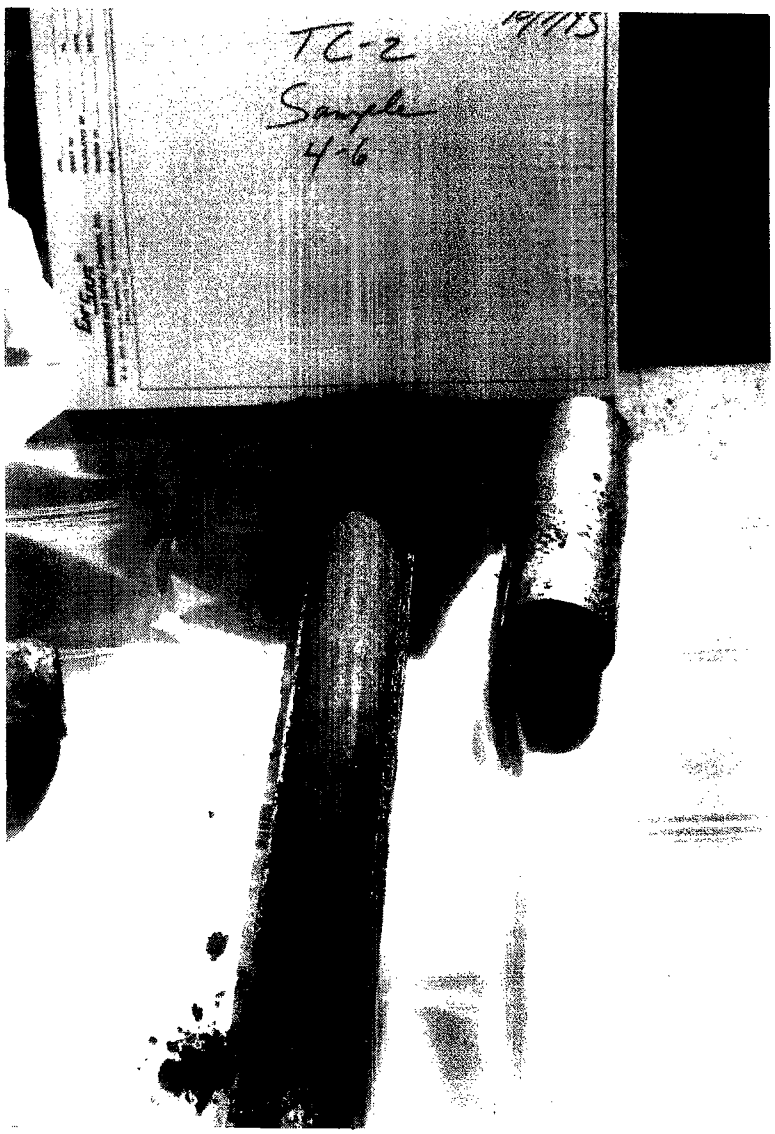
Here, an excavator bucket is shown full of tar.

The following three photographs illustrate split-spoon samples of tar and soil collected during the pre-design investigation. Each boring illustrates the various forms of tar that have been identified at the site: tar; tarry soil; stained soil; and clean soil.

(1) This boring was taken at sample location G1S from a depth of 18- to 20 feet below ground surface (bgs).



(2) This boring was taken at sample location TC-1 from a depth of 2 to 4 feet bgs.



(3) This boring was taken at sample location TC-2 from a depth of 4 to 6 feet bgs.

Appendix B
Offsite Well Survey

TAR LAKE – 1997 PRIVATE WELL SURVEY

Part I

Provider of Information:____

Telephone Number:____

Address of Antrim County Residence:________________________________

____

Other Address (if Antrim County is seasonal):__________________________

____

Part II

How long have you owned/rented this property?__________________________

Are you a full-time resident or a seasonal resident?______________________

If seasonal, how many months per year do you use the Antrim County residence?________

What is the source of your water:

- Private Well ☐ ________________________
- City/County Water ☐ ________________________
- Other ☐ ________________________

If you use multiple water supplies, please indicate what each is used for (i.e., drinking, laundry, irrigation, etc.).

Part III

If you use a private well, when was it installed?________________________________

How deep is it?________________________________

What is the pumping rate?________________________________

If you use a private well, does it have any taste, odor, or color?________________

If yes, have these changed during your residence (i.e., better or worse)?__________

Do you use your private well for drinking/cooking water?____________________

Do you use any type of water treatment device?__________________________

If yes, please specify type and manufacturer.____________________

Part IV

If we have further questions, where and when may we contact you?______________

____

Would you permit a technician to sample your well water?____________________

Please return all surveys in the enclosed, pre-addressed envelope by XXXX XX, 1997.