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FINAL

ENVIRONMENTAL INVESTIGATION AND RISK ASSESSMENT PHASE I REPORT TACONY WAREHOUSE PHILADELPHIA, PENNSYLVANIA

SUBMITTED TO:

U.S. ARMY ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND 21010-5401

SUBMITTED BY:

VERSAR, INC.
2010 CABOT BOULEVARD WEST
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Versar, Inc., performed and Environmental Investigation at the Tacony Warehouse Facility in Philadelphia, Pennsylvania. This final document presents the findings of the investigation, including an analysis of the analytical data obtained during the investigation. The Risk Assessment included as Section 8 of the document evaluates prospective risks of compounds identified on the site. This document provides the basis for the Phase II Report; ARARs Evaluation and Alternatives Analysis for the Tacony Warehouse Site.

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EXECUTIVE SUMMARY

Versar, Inc. (Versar) conducted an Environmental Investigation (EI) at the Tacony Warehouse in Philadelphia, Philadelphia County, Pennsylvania. The initial investigative phase of the EI was conducted from October 1990 through January 1991. A follow-on investigation was conducted in June and July 1991, and a confirmatory investigation was conducted in May and June 1992. The U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) contracted Versar to perform the EI under contract DAAA15-90-D-0014. Modification No. 1 to the subject contract provided for the follow-on investigation and Modification No. 2 allowed the confirmatory investigation. This document contains the EI report for the Tacony Warehouse.

During the EI, samples were collected of ground water, surface water, sediment, and soil, and wipe samples were collected from building surfaces for EPA TCL parameter analyses. In addition, samples were collected from underground storage tanks for product identification, from onsite transformers for PCB analyses, and from suspected asbestos-containing building materials. A radiological investigation of onsite buildings was also conducted.

The results of the EPA TCL analyses showed elevated levels of metals, volatile organic compounds, and semivolatile organic compounds (primarily polycyclic aromatic hydrocarbons) in the various environmental media. The primary sources of the contamination were tentatively identified as the former spray pond and the above ground and underground storage tanks located onsite.

Ground water sampling identified the presence of tetrachloroethylene and associated breakdown products including vinyl chloride in the area of an abandoned underground storage tank at the site. Ground water flow patterns in the area of concern were complicated by mounding believed to be caused by leakage from the facility's storm sewer system. The mound and aquifer materials in the area of concern have an apparent accelerating effect on ground water velocities that may have promoted movement of the volatile plume toward the southwestern property boundary. Confirmation of movement across the boundary, if any, could not be obtained due to physical constraints at the site.

Elevated levels of organic and inorganic constituents were detected in surface and subsurface soils at the site. Metals concentrations in surface soils were consistently several orders of magnitude above subsurface soil concentrations. Subsurface concentrations are believed to primarily represent the variability of soils at the site. Organic compounds detected at low levels in surface soils (petroleum hydrocarbons, chlorinated herbicides, and PCBs) are related to the historic application of waste oils and herbicides to control weed growth. No indication of movement of these compounds to subsurface soil and ground water was discovered. The source of PAH's, petroleum hydrocarbons, and VOCs in subsurface soils are believed to be the above and underground storage tanks and the spray pond. These compounds, with the exception of VOCs, have not had a confirmed impact on ground water at the site and have remained primarily in the area of deposition.

The tank identification sampling indicated that the materials stored in the tanks were petroleum products. The contents of an abandoned underground storage tank could not be determined, although environmental samples suggest solvent disposal. The transformer sampling indicated that several of the transformers were either PCB contaminated or PCB containing, and the asbestos sampling revealed the presence of several asbestos containing building materials located throughout the site. The radiological survey did not reveal any elevated radiation levels at the TW site.

An evaluation was conducted of the human health risks and environmental endangerment posed by site-related chemicals on and potentially migrating from the Tacony Warehouse Site. The risks associated with exposure to contaminants identified at the Tacony Warehouse site were evaluated using the available monitoring data, as presented in this report. Models were used to obtain concentration estimates if monitoring data was unavailable. The risks were determined based on the absence of any actions to control or mitigate the predominant site characteristics of concern (i.e., under an assumption of no action). The baseline risk assessment evaluated existing monitoring data against standard EPA criteria to identify chemicals of potential concern (metals, pesticides, semi-volatile and volatile organics). Chemicals were identified in surface soils along the railroad track, subsurface soils for the entire site and in the former spray pond area, ground water, and surface water and sediments within the storm drain system.

Possible present and future receptors for the chemicals of potential concern and potential exposure pathways were identified using local demographic and land use data, as well as site observations. The following pathway/receptor combinations were assessed:

- Ingestion of surface soil by onsite workers and trespassers (present),
- Dermal absorption of surface soil by onsite workers and trespassers, (Present)
- Ingestion of surface soil by onsite residents (future),
- Dermal absorption of surface soil by onsite residents (future),
- Ingestion of surface soil by onsite workers (future),
- Dermal absorption of surface soil by onsite workers (future),
- Ingestion of surface soil by onsite recreational users (future),
- Dermal absorption of surface soil by onsite recreational users (future),
- Ingestion of subsurface soil by onsite construction workers (future),
- Inhalation of fugitive dust generated from subsurface soils by onsite construction workers (future),
- Dermal absorption of subsurface soil by onsite construction workers (future),
- Ingestion of ground water by onsite residents (future),
- Inhalation of volatiles in ground water by residents (future),
- Dermal absorption of ground water by onsite residents (future).

Exposure to chemicals of potential concern in surface water and sediments are considered unlikely due to the high dilution of the Delaware River and because no surface water bodies are located on the Tacony Warehouse site. Sediment movement in the storm drainage system is unlikely due to the trap-like configuration of the storm drains.

The exposure point concentrations of the chemicals of potential concern were then quantitatively estimated for these media. The reasonable maximum exposure (RME) for each media was estimated using the 95 percent upper confidence limit of the arithmetic mean of the respective chemical concentrations. Chemical-specific intakes, or doses, were then calculated for the exposure pathways/receptors. The toxicity of the chemical was then compared to the respective dose to evaluate the risk of deleterious effects to human health.

The risk evaluation assessed the potential for both carcinogenic and non-carcinogenic effects. Of the chemicals assessed, 3 are classified as human carcinogens and 17 are classified as probable human carcinogens. The following scenarios yielded unacceptable risks (i.e., risks that were above the target risk range of 1E-04 to 1E-06):

- residential ground water ingestion by adults and children (entire site, MW-9 only, and entire site minus MW-9);
- residential surface soil ingestion by adults and children.

These are all potential future uses of the site. All present uses of the site yielded risks that were either within or below the target risk range of 1E-04 to 1E-06. Although individual pathway risks were within the target risk range, the total site risk was exceeded for future residential users of the site via ground water and surface soil exposure. Almost all carcinogenic risk for surface soils can be attributed to ingestion of arsenic. Arsenic, vinyl chloride, and tetrachloroethene provide most of the risk for ground water ingestion.

Non-carcinogenic hazards were assessed by comparing chemical-specific reference doses (i.e., the daily dose of a chemical to which humans can be exposed without appreciable risk of deleterious effects during a lifetime) to estimated doses. If the resulting hazard quotient is less than one, it is unlikely that even sensitive populations would experience adverse effects. If the index exceeds unity, adverse non-carcinogenic health effects may occur. In the event that a hazard index exceeded 1, chemicals were analyzed by target organ or critical effect. Non-carcinogenic hazards exceeded threshold levels for the following scenarios:

- residential ground water ingestion (entire site, MW-9, and entire site minus MW-9);
- residential ground water dermal absorption (entire site);
- residential surface soil ingestion (children only);
- subsurface soil ingestion (future excavation);
- subsurface soil inhalation (future excavation).

These all pertain to potential future uses of the property. Present uses of the site yielded risks below the threshold. Individual pathway hazards exceeded the threshold level for future residential ground water for both adults and children, for surface soils for potential future residential use by children, and subsurface soils for future excavation workers. Primary contributors to hazards from ground water ingestion were manganese, thallium, arsenic, cis-1,2-dichloroethene, and tetrachloroethene. Arsenic was the main contributor to the hazard via surface soil ingestion. Arsenic and thallium were primarily responsible for the subsurface soil ingestion hazard.

Ground water risks and hazards are probably over estimated because the use of ground water beneath the site as a potable source is unlikely. Public water is readily available and the presence of suspended solids makes unfiltered ground water virtually unusable. Additionally, due to the industrial and commercial land use of the area surrounding Tacony Warehouse, it is unlikely that the property will be used for residential purposes.

The potential for adverse effects to ecological receptors was also addressed. Nesting shorebirds and migratory waterfowl residing in the area, shellfish, and other aquatic life were considered, with aquatic life in the Delaware River immediately adjacent to the site the primary concern. Potential exposure from surface water and sediments were assessed. The average and maximum surface water concentrations for each surface water chemical of potential concern were compared against ambient water quality criteria for both freshwater and marine (saltwater) life because of the tidal nature of the Delaware River near the site. Cadmium, copper, lead, silver, and zinc were above acute freshwater criteria. All chemicals, except for arsenic, were above chronic freshwater criteria. All chemicals, except arsenic and mercury, were above the acute marine criteria, and all chemicals were above the chronic marine criteria. Site surface water concentrations were also compared to PADER criteria for continuous and maximum exposures. Cadmium, chromium, copper, lead, mercury, nickel, silver, thallium, and zinc exceeded PADER continuous criteria for surface water concentrated ions. Cadmium, thallium, and zinc exceed PADER maximum criteria. Although most of the chemical concentrations exceed at least one criteria, it is unlikely that aquatic life will be adversely affected. The evaluation uses onsite surface water concentrations from the storm drain system and sumps (where there is no highly developed aquatic life) and other conservative assumptions to assess conditions in the Delaware River. Dilution afforded by the river, estimated to be at least one hundred-thousand fold, is not considered.

Chemical concentrations in sediments from the site storm drain system were used to assess the potential effects on Delaware River benthos. Existing concentrations in the sediment were compared against interim sediment quality criteria, using a conservative assumption of sediment organic content of 1 percent (the criteria become more stringent as the organic content decreases). Phenanthrene and fluoranthene exceeded available interim sediment criteria. All sediment COPCs exceeded the Biological Effects Criteria (Effects Range-Low) for all compounds except the semi-volatiles, gamma-chlordane, and isodrin. Cadmium, chromium, copper, lead, nickel, zinc, and PCB 1260 exceeded the Effects Range-Moderate Criteria. Again, it is likely that the potential for adverse effects is overestimated. Sediment concentrations from the site storm drain system do not reflect concentrations in the Delaware River sediments. It is unlikely that sediment movement from the site storm drains will occur because of the trap-like structure of the drains. Additionally, detrital material in the drain system is likely to raise the organic content well above 1 percent.

SECTION 1.0

INTRODUCTION

1.1 BACKGROUND

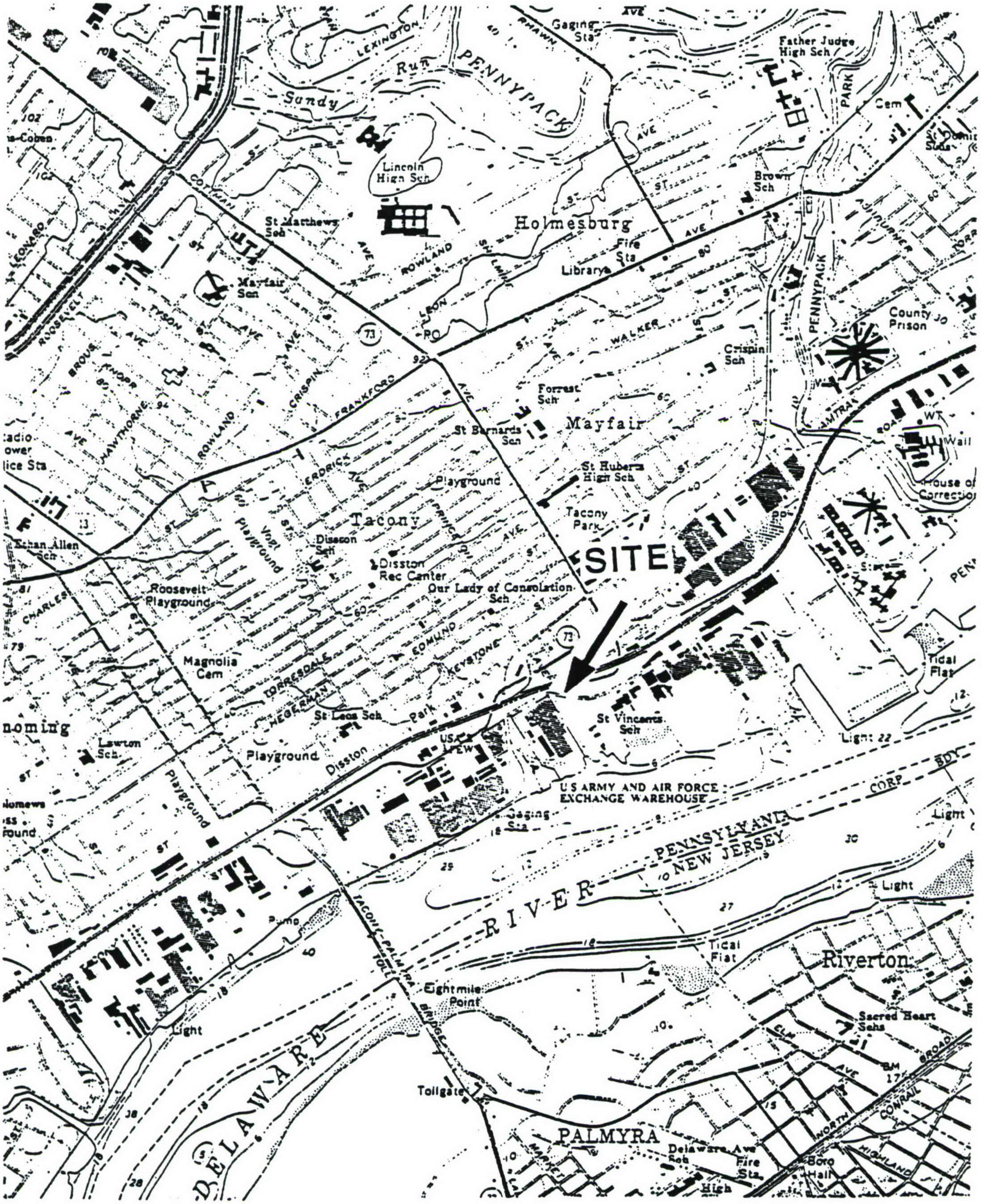
This EI report has been prepared by Versar for the Tacony Warehouse (TW) site in Philadelphia, Pennsylvania. Versar was contracted by USATHAMA to perform an EI at TW, as dictated in Contract No. DAAA15-90-D-0012. The course of this EI has followed the requirements and procedures of the approved project documents and the subject contract. This document has been prepared in accordance with EPA guidance on Remedial Investigation (RI) reports. This EI report presents a compilation of relevant data and analyses obtained during the investigation, with appropriate conclusions to address the need, if any, for remedial action at TW.

This section summarizes the basis for the EI, the objectives of the investigation, the history of site operations, and previous investigations performed at the site. The information presented represents that acquired and reviewed prior to the execution of the EI, or obtained during the course of the investigation.

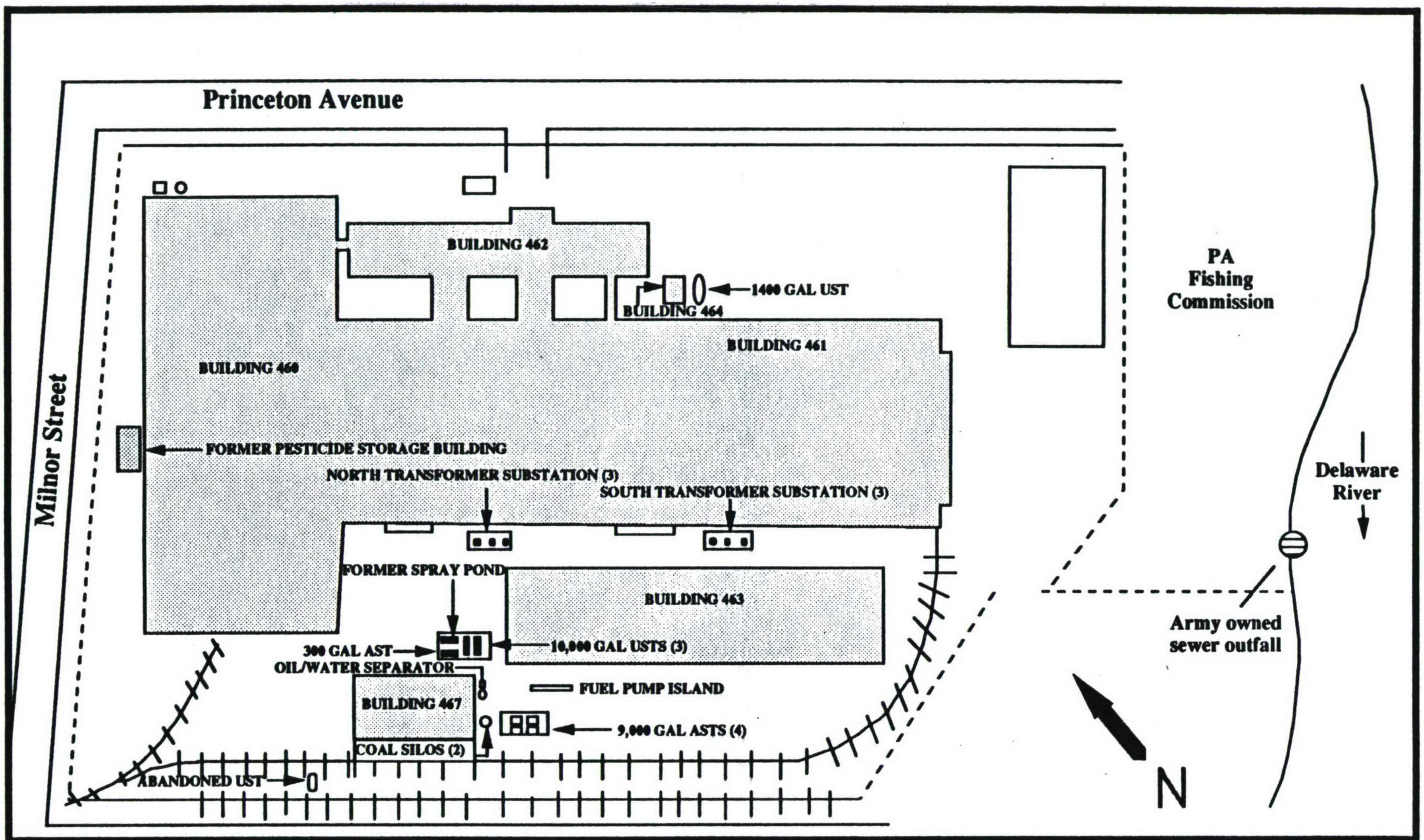
1.2 SITE LOCATION AND HISTORY

The Tacony Warehouse (TW) site consists of a 14.2 acre tract located on the northwestern bank of the Delaware River in Philadelphia, Pennsylvania. The acreage of the site includes a 0.9 acre parcel located on the south side of the property that is leased to the Pennsylvania Fish Commission for parking. The facility is located at 1500 Princeton Avenue, and has coordinates of latitude 40° 01′ 17" N and longitude 75° 02′ 54" W. The location of the TW site is depicted in Figure 1-1.

The TW site comprises a total of six buildings and surrounding land, the majority of which is paved. The site layout is presented in Figure 1-2. Onsite buildings include the warehouses (buildings 460 and 461), the administration building (building 462), the steam plant (building 467), a boiler building (building 464), and a storage port and vehicle maintenance area (building 463). Other structures of note at the property are the five



Tacony Warehouse Philadelphia, Pennsylvania	Source: U.S.G.S Topographic Map Frankford, PA Quadrangle	Figure 1-1 Site Location Map
Versar Inc. Langhorne, Pennsylvania	Scale: 1-inch equals 24,000 feet	



TACONY WAREHOUSE
PHILADELPHIA, PA

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SCALE: 1-INCH APPROX 150 FEET

FIGURE 1-2
SITE LAYOUT MAP

underground storage tanks, the five above ground storage tanks, the former spray pond, the two transformer substations, and the former pesticide storage building.

TW was constructed and established as an armor plate assembly facility in 1943 on land purchased from the Warner Company, which at the time also owned and operated the concrete plant on the adjacent property. The plant was initially operated by Henry Disston and Sons Co., but control was subsequently transferred to the Frankford Arsenal in April 1944. Frankford Arsenal actively used the property for storage in the 1950's and 1960's.

In 1970, TW was assigned to the Army and Air Force Exchange Service (AAFES). AAFES utilized the facility for warehousing of consumer products including clothing, housewares, and automotive products. In June 1976, the accountability for TW was transferred to Fort Dix. AAFES vacated the building, and in November 1987, the New Cumberland Army Depot (NCAD) entered into an agreement with Fort Dix. NCAD warehouses items such as generators, empty drums, office furniture, clothing, and spare parts. NCAD's operations were inactive at the writing of this report.

Due to a number of periods of inactivity and numerous changes in accountability at TW, little documentation exists for operations prior to 1970. However, TW was reportedly a fairly active facility from its founding until at least 1966. A review of aerial photographs during a prior investigation reportedly showed numerous automobiles and tanks (i.e., armored military vehicles) on the property in the early 1950's. Activity at TW during World War II is believed to have included welding, cutting, and painting. The spray pond used in cooling armor remained visible in aerial photographs throughout the 1960's.

A number of physical and operational aspects of the TW site have been identified as potential environmental concerns. The following is a brief summary of the areas of concern. A more detailed description can be found in the Enhanced Preliminary Assessment for Tacony Warehouse.

Five underground storage tanks (USTs) are present at the TW site. The tanks are all out of service. There are three 10,000 gallon USTs buried in the former spray pond. These tanks contained gasoline, diesel fuel, and No. 2 fuel oil, are of single-walled fiberglass construction, and were installed between 1972 and 1974. There is an abandoned UST located west of building 467. The size, construction, age, and contents of this tank are unknown. However, the tank was apparently used to store gasoline or diesel fuel in the past. The tank may also have been used as a waste tank. The final UST on the property is a 1,400 gallon tank of unknown construction installed in 1943. This UST held No. 2 fuel oil and is located southeast of building 464. None of the tanks are known to have been precision tested since the time of installation.

A former spray pond existed east of building 467. The pond was part of a cooling water process for an oil bath associated with armor plating operations. The pond is believed to be concrete lined and was filled with soil between 1962 and 1970. Pond discharge practices and the makeup of the oil are unknown. The three 10,000 gallon USTs previously described were installed in the former spray pond area.

There are four 9,000 gallon above ground storage tanks located south of building 467. A concrete block wall of questionable integrity surrounds the tanks. The tanks were installed between 1943 and 1953 and contain No. 6 fuel oil. The tanks are no longer in use. The tanks and associated piping are in poor condition and evidence of leakage or spillage has been observed. The final above ground storage tank is a 300 gallon, skid-mounted tank that was reported to have contained gasoline. However, it was empty at the time of the field investigation.

An oil/water separator is located east of building 467. The separator is believed to have been used for boiler water blowdown and may also have been used for discharge from the spray ponds. The separator may discharge to the storm sewer system that drains the property. Other potential sources for contamination entering the storm sewer are the storm drains that convey runoff from the property and the floor drains within the facility buildings. The storm drain discharges to the Delaware River, although the integrity of the storm water system is unknown.

Railroad tracks are located on the western portion of the TW property. Waste oil and herbicides were sprayed along the tracks to control weeds. The makeup of the waste oil and the types of herbicides used are unknown.

Potential environmental concerns are also presented by the possible presence of PCBs in electrical equipment on the site, the potential existence of asbestos containing materials in onsite buildings, a former pesticide storage building, and the possibility that radioactive materials, specifically depleted uranium, were stored at the site during the time the Frankford Arsenal used the facility.

1.3 SUMMARY OF PREVIOUS INVESTIGATIONS

In September 1989, Roy F. Weston, Inc. performed an Enhanced Preliminary Assessment of TW. The findings of this investigation were documented in a report dated December 1989. No environmental sampling was conducted during the assessment. The purpose of the assessment was to identify potential environmental concerns at the site based on a visual site inspection, a review of available records, and interviews with people knowledgeable of the site and its history. The findings of the Enhanced Preliminary Assessment provided the basis for conducting this EI.

The plans for the performance of the EI were prepared by ICF Technology Inc. and submitted to USATHAMA in July 1990. These plans included the Sampling Design Plan, the Technical Plan, an Accident Prevention and Safety Plan, and a Management Plan. In preparing the plans, ICF Technology, Inc. utilized the Enhanced Preliminary Assessment and performed a site visit in February 1990. The plans documented the procedures to be followed during the completion of the EI by Versar, Inc.

1.4 ENVIRONMENTAL INVESTIGATION SUMMARY

The objective of conducting this EI is to evaluate the nature and extent, if any, of hazardous constituents in the ground water, surface water, surface and subsurface soils, building materials, and electrical equipment at the facility. The EI included sampling, monitoring, and exposure assessment, as necessary. The purpose was to gather sufficient information to determine the necessity, if any, for and the proposed extent of remedial action in preparation for sale/transfer of the property.

1.5 REPORT OVERVIEW

The remainder of this report is organized as follows:

- Section 2 provides a review of the site setting, including information on demography, land use, topography, climate, surface water, and geology and hydrogeology.
- Section 3 presents a summary of the EI field activities. The tasks executed during the EI are discussed in this section.
- Section 4 provides a summary of results, including hydrogeological observations and measurements, radiological survey results, and the results of chemical analyses on environmental samples.
- Section 5 presents quality assurance program information for the investigation.
- Section 6 provides an assessment of the data obtained during the investigation.
- Section 7 describes the remedial alternatives potentially applicable to the site.
- Section 8 is the Risk Assessment, which evaluates the potential threat to the environment and public health of any contamination detected at the site.
- Section 9.0 lists the references used in preparing this report.

SECTION 2.0

SITE SETTING

2.1 DEMOGRAPHY

TW is situated within a commercial and light industrial area outside of residential neighborhoods within the City of Philadelphia. The nearest populated area is located approximately 500 feet north of the site. This area, and others to the north and west, are best described as working-class residential. Commercial and light industrial properties are interspersed throughout the surrounding community. The site is separated from population centers of Philadelphia by Interstate 95. The Delaware River buffers the site from the suburban communities of Palmyra and Riverton, New Jersey.

A review of 1990 census information available for a 3-mile radius surrounding the TW site revealed a total approximate population of 23,806 people. The census includes information from the April 1990 census questionnaire for the City of Philadelphia and the County of Philadelphia, Pennsylvania. The census information includes a breakdown of population according to age, persons per household, total number of households, etc. According to the census, 97.5% of the residents within the study area are white, 1.35% are black, and 1.15% are other. There are approximately 6,304 people under the age of twenty, 8,815 in the 20 to 44 age bracket, 4,444 are between the age of 44 and 65, and 4,243 people are over 65. The median value of an owner occupied household is $52,120, while the median monthly rent is $340.

2.2 LAND USE

The TW site is located along the industrial riverfront of the Delaware River in Northeast Philadelphia. Industrial and commercial properties border the site to the west. These operations include a concrete plant, a carpet warehouse, and various other warehousing and manufacturing businesses. The TW site is bounded to the north by Milnor Street and Interstate 95, beyond which lies a densely populated residential neighborhood. To the east, Princeton Avenue and undeveloped land border the property. The undeveloped land is associated with St. Vincent's Home, an orphanage located approximately 1,000 feet east of the subject property. A recreational boat launch and the Delaware River border the site to the south. In addition, a marina is located adjacent to the boat launch to the east.

2.3 TOPOGRAPHY

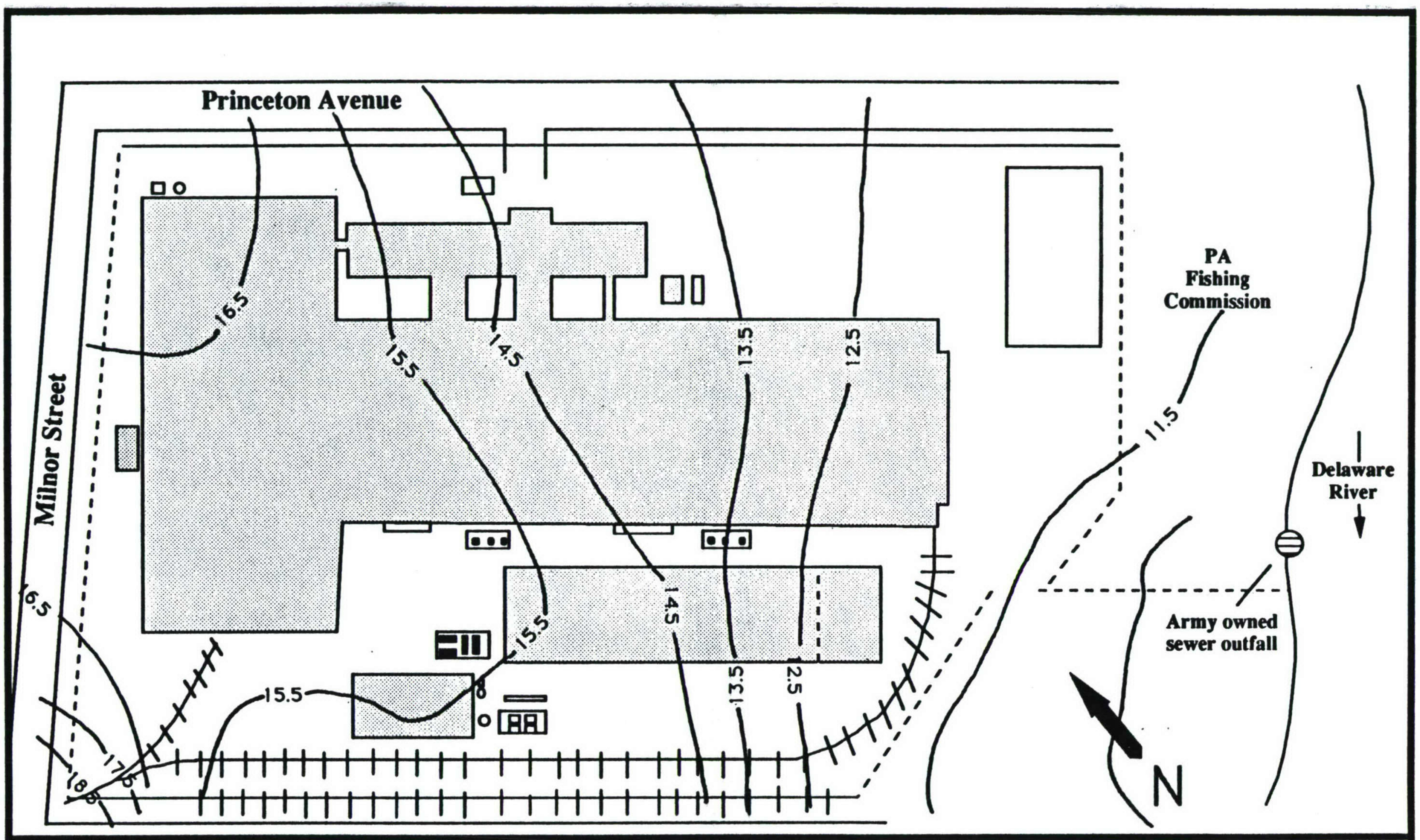
The TW site is relatively flat with little vertical relief. Elevations on the property, based on survey data obtained during the EI, are presented in Figure 2-1. There is less than 8 feet of vertical relief throughout the entire site. Surface runoff on the property is collected in an onsite storm sewer system. Therefore, little surface drainage is expected to flow overland onto surrounding properties. In addition, little surface runon is expected from neighboring properties.

2.4 CLIMATE AND METEOROLOGY

Philadelphia, and thus the TW site, are located in an area exhibiting a humid, continental climate. Prevailing westerly winds carry weather systems from the interior of the continent over the site, while the Atlantic Ocean acts as a moderating influence on the climate. The factors dictating the climate of the area include the prevailing western winds, the proximity to the Atlantic Ocean, and the proximity to the Appalachian Mountains.

The average temperature is 54.6°F annually, and temperatures generally remain between 0° and 100°F. The coldest month is January with a normal temperature of 31.2°F, and the warmest month is July with an average temperature of 76.5°F. High humidity, common during the summer months, adds to the discomfort of the high temperatures. Because of the blocking effect of the Appalachian Mountains to the west, and the moderating effect of the Atlantic Ocean to the east, periods of very high or very low temperatures rarely last longer than three or four days.

Precipitation is generally distributed evenly throughout the year, with maximum amounts occurring during the spring and late summer months. August is the wettest month with an average of 4.10 inches of precipitation, and February is the driest month, with an average of 2.81 inches of precipitation. The normal annual precipitation is 41.42 inches. The majority of summer



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SCALE: 1-INCH APPROX 150 FEET
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FIGURE 2-1
TOPOGRAPHIC
CONTOUR MAP

rainfall occurs as the result of showers and thundershowers. During the rest of the year, storm systems from the interior of the continent and coastal storms produce the majority of the precipitation. Coastal storms produce heavy rains during warm months and heavy snow or mixtures of rain and snow during winter months.

2.5 SURFACE WATER

The Delaware River flows past the TW site in a southwesterly direction. The flow of the river is tidally influenced, with an estimated average variation in elevation of approximately 3 feet from high tide to low tide. Flow in the river averages 8.7 billion gallons per day. The channel within the river is maintained at a depth of approximately 45 feet to allow the passage of large ships. The river is used for recreational, commercial, and industrial purposes in the area of the site. An intake used to obtain drinking water for distribution in Philadelphia is located approximately 2 miles upstream of TW. A major municipal sewage treatment plant is located approximately 2.5 miles downstream of TW.

No surface water bodies exist on the TW site. Storm water runoff from the site is collected in storm drains that discharge to an Army-owned storm sewer. The storm sewer has a point discharge to the Delaware River south of the facility boundaries. A storm sewer that runs under Princeton Avenue and receives drainage from the extreme eastern edge of the site also discharges to the Delaware River. No plans for the storm sewer system are known to exist and the actual point of the system's discharge to the Delaware is unknown. From surficial observations, it is apparent that the storm drains are trap-like structures that retain sediment and debris. Water entering the drains is directed to a network of piping that discharge to primary sewer lines, one of which leads to the Delaware River and the other to Princeton Avenue. Surface runoff outside of the storm sewer system is negligible and no significant source of runon has been identified. The area of the site south of Building 461 lies within the 100-year floodplain. Floodplain boundaries are depicted on Figure 2-2.

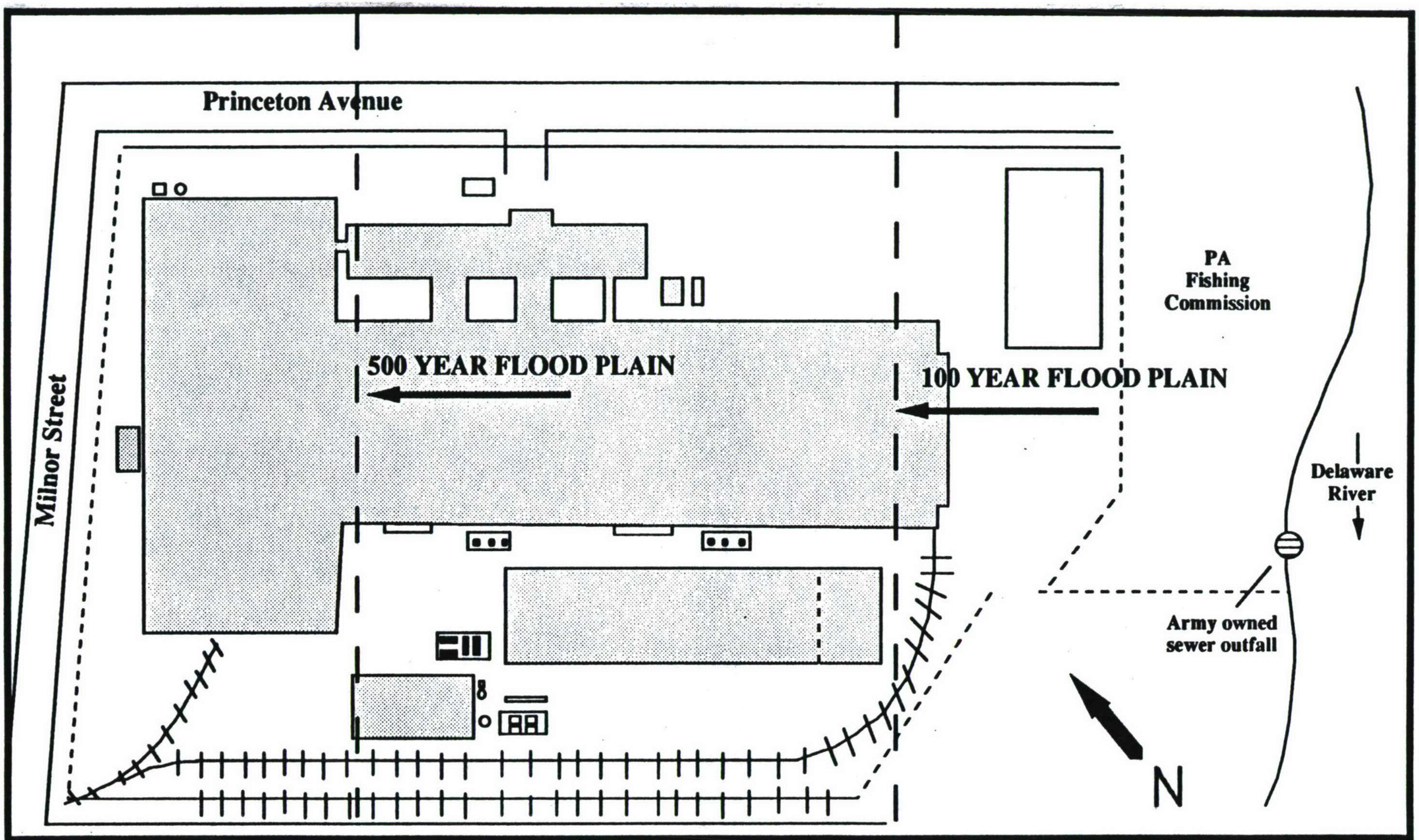

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FIGURE 2-2
FLOOD PLAIN MAP

2.6 REGIONAL GEOLOGY AND HYDROGEOLOGY

2.6.1 Geology

The Tacony Warehouse lies within the Coastal Plain Physiographic Province and is bound on the northwestern edge by the Piedmont Province. The Coastal Plain Province is a narrow strip of Cretaceous and later age unconsolidated sediments that lie in the southeastern corner of Pennsylvania along the Delaware River. The transition from the Coastal Plain to the Piedmont Province occurs along the inner or landward margin known as the Fall Line. The Fall Line is topographically identified by an abrupt transition from the flat lowlands of the Coastal Plain to the rolling hills of the Piedmont.

The oldest and deepest sediments are of Cretaceous age and belong to the Raritan Formation. The formation is divided into six members. These six members, in ascending order, are the Farrington sand, the lower clay, the Sayreville sand, the middle clay, the Old Bridge sand, and the upper clay. The Raritan is overlain in adjacent parts of New Jersey by the Magothy Formation, but the Magothy Formation has not been identified in the Philadelphia area. The sediments that overlie the Raritan are Pleistocene deposits consisting of coarse sand and gravel interbedded with clay, silt, and fine sand. They, in turn, are overlain by recent floodplain deposits consisting of dark gray mud, silt, and sand (Greenman et al, 1961). A generalized stratigraphic section of the Coastal Plain of southeastern Pennsylvania is provided in Figure 2-3.

The oldest rock formations associated with the Coastal Plain Province are exposed at various outcrops northwest of the Fall Line in the Piedmont Province. The bedrock geology consists primarily of pre-Cretaceous crystalline schists and gneiss of the Wissahickon Formation of Late Protozoic and early Paleozoic age, with quartzite from the Chickies Formation of early Cambrian age and scattered masses of gneissic rocks of uncertain age having granitic and gabbroic composition (Greenman et al, 1961).

The pre-Cretaceous crystalline rocks are fine to coarse-grained, crystalline, banded rock characterized by excess mica. The rocks comprise

Generalized stratigraphic section of the Coastal Plain of southeastern Pennsylvania.

System	Series	Formation and member	Symbol	Maximum Thickness (feet)
Quaternary	Recent	Alluvium	Qal	72
		- - - *Unconformity* - - -		
	Pleistocene	Cape May formation (Illinoian)	Qcm	80
		- - - *Unconformity* - - -		
		Pensauken formation (Illinoian)	Qp	
		- - - *Unconformity* - - -		
Cretaceous	Upper Cretaceous	Magothy formation	Km	10
		- - - *Unconformity* - - -		
		Upper clay member	Kru	35
		- - - *Unconformity* - - -		
		Raritan formation Old Bridge sand member	Kro	55
		- *Unconformity* - - -		
		Middle clay member	Krm	60
		- *Unconformity* - - -		
		Sayreville sand member	Krs	49
		- *Unconformity* - - -		
		Lower clay member	Krl	61
		- *Unconformity* - - -		
		Farrington sand member	Krf	87
		- - - *Unconformity* - - -		
Pre-Cretaceous	Glenarm	Crystalline rocks	p	?

Tacony Warehouse
Philadelphia, Pennsylvania

Versar Inc.
Langhorne, Pennsylvania

Source: PA Geological Survey
Bulletin W-13

Figure 2-3
Stratigraphic Section

three distinct lithologies, including hornblende gneiss, granite gneiss, and a sequence of alternating micaceous schists and quartzite.

In summary, pre-Cretaceous crystalline rocks outcropping northwest of the Fall Line dip southeastward to form the basement upon which the Coastal Plain sediments were deposited. In the vicinity of the Tacony Warehouse, the Pleistocene and recent deposits appear to lie unconformably on the crystalline bedrock.

2.6.2 Hydrogeology

The Coastal Plain Province of Pennsylvania contains two aquifers of local importance, the lower crystalline rocks and the upper unconsolidated sediments.

Philadelphia is underlain by crystalline rocks extending from the Piedmont, which are in turn overlain by the unconsolidated aquifer deposits of the Coastal Plain. The unconsolidated deposits of the Potomac Group and Raritan Formation deposits comprise the Potomac-Raritan-Magothy aquifer system, which in turn is subdivided into the following members: lower sand, lower clay, middle sand, middle clay, upper sand, and upper clay.

Regionally, the upper aquifer, or water table aquifer, has been thought to be controlled by the surface topography. Generally, ground water movement in the regional water table body is from the highest points in the Coastal Plain topography, near the Fall Line, toward the Delaware and Schuylkill Rivers. The historic hydraulic gradient is slight, on the order of 10 feet to the mile or less, and the rate of movement is correspondingly low.

In the vicinity of the Tacony Warehouse, the Pleistocene and recent deposits comprise the entire unconsolidated aquifer. Historic information indicates that there is an abrupt unconformity which eliminates the Magothy and Raritan Formations from the area leaving the Pleistocene and recent deposits lying directly on the underlying crystalline bedrock. The main sources of recharge are in undeveloped areas from precipitation and in the outcrop area of the water bearing beds. The recent and Pleistocene sediments appear to fall into the direct precipitation recharge regime because the majority of the sediment deposits are shallow or exposed at the surface. Lower sediment deposits are also recharged through percolation of water through permeable overlying deposits.

The quality of ground water in the water table aquifer has depreciated severely over time due to urban development in the Philadelphia area. Most of the recharge area for the aquifer has been either covered with buildings or paved. Potentially contaminated recharge was introduced directly into the aquifer by leakage from sewers and cesspools, as well as concentrated industrial activity.

The contaminated waters commonly contain relatively large concentrations of iron and carbon dioxide. Increased development caused increased pumping rates, which in turn created a greater zone of influence within the aquifer. Historic analysis of water table wells in the Philadelphia area indicates that the quality of water has depreciated to the extent that the water does not meet recommended threshold standards for drinking water supplies or industrial cooling use. This degradation pertains largely to the upper water table aquifer and, to a lesser extent, to the lower confined unconsolidated aquifers.

The crystalline rocks of the Coastal Plain are considered to be a poor aquifer due to their low water-bearing properties. The crystalline rocks comprise a variety of rock types (e.g., gneiss and schist), and the different lithologies have little effect upon their water-bearing properties. The rocks are dense and, when unaltered, are virtually impervious to water. Although joints, fractures, and weathered zones constitute a small part of the total rock volume, they provide the majority of storage and movement of small quantities of ground water.

SECTION 3.0

ENVIRONMENTAL INVESTIGATION ACTIVITIES

This section discusses the implementation of the specific procedures described in the Sampling Design Plan, the supplement to the Sampling Design Plan, and the Confirmatory Investigation Scope of Work for the TW site. Overall, there were no substantial deviations from the plans during performance of the EI. Detailed descriptions of the procedures (i.e., equipment decontamination, sampling protocol, health and safety, etc.) appear in the aforementioned plans, the Quality Assurance Project Plan, the Health and Safety Plan, and the Technical Plan prepared for the TW EI.

The basic requirement for all work performed was that the data collected maintain consistent quality. Data must be precise, accurate, representative, complete, and comparable. To meet these objectives, site activities and sample handling were executed in accordance with the Quality Assurance Plan prepared for the investigation.

Initial EI field activities commenced on October 1, 1990, and were completed on February 14, 1991. Follow-on investigation field activities were performed from June 17, 1991 through July 22, 1991. Confirmatory investigation field activities were conducted between May 20, 1992 and June 24, 1992.

Analytical support for chemical analyses was provided by A.D. Little through the USATHAMA CLASS system. Sample Chain-of-Custody forms are presented in Appendix C. Soil, surface water, sediment, and ground water samples were analyzed for EPA Target Compound List (TCL) parameters. Tables 3-1 through 3-3 present a listing of the EPA TCL analytical parameters used for this EI. Compounds identified and quantified were not limited to those on the TCL. Asbestos samples were also collected and analyzed by Versar's certified laboratory.

The environmental investigation at the study property consisted of the following activities:

- Radiation and asbestos surveys of onsite buildings,

TABLE 3-1

EPA TCL VOLATILE ORGANIC COMPOUNDS

PARAMETER
Methylene Chloride
1,1-Dichloroethane
trans-1,2-Dichloroethene
1,1-Dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1-Trichloroethane
Carbon Tetrachloride
Trichloroethene
Benzene
1,1,2-Trichloroethane
Tetrachloroethene
Toluene
Chlorobenzene
Ethylbenzene
1,2-Dichloropropane
Cis-1,3-Dichloropropene
Vinyl Chloride
Chloroethane
Chloromethane
Bromoform
Dibromochloromethane
trans-1,3-Dichloropropene
1,1,2,2-Tetrachloroethane
Bromodichloromethane
Bromomethane
Acetone
Carbon Disulfide
2-Butanone
Vinyl Acetate
4-Methyl-2-pentanone
Styrene
Xylenes

TABLE 3-2

EPA TCL SEMIVOLATILE COMPOUNDS

PARAMETER
Phenol
bis(2-Chloroethyl)ether
2-Chlorophenol
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Benzyl Alcohol
1,2-Dichlorobenzene
2-Methylphenol
bis(2-Chloroisopropyl)ether
4-Methylphenol
N-Nitrosodipropylamine
Hexachloroethane
Nitrobenzene
Isophorone
2-Nitrophenol
2,4-Dimethylphenol
Benzoic Acid
bis(2-Chloroethoxy)methane
2,4-Dichlorophenol
1,2,4-Trichlorobenzene
Naphthalene
4-Chloroaniline
Hexachlorobutadiene
4-Chloro-3-methylphenol
2-Methylnaphthalene
Hexachlorocyclopentadiene
2,4,6-Trichlorophenol
2,4,5-Trichlorophenol
2-Chloronaphthalene
2-Nitroaniline
Dimethylphthalate
Acenaphthylene

PARAMETER
3-Nitroaniline
Acenaphthene
2,4-Dinitrophenol
4-Nitrophenol
Dibenzofuran
2,4-Dinitrotoluene
Diethylphthalate
4-Chlorophenyl-phenyl ether
Fluorene
4-Nitroaniline
4,6-Dinitro-2-methylphenol
N-Nitrosodiphenylamine
4-Bromophenyl-phenyl ether
Hexachlorobenzene
Pentachlorophenol
Phenanthrene
Anthracene
Di-n-butylphthalate
Fluoranthene
Pyrene
Butylbenzylphthalate
3,3-Dichlorobenzidine
Benzo[a]anthracene
Chrysene
bis(2-Ethylhexyl)phthalate
Di-n-octylphthalate
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[a]pyrene
Indeno[1,2,3-cd]pyrene
Dibenzo(a,h)anthracene
Benzo[g,h,i]perylene

PARAMETER
2,6-Dinitrotoluene
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (lindane)
Heptachlor
Aldrin
Heptachlor Epoxide
Endosulfan I
Dieldrin
4,4'-DDE
Endrin
Endosulfan II
4,4'-DDD
Endosulfan Sulfate
4,4'-DDT
Endrin Ketone
Methoxychlor
alpha-Chlordane
gamma-Chlordane
Toxaphene
Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260

TABLE 3-3

EPA TCL INORGANIC COMPOUNDS

PARAMETER
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cyanide
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

- Installation and development of 14 monitoring wells, and 2 piezometers,
- Drilling of soil borings and collection of soil samples for classification,
- Collection of wipe samples from spill areas and fluid samples from transformers, and
- Soil, surface water, sediment, tank content, and ground water sampling.

3.1 BUILDING INVESTIGATION

3.1.1 Radiological Survey

A geiger-counter sweep was performed within building 461 during the investigation. The purpose of the sweep was to identify the presence (if any) of radioactive emissions. Based on historical information, there was the remote possibility that depleted uranium had been stored in the warehouse, although such storage is not documented. The sweep was performed with a Ludlum Model 3 meter equipped with a 44-9 pancake probe, having a detection limit of 10 kilo-electron volts to 13 mega-electron volts with an efficiency of 70 percent for strong beta emitters (p32) and 10 percent for weak beta emitters (carbon-14). The accuracy of the instrument is +/- 10 percent.

Background readings were established outside of the building prior to the sweep. The survey was completed by taking measurements at ten foot linear intervals along the interior floor/wall intersections, at ten foot intervals along the interior walls approximately five feet above the floor/wall survey points, at ten foot intervals along floor cracks and joints, and at the points of intersection of a 10-foot by 10-foot survey grid established on exposed floor space within the warehouse. Measurements were taken at a distance of one inch from the subject floors and walls. Since no anomalies were detected during the survey, geiger-counter sweeps were not performed in the basements of building 461, or in building 460.

In addition to the geiger-counter sweep, radon monitoring was performed. The radon survey consisted of the placement of two radon gas detectors in each of the two basements within building 461. The specific detectors used were

Alpha Tracks. The detectors remained undisturbed in the basements for a period of approximately ninety days, at the end of which they were collected and sent to REM Analytical Services for analysis.

3.1.2 Asbestos Survey

An asbestos survey was conducted to investigate, discover information regarding, and otherwise evaluate the existence, type, condition, susceptibility to damage, relative risk (friability), and extent of suspected asbestos-containing materials (ACM) at the TW site. Architectural specifications and construction drawings were requested prior to the site visit. However, no drawings are known to exist for the property. The asbestos survey was conducted using a 2-person survey team, including an AHERA-certified Asbestos Inspector.

Prior to collecting bulk samples, a visual inspection was conducted of the buildings to be surveyed. This inspection determined the location of suspected ACM, number of asbestos samples to be collected at each building, and identified homogeneous areas, which are areas that appear similar in terms of color, texture, and date of material application. Materials considered to be suspected ACM that were subsequently sampled include surfacing materials, preformed thermal insulating products, textiles, concrete-like products, paper products, roofing material, miscellaneous building materials (i.e., joint compound, caulking, etc.), floor tile and associated floor tile mastic, wall coverings, and paints.

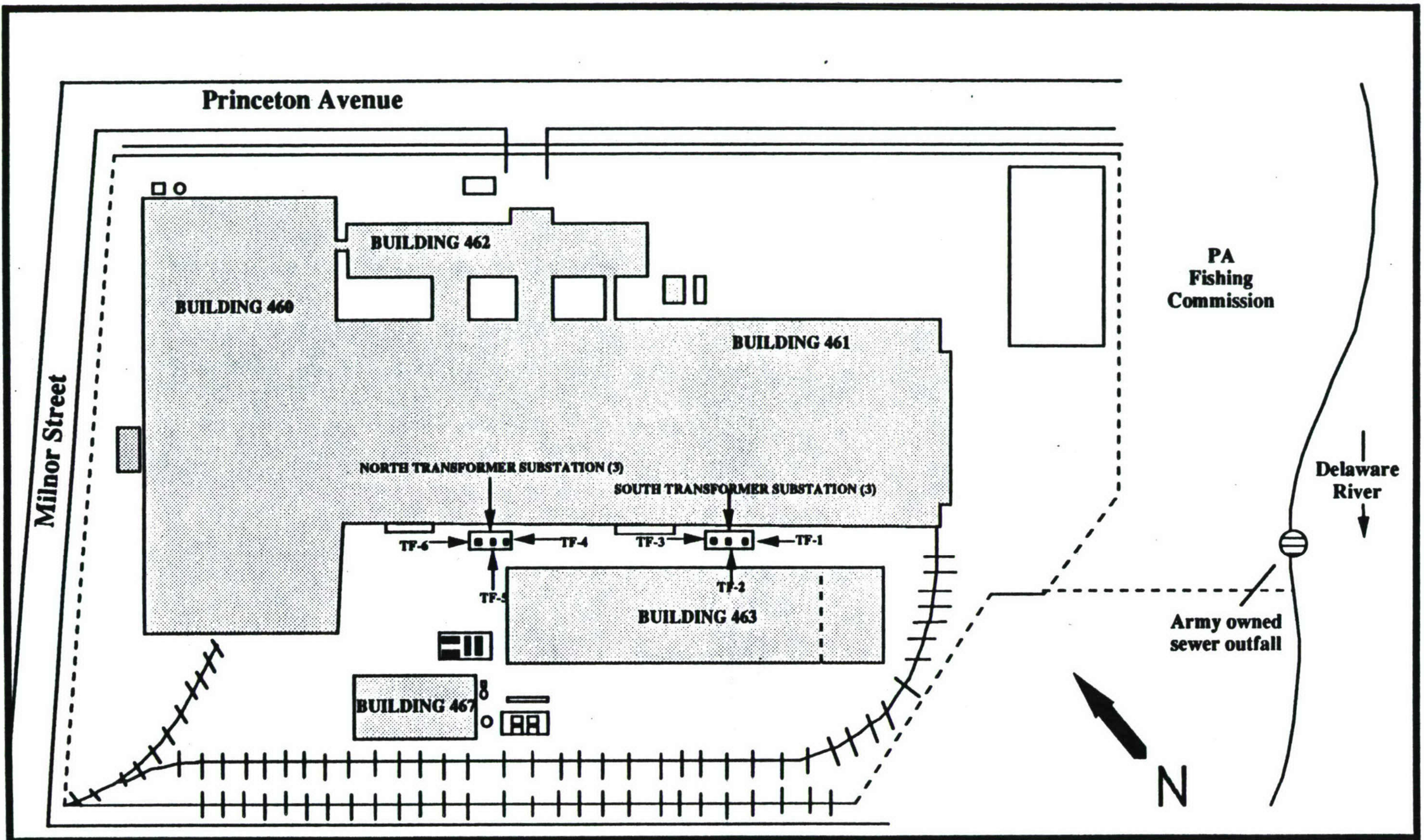
Bulk sampling involved the collection of a small sample of the suspect material following AHERA and U.S. Army guidelines. Sampling was conducted at locations where material damage would be minimized, and where the location was not readily visible to building occupants. The sample area was wetted with an amended water solution to minimize the release of airborne fibers during sample collection. A knife or boring tool, which was cleaned after the collection of each bulk sample, was used to remove a small sample of suspect material, insuring that an entire cross-section of the suspect material was present in the sample. When sampling friable material, plastic was placed beneath the sample area to collect any lose material that had fallen during sample collection. The plastic was sprayed with encapsulant prior to disposal. Sampled areas having a potential for a fiber release were sealed with clear encapsulant. A total of 66 bulk samples, including quality control samples, were obtained from potential ACM throughout all buildings. The following is a summary of the number of samples collected at each building:

BUILDING	BULK SAMPLES COLLECTED
Building 467 (Steam Plant)	15
Building 462 (Administration Building)	33
Building 461 (Warehouse)	6
Building 460 (Warehouse)	7
Building 464 (Heat Plant)	2
AGST Near Building 467	1
Building 461 (Basement)	2
Total Asbestos Bulk Samples:	66

The suspect material was placed into a sample container, labeled, and sealed. Upon completion of the asbestos sampling activities, the bulk samples were placed in a sealed shipping container and sent to Versar's analytical laboratory in Springfield, Virginia, for analysis. Bulk asbestos sample analysis was performed in accordance with the Environmental Protection Agency's recommended test method: Interim Method 600/M4-82-020; "Determination of Asbestos in Bulk Insulation Samples" using polarized light microscopy and dispersion staining. The asbestos samples were analyzed by a trained microscopists at Versar's American Industrial Hygiene Association (AIHA) accredited (No. 265) and National Voluntary Laboratory Accredation Program (NVLAP) certified laboratory.

3.1.3 Transformers

Transformer fluid samples were collected from the six ground-mounted transformers located at the TW site. The sample locations are depicted in Figure 3-1. Samples could not be obtained from electrical switch gear in the steam plant at the site. In addition, it was indicated by facility personnel that two pole-mounted transformers located along Princeton Avenue, just outside the facility fence, were not owned by the subject facility, and therefore could not be sampled. Three of the sampled transformers were not in service at the time of the investigation. All fluid samples were obtained



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SCALE: 1-INCH APPROX 150 FEET

- **TRANSFORMER FLUID SAMPLE LOCATION**

FIGURE 3-1
TRANSFORMER FLUID
SAMPLE LOCATION MAP

from drain plugs at the base of the transformers. The fluid was drained directly into the sample containers. The six fluid samples collected were submitted to the CLASS laboratory for PCB analysis.

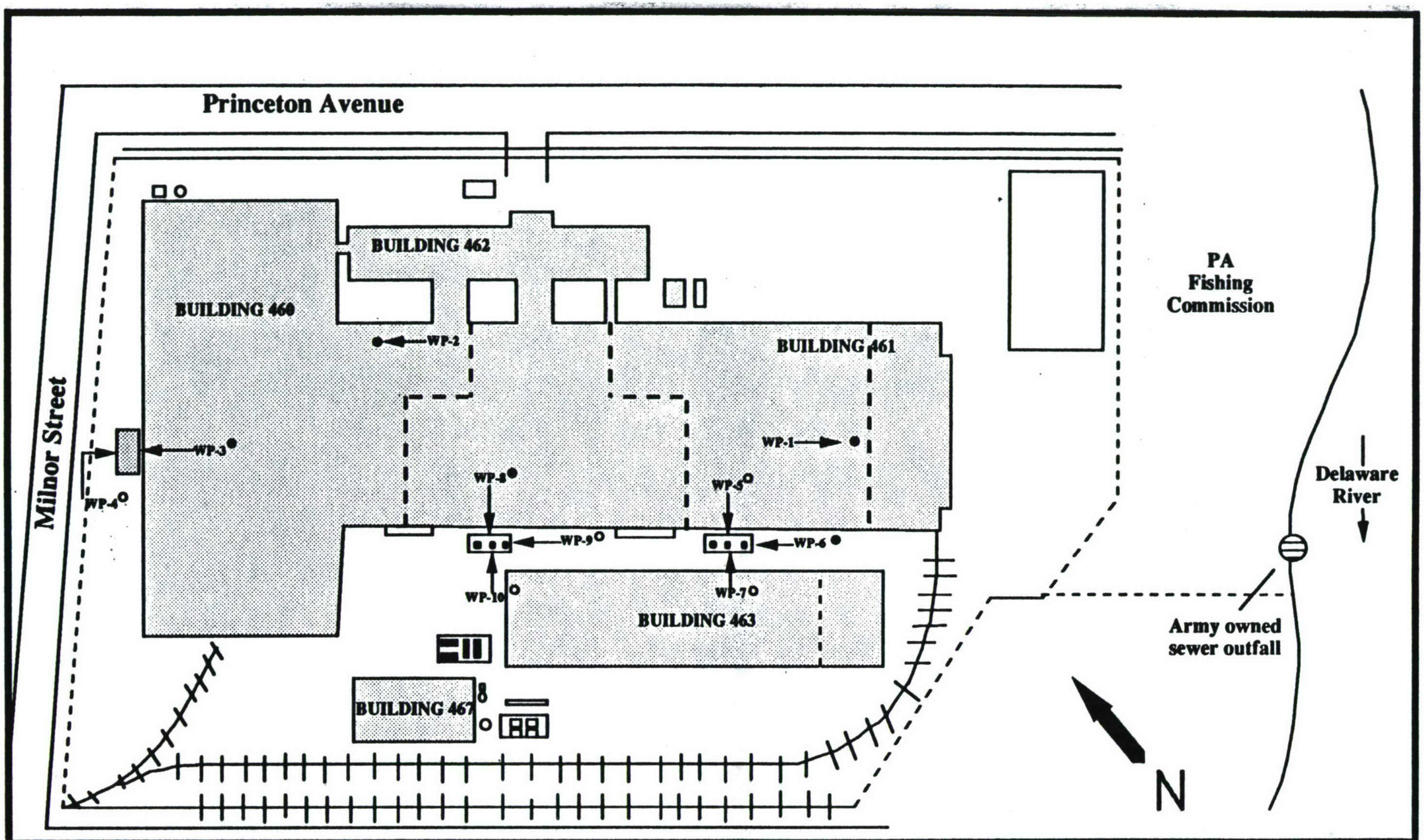
3.1.4 Spills

Wipe samples were collected from ten locations within onsite structures where evidence of spills was observed or where the potential for past spills of hazardous materials exists. The locations of the wipe samples are depicted in Figure 3-2. The samples were collected with sterile cotton pads soaked with 5 milliliters (ml) freon for TPHC analysis, or soaked in 5 ml of hexane for PCB, pesticide, and herbicide analyses. At each sample point, a 10 cm x 10 cm template was placed over the chosen sample wipe area. Preference was given to areas exhibiting evidence of spills. The entire area was then wiped in the horizontal direction followed by the vertical direction. Samples collected from the hydraulic fluid spills in building 461 were analyzed for PCBs and TPHC; samples collected from the transformer substation were analyzed for PCBs; and samples collected from the former pesticide storage building were analyzed for PCBs, pesticides, and herbicides.

3.2 SURFACE AND SUBSURFACE SOILS

3.2.1 Surface Soils

Four surface soil samples (SS-1 through SS-4) were obtained from the railroad track bed located along the western edge of the TW site (see Figure 3-3). The samples were collected in random fashion along the length of the track. The sampling was designed to determine if any residual contamination was present as the result of past weed control activities. Two background samples (SS-5 and SS-6) were collected during the confirmatory investigation. SS-5 was located approximately 50 feet from the area of concern and SS-6 was located on the opposite side of the site from the railroad. Both background locations exhibited no visual evidence of impacts from site activities. Stainless steel augers were used to obtain the samples from 0 to 18 inches below the ground surface. The samples were submitted to the CLASS laboratory and analyzed for EPA TCL metals, TPHC, and PCBs/pesticides. Background samples were analyzed for TCL metals only.



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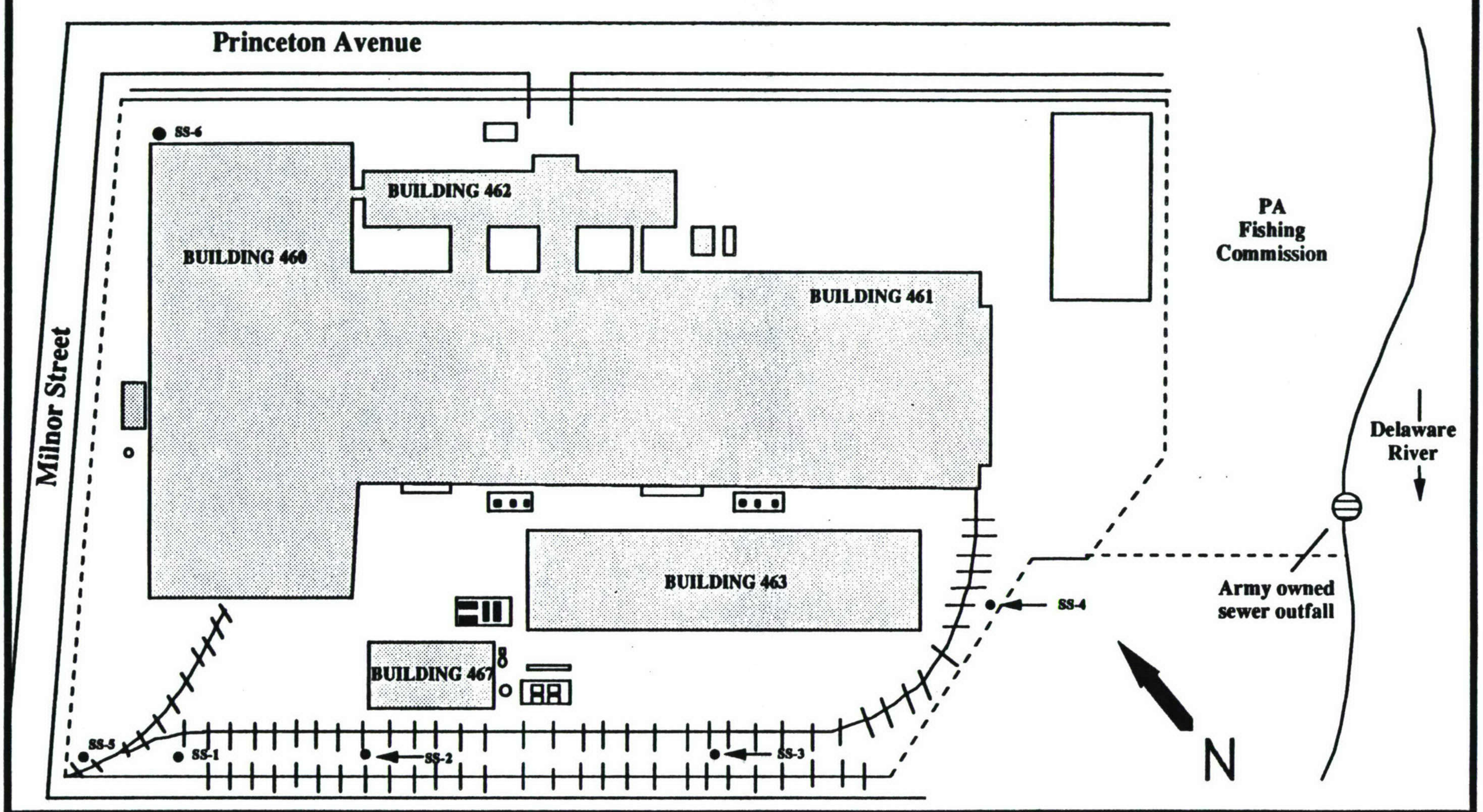
SCALE: 1-INCH APPROX 150 FEET

○ WIPE SAMPLE LOCATION (COLLECTED FROM WALL)
● WIPE SAMPLE LOCATION (COLLECTED FROM FLOOR)

FIGURE 3-2
WIPE SAMPLE
LOCATION MAP



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SCALE: 1-INCH APPROX 150 FEET

● **SURFACE SOIL SAMPLE LOCATION**

FIGURE 3-3
SURFACE SOIL SAMPLE
LOCATION MAP

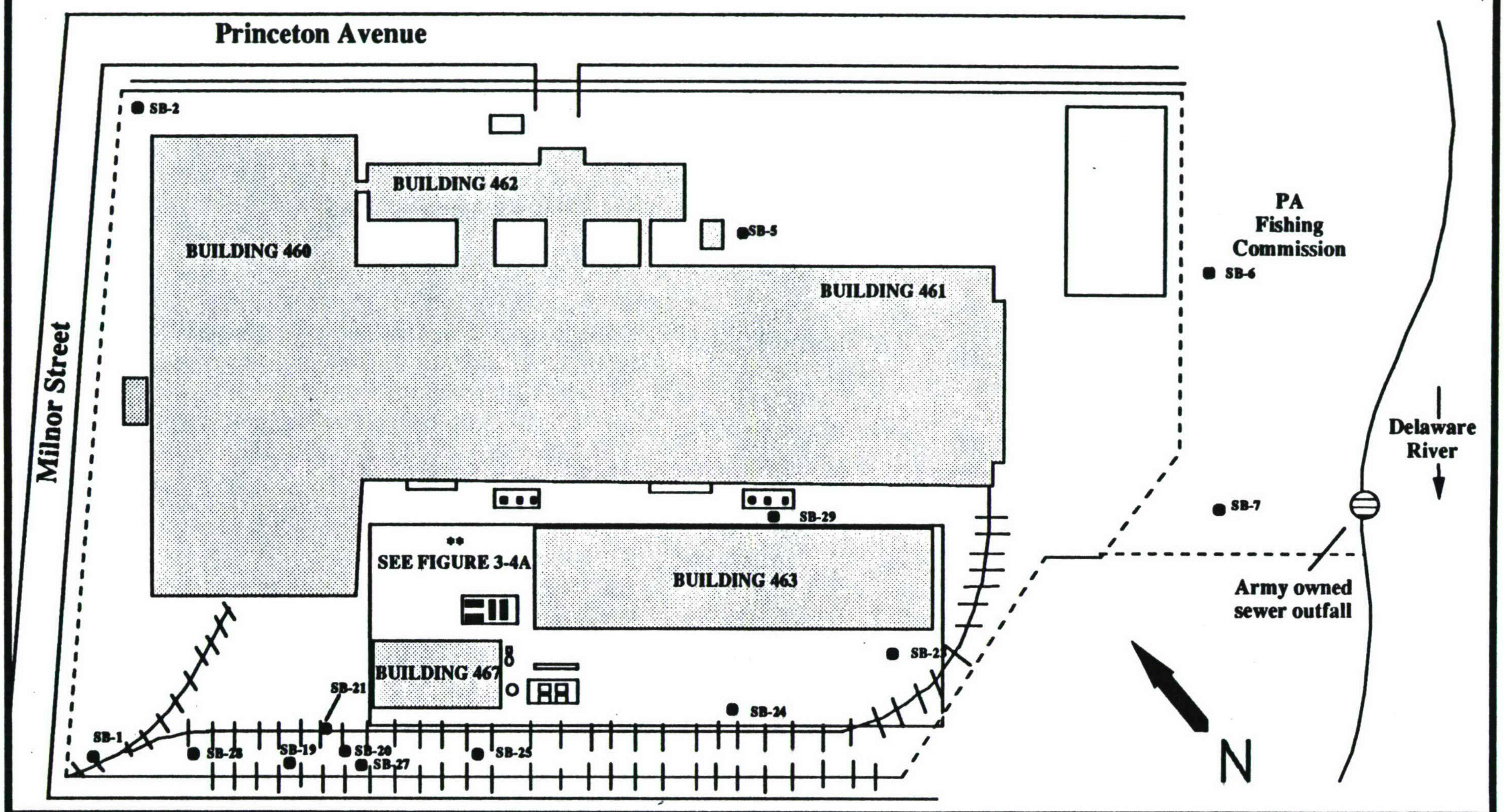
3.2.2 Subsurface Soils

The primary objectives of the soil boring program were to facilitate monitoring well installation; to assess the stratigraphy of the subsurface soil at the site; and to assess possible subsurface soil contamination in the vicinity of the ASTs located south of building 467, the USTs located north of building 467, the UST located southeast of building 464, the AST and USTs in the former spray pond area, and the oil/water separator located east of building 467.

Soil borings were installed at 27 locations, 10 during the initial investigation field work, 11 during the follow-on field work, and 6 during the confirmatory investigation. The soil boring locations are depicted on Figure 3-4. Two planned locations, SB-18 and SB-26, were not installed based on field decisions. Subsurface soil samples were collected at each location for lithological characterization, and samples were also collected at selected locations for chemical analysis. The borings were advanced in accordance with the procedures in the USATHAMA Sampling Design Plan and Geotechnical Requirements.

The soil borings were installed using a (CME-75) truck-mounted drilling rig. The soil borings that were drilled for subsequent monitoring well installation were advanced using 8.25-inch outer diameter (O.D.) hollow-stem augers (HSA), and those that were drilled for the purpose of assessing the stratigraphy and possible zones of contamination were advanced using 4.25-inch O.D. HSA. Soil samples for lithological classification were collected from the borings using standard split-spoon sampling techniques at continuous 2-foot intervals from the ground surface to the water table and at 5-foot intervals from the water table to completion of the boring. Samples for chemical analysis were obtained from split-spoons at selected intervals.

Upon retrieval, each split-spoon sample was screened for volatile organic compounds (VOCs) using a photoionization detector and was visually examined for evidence of contamination. After screening and visual examination, the soil was lithologically characterized according to the Unified Soils Classification System (USCS). All cuttings and other wastes generated during



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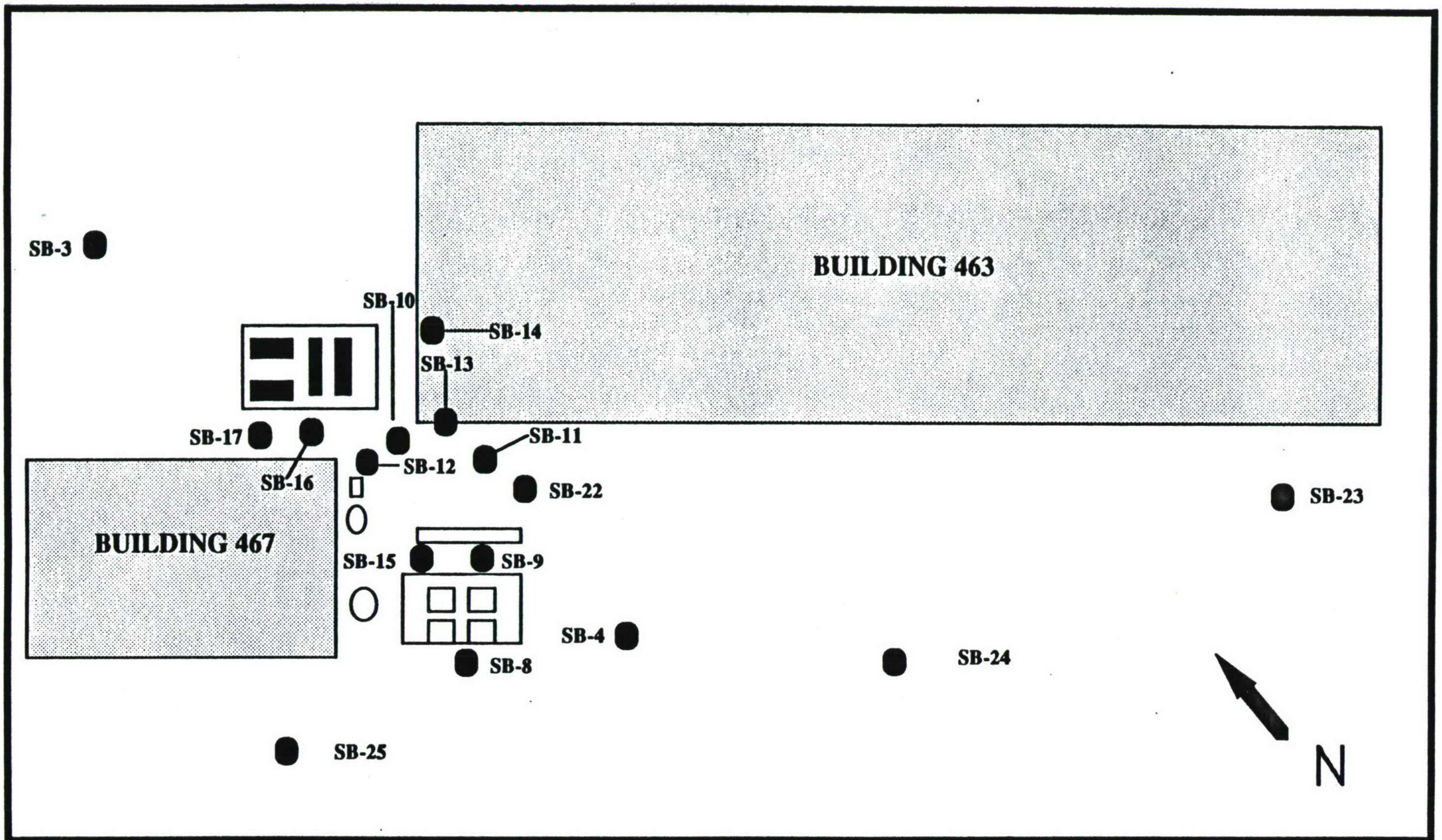
SCALE: 1-INCH APPROX 150 FEET

● SOIL BORING LOCATION

FIGURE 3-4
SOIL BORING
LOCATION MAP



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SCALE: 1-INCH APPROX 60 FEET

● SOIL BORING LOCATION

FIGURE 3-4A
SOIL BORING
LOCATION MAP

boring installation were containerized in 55-gallon drums and stored onsite. Borings not selected for monitoring well installation (i.e., SB-8, SB-9, SB-10, SB-11, SB-12, SB-14, SB-15, SB-16, and SB-17) were sealed immediately upon completion with a cement-bentonite grout mixture.

Subsurface soil samples for chemical analyses were obtained from 22 of the 27 borings. Samples for VOC analysis were collected directly from the split-spoons, while the remaining sample was homogenized prior to placement in the appropriate sample container. One sample for chemical analyses was obtained from each boring at the depth where the water table was encountered. An additional sample for chemical analyses was obtained from three borings based on visual observations of contamination and elevated HNμ readings. A total of 25 subsurface soil samples were submitted and analyzed for EPA TCL parameters and TPHC.

At the conclusion of each boring and/or drilling activity and before proceeding to the next drilling location, all drilling tools and augers were decontaminated according to procedures outlined in the USATHAMA Sampling Design Plan.

The following subsections briefly describe the rationale used in selecting the soil boring locations at the TW site.

3.2.2.1 Above Ground and Underground Storage Tanks

Five above ground storage tanks (ASTs) and five underground storage tanks (USTs) were investigated at the Tacony Warehouse. The subsurface investigation consisted of drilling soil borings and installing monitoring wells.

Three soil borings were installed in the vicinity of the ASTs located south of building 467 (i.e., SB-4, SB-8, and SB-9). One subsurface soil sample for chemical analyses was collected from each of the three borings at the depth where the water table was encountered (8-10, 10-12, and 10-12 feet below grade surface [BGS], respectively). Borings SB-4, SB-8, and SB-9 are located adjacent to the retaining wall which surrounds the ASTs; one on the southern side, one on the western side, and one on the eastern side of the retaining wall.

Soil boring SB-5 was advanced downgradient of the UST located south of building 464. A soil sample for chemical analyses was obtained at the soil/water interface (10-12 feet BGS), and the boring was converted to a monitoring well (MW-5).

Three soil borings (i.e., SB-19, SB-20, and SB-21) were installed downgradient from the abandoned UST north of building 467. One subsurface soil sample for chemical analyses was obtained from each boring at the depth where the water table was encountered (7-9, 9-11, and 9-11 feet BGS). Borings SB-19, SB-20, and SB-21 are located southwest, south, and southeast of the abandoned UST, respectively. Monitoring well MW-9 was installed in boring SB-20.

3.2.2.2 Former Spray Pond

The former spray pond contains three USTs and one AST. Six soil borings (i.e., SB-3, SB-10, SB-13, SB-14, SB-16, and SB-17) were advanced in the vicinity of the former spray pond. One subsurface soil sample for chemical analyses was collected from each boring at the soil/water interface (14-16, 10-12, and 9-11 feet BGS for rest). Additional samples for chemical analyses were collected from SB-10 (4-6 feet BGS), SB-13 (3-5 feet BGS), and SB-17 (3-5 feet BGS) within intervals that showed evidence of contamination (e.g., staining, odor, or discoloration). The boring locations are depicted on Figure 3-4A. Monitoring well MW-3 was installed in SB-3, and MW-8 was installed in SB-13.

3.2.2.3 Oil/Water Separator

Two soil borings, SB-12 and SB-15, were installed around the oil/water separator. One subsurface soil sample for chemical analyses was obtained from each boring at the soil/water interface (both 9-11 feet BGS). Boring SB-12 is located directly east of the oil/water separator, and boring SB-15 is south and downgradient of the unit (see Figure 3-4A).

3.2.2.4 Pump Island and Piping

Two additional borings, SB-11 and SB-22, were installed to investigate possible contamination surrounding the pump island and associated piping. One subsurface soil sample for chemical analyses was obtained from each boring at the soil/water interface (9-11 feet BGS). Boring SB-11 is located on the northeast side of the pump island and directly south of the buried product lines connecting the pumps and tanks. SB-22 is located at the southern end of the pump island. Soil boring SB-22 was converted to monitoring well MW-10.

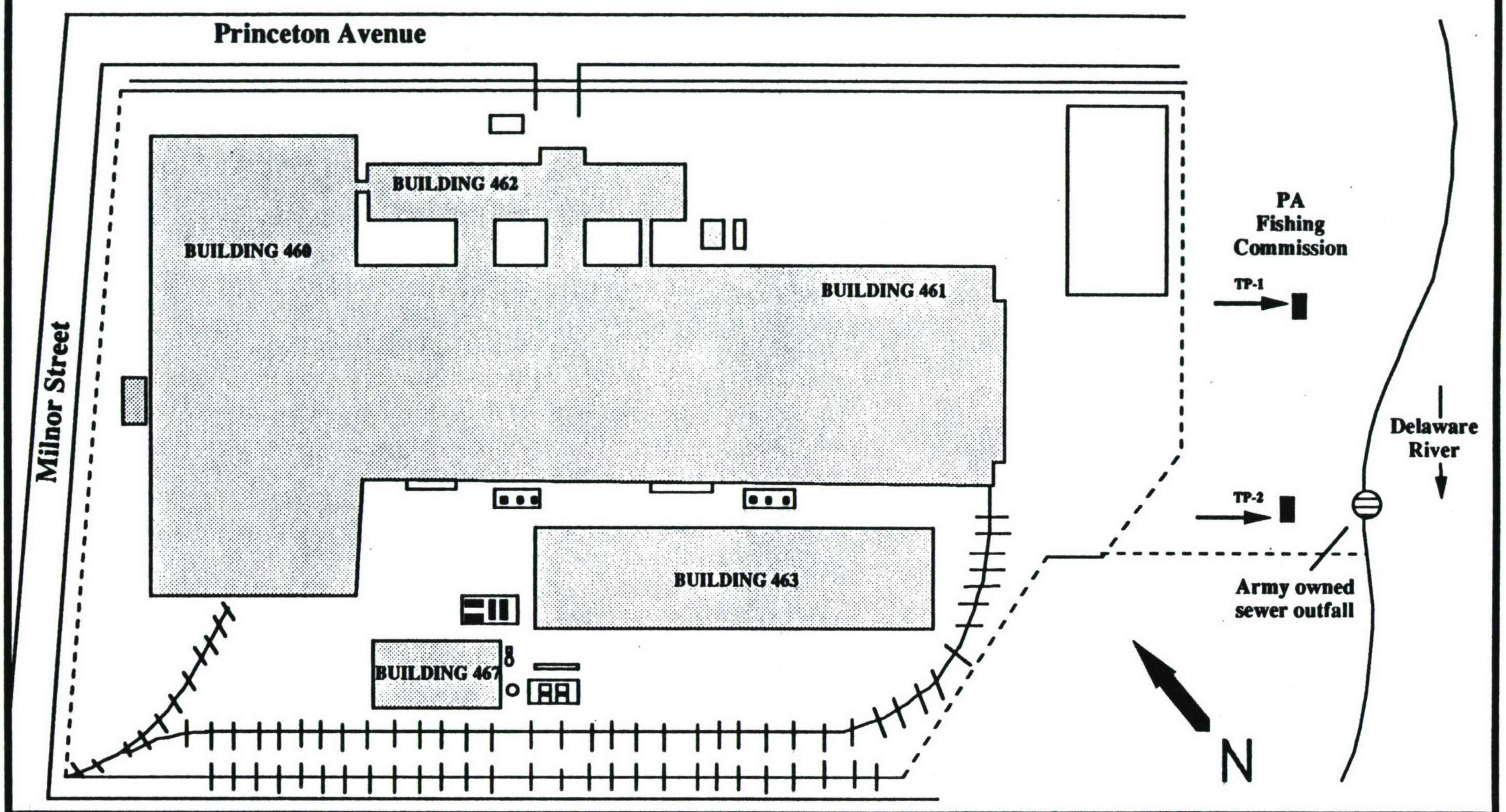
3.2.2.5 Confirmatory Investigation

Six soil borings were installed during the confirmatory investigation. The borings were installed to facilitate the installation of monitoring wells and piezometers intended to further delineate the extent of contamination discovered during earlier stages of the investigation, and were also designed to collect additional information on possible ground water mounding beneath the site. Boring SB-23 was advanced adjacent to the southern corner of building 463 and was converted to monitoring well MW-11. SB-24 was drilled due south of MW-4 and was converted to monitoring well MW-12. SB-27 was installed downgradient of MW-9 and was converted to monitoring well MW-14. Soil boring SB-28 was advanced between MW-1 and MW-9 and was converted to monitoring well MW-15. One subsurface soil sample for chemical analyses was collected at the soil/water interface in each of the four above described borings (9-11 feet BGS in SB-23 and SB-24, 7-9 feet BGS in SB-27 and SB-28).

Two additional borings were installed for the purpose of siting piezometers. Subsurface soil samples for chemical analysis were not collected from these borings. SB-25 was installed between MW-14 and MW-12 and was converted to piezometer P-1. SB-29 was installed southeast of MW-3, between buildings 461 and 463, and was converted to piezometer P-2.

3.2.2.6 Fill Area

Two test pits, TP-1 and TP-2, were excavated during the Phase I investigation on December 5, 1990, in the 0.9 acre area leased to the Pennsylvania Fish Commission (see Figure 3-5). The purpose of the test pits was to allow for visual inspection of the fill material and to determine whether the area warranted further investigation. The test pits were installed in accordance with the requirements outlined in the USATHAMA Sampling Design Plan.



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SCALE: 1-INCH APPROX 150 FEET

▮ TEST PIT LOCATION

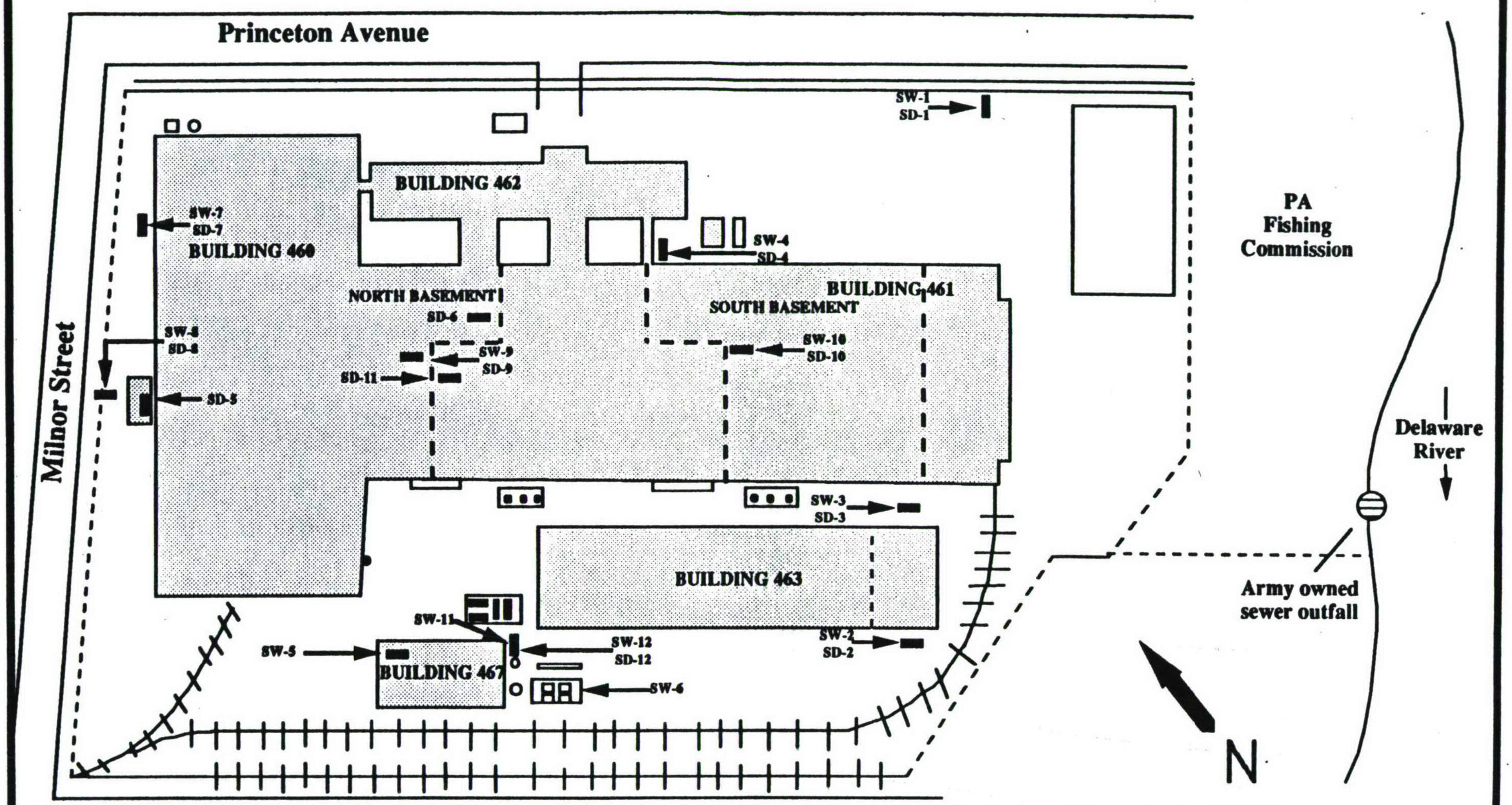
FIGURE 3-5
TEST PIT
LOCATION MAP

Installation was completed using a front-end loader/backhoe capable of excavating to a depth of 10 feet. Each pit was excavated to the top of the water table. The approximate dimensions were 3 feet wide by 15 feet long by 10 feet deep. The contents of each pit were visually inspected, characterized, and screened with an HNu for volatile organics by a qualified Versar geologist. The lithological characterization of the pits consisted of a mixture of fine to coarse sand and gravel, some silt, cobble size rock, brick and concrete, boulder sized slabs of concrete, and wood, brick, and concrete fragments (i.e., fill material). The fill did not exhibit any visible signs of contamination (e.g., staining, odor, discoloration), and all HNu field screening measurements were 0 ppm above background. Therefore, no subsurface soil samples were collected for laboratory analysis. The pits were backfilled by the front-end loader immediately upon completion of lithological characterization and field screening.

3.3 SURFACE WATER AND SEDIMENTS

Although no surface water bodies exist on the TW site, surface water runoff and associated sediments are collected in an onsite storm drain system. During the investigation, surface water and sediment samples were collected from six storm drains onsite and from two sumps in the basements of building 461. Samples from the storm drains were obtained from the trap-like drains, not directly from the sewer pipe. Additional surface water samples were collected from the utility tunnel, oil water separator and the above ground storage tank containment structure. Additional sediment samples were collected from the following locations: (1) the floor drain in the pesticide storage building, (2) two floor drains in building 461, (3) the oil/water separator, and (4) the sand absorbent on the basement floor in building 461. The surface water and sediment sampling locations are depicted in Figure 3-6.

All samples were grabs, with the exception of the sediment sample obtained from the two floor drains in building 461. Surface water samples were collected by submersing glass beakers into the water to be sampled. Sample volumes were poured directly from the beakers into the appropriate sample container, starting with the VOC aliquot. Each sample container was rinsed three times with sample prior to collecting the sample for analyses.



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LANGHORNE, PA

SCALE: 1-INCH APPROX 150 FEET

▬ SURFACE WATER SAMPLE LOCATION & SEDIMENT SAMPLE LOCATION

FIGURE 3-6
SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP

Field measurements for pH, conductivity, and temperature were taken for each surface water sample. A total of 12 surface water samples, plus a sample of the decontamination water, were analyzed for EPA TCL parameters and TPHC by the CLASS laboratory.

Where applicable, sediment samples were collected at each location subsequent to collection of the respective surface water sample. Stainless steel scoops and augers were used for collecting the samples. Samples for volatile organic analysis were collected directly from the sampling device. The sediment sample volume for the remaining parameters was homogenized in a stainless steel bowl prior to placement in the appropriate sample containers.

In the case of the composite sample from building 461 floor drains, equal volumes were collected from the two floor drains. Volumes for volatile organic analysis were collected first. The remaining sample volume was homogenized in a stainless steel bowl prior to placement in the appropriate containers. Samples collected from the storm drains, oil/water separator, basement sumps, and building 461 floor drains were analyzed for EPA TCL parameters. The sample from the floor drain in the former pesticide storage building was analyzed for pesticides/PCBs and herbicides, and the sample of sand absorbent was analyzed for PCBs and TPHC. A total of 12 sediment samples were analyzed by the CLASS laboratory.

3.4 GROUND WATER INVESTIGATION

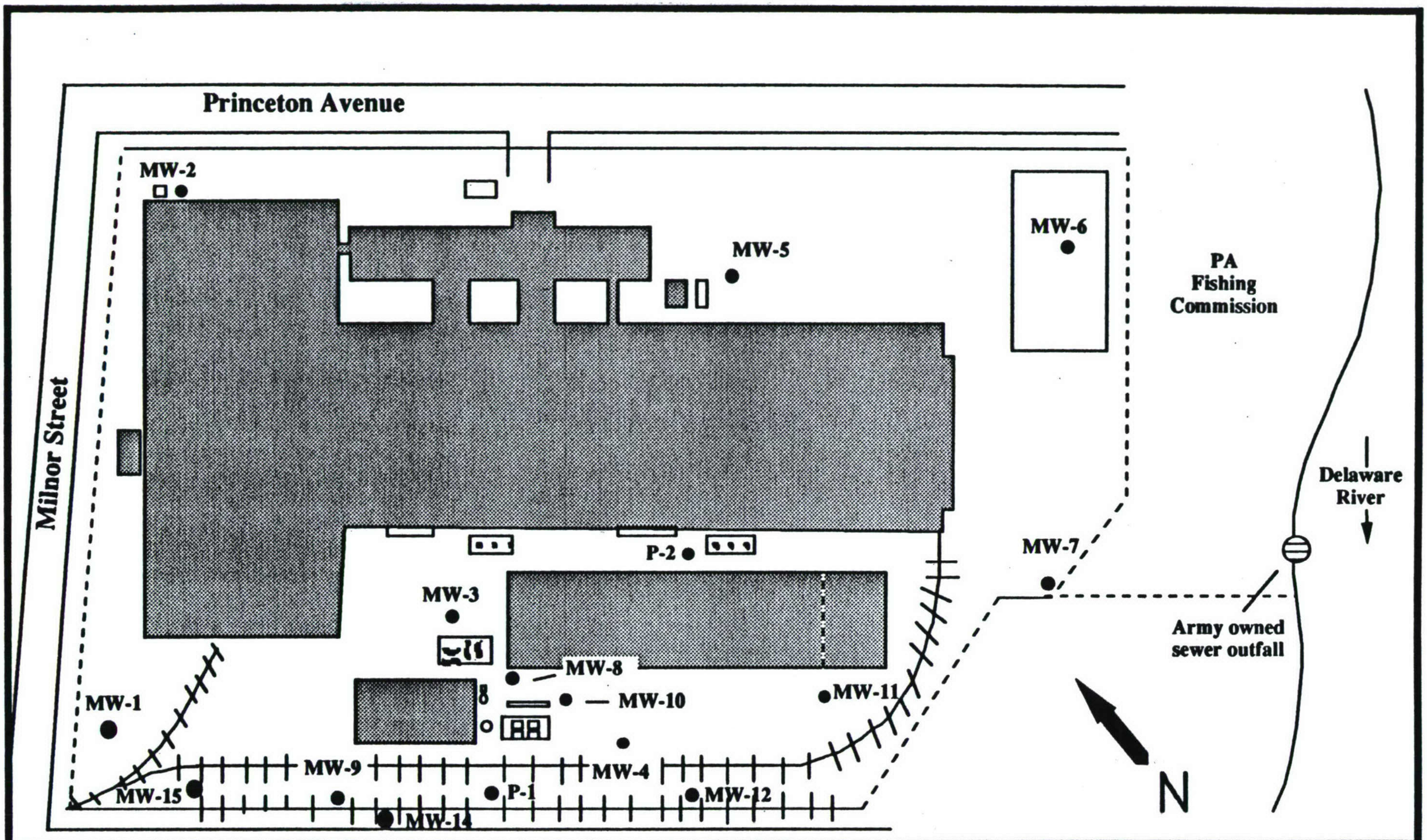
3.4.1 Monitoring Well Installation

Following completion of soil boring activities, 14 overburden aquifer monitoring wells were installed at the Tacony Warehouse. Soil borings SB-1, SB-2, SB-3, SB-4, SB-5, SB-6, SB-7, SB-13, SB-20, and SB-22 were converted to monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, and MW-10, respectively. During the confirmatory investigation, soil borings SB-23, SB-24, SB-25, SB-27, SB-28, and SB-29 were converted to monitoring wells and piezometers MW-11, MW-12, P-1, MW-14, MW-15, and P-2.

The locations of the wells were selected to investigate ground water and chemical characteristics beneath the site. Piezometers were installed to supplement groundwater elevation data obtained from monitoring wells.

Monitoring wells MW-1 and MW-2 were designed to identify background water quality conditions. Location MW-3 was selected to provide downgradient data for possible contamination emanating from beneath buildings 460 and 461 and upgradient data for possible ground water contamination related to the AST and USTs located in the former spray pond area, as well as any possible contamination from the spray pond itself. Monitoring well MW-4 was positioned downgradient of the ASTs located south of building 467. Similarly, MW-5 was designed to provide downgradient ground water data for the UST located east of building 461 near the guardhouse, and MW-8 was designed to provide downgradient data for the ASTs, USTs, and the spray pond. The location for MW-9 was selected to provide ground water data for downgradient of the abandoned UST located west of building 467. Well MW-10 was positioned south of the pump island to detect any possible ground water contamination resulting from leaking pipes and pumps. The remaining initial monitoring wells, MW-6 and MW-7, were placed south of building 461 in the 0.9 acre fill area to provide downgradient ground water data related to the entire site. Table 3-4 indicates initial monitoring well siting rationale. Table 3-5 demonstrates how these siting rationales were affected by unpredicted ground water flow patterns.

Monitoring wells and piezometers installed during the confirmatory investigation were designed to collect additional information on areas of concern identified during initial phases of the EI. Monitoring well MW-11 was sited to provide data for the area between MW-4 and MW-7. MW-12 was designed to collect data downgradient of MW-4. Monitoring well MW-14 was sited downgradient of MW-9 and was positioned as a well couplet with MW-9, monitoring the basal portion of the aquifer. MW-15 was installed upgradient of MW-9 to further evaluate the area of the abandoned UST. Piezometers P-1 and P-2 were positioned to provide additional ground water elevation data needed to evaluate the presence of a ground water mound in the area of MW-8. Monitoring well and piezometer locations are provided in Figure 3-7. A more detailed explanation of these monitoring well locations and piezometers is presented in Table 3-6.



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SCALE: 1-INCH EQUALS APPROX. 150 FEET

● GROUND WATER MONITORING WELL OR PIEZOMETER

FIGURE 3-7
GROUND WATER MONITORING WELL & PIEZOMETER LOCATION MAP

TABLE 3-4

Original Rationale for the Siting of Monitoring Wells Based on Predicted Ground Water Flowpaths.*

MW-1 and MW-2	Sited to monitor background water quality conditions.
MW-3	Sited to monitor buildings 460 and 461 and to monitor the area upgradient of ASTs and USTs in the vicinity of building 467 and the former spray pond area.
MW-4	Sited to monitor the area downgradient of the ASTs south of building 467.
MW-5	Sited to monitor the area downgradient of the USTs located east of building 461 near the guardhouse.
MW-6 and MW-7	Sited to monitor general water quality conditions downgradient of the Tacony Warehouse site as a whole.
MW-8	Sited as downgradient well to ASTs, USTs, and spray pond west of building 461.
MW-9	Sited to monitor the area downgradient of the abandoned UST west of building 467.
MW-10	Sited to monitor the area downgradient of the pump island west of building 463.

* Based on Sampling Design Plan (Task Order 16) dated May 1990.

TABLE 3-5

Review of the Tacony Warehouse Monitoring Well Array Subsequent to the Preparation of Site Water Table Maps.

MW-2	This well does not appear to be monitoring background water quality conditions as originally intended, rather it is indicated to be monitoring potential ground water impacts associated with former building 460 activities.
MW-3	Ground water mounding in the vicinity of this well has apparently caused a reversal in hydraulic gradient; MW-3 is indicated to be downgradient instead of upgradient from the former spray pond and USTs located west of building 461.
MW-6	This well is interpreted to be monitoring the area downgradient of MW-7 and not general water quality conditions downgradient of the TW site as a whole.
MW-8	Located at the center of a ground water mound, this well appears to be impacted by leakage from a storm water collection manhole located just a few feet away; analytical data from water samples taken at this location should be interpreted accordingly.

TABLE 3-6

Objectives of Monitoring Wells Installed During June, 1992 Phase of Work.

MW-11	Sited to determine if TPHC contamination in monitoring wells MW-4 and MW-7 were related and represented the same contaminant plume.
MW-12	TPHC plume delineation downgradient of MW-4.
MW-14	Sited to complement MW-9, as part of well couplet; monitor for dense non-aqueous phase liquids (DNAPLS) in the basal portion of the aquifer, also used to evaluate vertical hydraulic gradients.
MW-15	Sited at a mid-point between MW-1 and MW-9 to further evaluate the extent of PCE/vinyl chloride contamination in the latter well.
P-1	Installed as a piezometer to confirm the geometry of a ground water mound and to evaluate its impacts on ground water flowpaths; this piezometer could also be used to monitor TW site aboveground storage tanks (ASTS).
P-2	Installed as a piezometer to confirm the geometry of a ground water mound and to evaluate its impacts on ground water flowpaths.

At the outset of monitoring well installation activities at TW in June 1992, it was determined that only a single well could be installed in a downgradient location from MW-9. The physical constraint for this was the presence of overhead power lines located approximately 35' between MW-9 and the western site boundary. Following consultation between Versar and USATHAMA geologists, a decision was reached to install one well, MW-14, at a distance of 25 feet to the west-southwest of MW-9. This new well would be screened in the basal portion of the aquifer and would then function as a well couplet in conjunction with the water table well screen in MW-9. MW-15 was installed to ascertain upgradient water quality conditions to MW-9 and the contiguous abandoned UST.

The monitoring wells and piezometers were installed in accordance with the well construction specifications provided in the USATHAMA Geotechnical Requirements and the Sampling Design Plan. Each well was constructed of a 10-foot, 4-inch diameter, schedule 40 PVC screen with a slot size of 0.010 inches, and a 4-inch diameter, schedule 40 PVC riser pipe that either extended to existing grade, or 2.25 feet above grade. Piezometers were constructed in the same manner, but of 2-inch diameter PVC. The well and piezometer screens were installed to a depth intended to straddle the water table and intercept any free-phase floating product. The exception was well MW-14, which was screened from 25 to 35 feet below ground surface at the bottom of the aquifer.

A No. 1 morie pack was placed in the annular space between the well screen and the boring. The filter pack was installed synchronously with auger extraction and extended to five feet above the top of the screen. A five-foot bentonite seal was installed directly above the sand pack. Following placement, the bentonite seal was hydrated with approximately five gallons of water and allowed to swell for thirty minutes. The remaining annulus was then filled to the surface using a cement-bentonite grout. Each well was secured by a protective steel casing placed over the stand pipe, either level with grade or extending 2 to 2.5 feet above grade. The protective casing was secured in-place with a cement-sand-mortar collar. In addition, four 6-foot high, 3-inch diameter painted steel pickets were installed around each well that was completed above grade.

3.4.2 Well Development and Well Redevelopment

Following monitoring well completion, each well and piezometer was developed in accordance with the USATHAMA Sampling Design Plan, and all data was recorded. Well development records describing the physical characteristics of the water and development process are provided in Appendix K.

Well development was accomplished by pumping the ground water from the wells with a 3.5-inch diameter submersible pump and/or by using a Teflon or PVC bailer. Development proceeded until well discharge water was visibly clear and turbidity free to the maximum extent practical. During the development process, many of the wells revealed excessive draw down to the point of near dryness. A slow recharge rate caused the development process to continue over a one or two day period, which resulted in the use of multiple development methods (e.g, pumping and bailing). All water pumped from the wells was contained in 55-gallon drums and stored onsite.

Monitoring wells MW-2 and MW-9 were also redeveloped using a surge block and bailer. These two wells were chosen for redevelopment due to their anomalously low water levels and the impact of that data on water table elevation maps. The redevelopment of monitoring wells MW-2 and MW-9 did not result in any noticeable changes in their respective water levels.

During the development and redevelopment process, no water was added to the wells, nor were any airlift techniques used. Following well development, the submersible pump was decontaminated by purging at least 50 gallons of onsite potable water through the pump and all associated hoses and accessories. The final decontamination step consisted of rinsing all pumping equipment with deionized water. The bailers were decontaminated in accordance with the requirements in the USATHAMA Sampling Design Plan.

3.4.3 Surveying

All ground water wells and piezometers installed during the EI investigation were surveyed by a professional land surveyor (James M. Stewart, Inc.) to determine their geographic location. The Pennsylvania State Plane Coordinate system was used as the horizontal control with an accuracy of ± 3 feet to establish the well map coordinates. Additionally, elevations for the ground surface, the top of the PVC casing, and the top of the steel protective casing at each location were determined to an accuracy within ± 0.05 feet using the National Geodetic Vertical Datum of 1929. Surveyed well and piezometer coordinates and elevations are summarized in Table 3-7.

3.4.4. Water Level Measurements

Water levels for the 10 monitoring wells initially installed at Tacony Warehouse were recorded for seven rounds of measurements. The first three rounds of water level measurements were collected from monitoring wells MW-1 through MW-7, which were installed during the initial investigation. The other four rounds of water level measurements included wells MW-8 through MW-10, which were installed during the follow-on investigation, as well as the existing wells from the initial investigation. An additional three rounds of water level measurements were obtained during the confirmatory investigation. One round of measurements from the initial 10 wells was obtained prior to field activities and two rounds of water level measurements were obtained from all existing monitoring wells and piezometers at the site after installation activities. Water level measurements were obtained using an electronic water level sounding device. Each measurement was obtained from a surveyed reference point marked on top of the PVC casing, and the measurement was accurate to within 0.01 feet. Prior to each measurement, the water level indicator was thoroughly rinsed with deionized water, cloth-wiped, and allowed to air dry between consecutive measurement locations. All measurements were recorded in a field log book and tabulated in feet above mean sea level. Water level measurements for the June 15, 1992, sampling round are provided in Table 3-8 along with well construction data.

3.4.5 Ground Water Sampling

Ground water samples were collected from the 14 monitoring wells installed at the Tacony Warehouse. Monitoring wells MW-1 through MW-7 were sampled during the initial phase of the investigation on December 10, 1990, and wells MW-8 through MW-10 were sampled during the follow-on phase on July 8, 1991. Monitoring wells MW-4, MW-7, MW-9, MW-11, MW-12, MW-14, and MW-15

TABLE 3-7
TACONY WAREHOUSE
WELL LOCATIONS
SURVEYED WELLS COORDINATES AND ELEVATIONS

	ELEVATIONS			COORDINATES			
		CASING				NORTH	WEST
WELL#	GROUND	PVC INNER	PROTECTIVE OUTER	NORTH	EAST	LATITUDE	LONGITUDE
MW-1	19.26	21.11	21.26	262,696.12	2,759.781.93	40°O1'20.748"	75°02'12.459"
MW-2	16.82	18.68	19.05	262,908.93	2,760,297.22	40°01'22.694"	75°02'05.754"
MW-3	16.10	15.68	16.09	262,490.17	2,760,110.95	40°01'18.614"	75°02'08.313"
MW-4	15.24	14.66	15.24	262,246.78	2,760,085.81	40°01'16.217"	75°02'08.732"
MW-5	14.04	13.63	14.09	262,393.02	2,760,519.35	40°01'17.530"	75°02'03.104"
MW-6	11.93	14.39	14.73	262,055.74	2,760,700.47	40°01'14.143"	75°02'00.911"
MW-7	11.28	12.90	13.63	261,965.99	2,760,461.20	40°01'13.329"	75°02'04.020"
MW-8	15.92	15.82	16.10	262,363.37	2,760,109.08	40°01'17.362"	75°02'08.387"
MW-9	15.13	14.70	15.14	262,467.77	2,759,915.52	40°01'18.452"	75°02'10.832"
MW-10	15.28	14.52	15.19	262,303.05	2,760,118.65	40°01'16.763"	75°02'08.288"
MW-11	14.15	14.01	14.29	262,103.38	2,760,252.47	40°01'14.750"	75°02'06.647"
MW-12	14.41	14.16	14.43	262,163.77	2,760,076.36	40°01'15.400"	75°02'08.886"
MW-14	15.84	15.61	15.88	262,445.69	2,759,902.40	40°01'18.238"	75°02'11.010"
MW-15	17.14	19.49	19.90	262,569.19	2,759,850.51	40°01'19.473"	75°02'11.628"
P-1	14.65	14.45	14.71	262,316.45	2,759,978.76	40°01'16.938"	75°02'10.080"
P-2	16.46	16.14	16.51	262,290.88	2,760,287.81	40°01'16.591"	75°02'06.119"

HORIZONTAL DATUM: PENNSYLVANIA STATE PLANE COORDINATES NAD 27 SOUTH ZONE
VERTICAL DATUM: NGVD 1929

TABLE 3-8

WELL CONSTRUCTION DATA
TACONY WAREHOUSE SITE

WELL/ PIEZOMETER NUMBER	INSTALLATION DATE	TOTAL DEPTH (IN FEET)	SCREENED INTERVAL (IN FEET)	WATER TABLE ELEVATION* (6-15-92)	ELEVATION AT GRADE*	ELEVATION OF WELL* (PVC CASING)
MW-1	11-27-90	25.0	15.0-25.0	4.66	19.26	21.11
MW-2	11-27-90	23.7	13.7-23.7	2.30	16.82	18.68
MW-3	11-30-90	23.0	13.0-23.0	3.88	16.10	15.68
MW-4	11-29-90	19.5	9.5-19.5	5.65	15.24	14.66
MW-5	11-28-90	21.5	11.5-21.5	3.93	14.04	13.63
MW-6	12-3-90	19.2	9.2-19.2	3.39	11.93	14.39
MW-7	11-27-90	19.0	9.0-19.0	4.77	11.28	12.90
MW-8	6-20-91	19.8	9.8-19.8	6.52	15.92	15.82
MW-9	6-21-91	21.0	8.7-18.7	2.81	15.13	14.70
MW-10	6-24-91	18.5	8.5-18.5	5.49	15.28	14.52
MW-11	5-20-92	17.06	7.06-17.06	5.28	14.15	14.01
MW-12	5-21-92	17.18	7.18-17.18	5.58	14.41	14.16
MW-14	5-27-92	38.0	25.0-35.0	4.01	15.84	15.61
MW-15	5-26-92	18.0	7.55-17.55	4.53	17.14	19.49
P-1	5-21-92	18.0	6.15-16.15	5.86	14.65	14.45
P-2	5-22-92	18.17	8.17-18.17	4.61	16.46	16.14

* Elevation data is the height in feet above mean sea level.

were sampled during the confirmatory investigation on June 16 and 17, 1992. Analytical parameters for each well consisted of TCL parameters and TPHC. Ground water sampling was performed in accordance with the USATHAMA Sampling Design Plan.

Sampling occurred after the wells were developed in accordance with the USATHAMA Geotechnical Requirements. Following development, a 14-day aquifer stabilization period elapsed before ground water samples were obtained. Wells were sampled in order of expected increasing contamination (i.e., upgradient to downgradient). Upon initial opening of the well, an HNu reading was obtained to determine the presence of volatiles in the well head and to determine whether the action levels denoted in the Health and Safety Plan were exceeded. There were no persistent elevated head space readings above action levels, so all sampling was performed under level D personal protection.

The depth to water was recorded, and the purge volume was calculated (i.e., five times the volume of the standing water in the well, including the saturated gravel pack). The ground water was evacuated from each well using a 2-inch diameter submersible pump or a teflon bailer. However, five well volumes were not purged from the onsite wells because aquifer recharge did not facilitate sustained pumping (i.e., the wells were pumped dry). Each well was pumped until all the available standing water was removed twice. The well was then allowed to recharge prior to sampling. Field measurements for water quality (e.g., pH, specific conductance, and temperature) were obtained before, during, and after purging and recorded in the field log book. All purge water was contained in 55-gallon drums and stored onsite.

Following recharge of the water to volumes required for sampling, ground water samples were obtained using a dedicated Teflon bailer and a length of nylon rope. Samples were collected in order of decreasing volatility (i.e., VOC, semi-volatiles, TPHC, metals, and cyanide). Each sample was labeled, packed in a cooler at 4°C, and shipped with a completed chain-of-custody form by overnight express to the CLASS laboratory.

3.4.6 Slug Tests

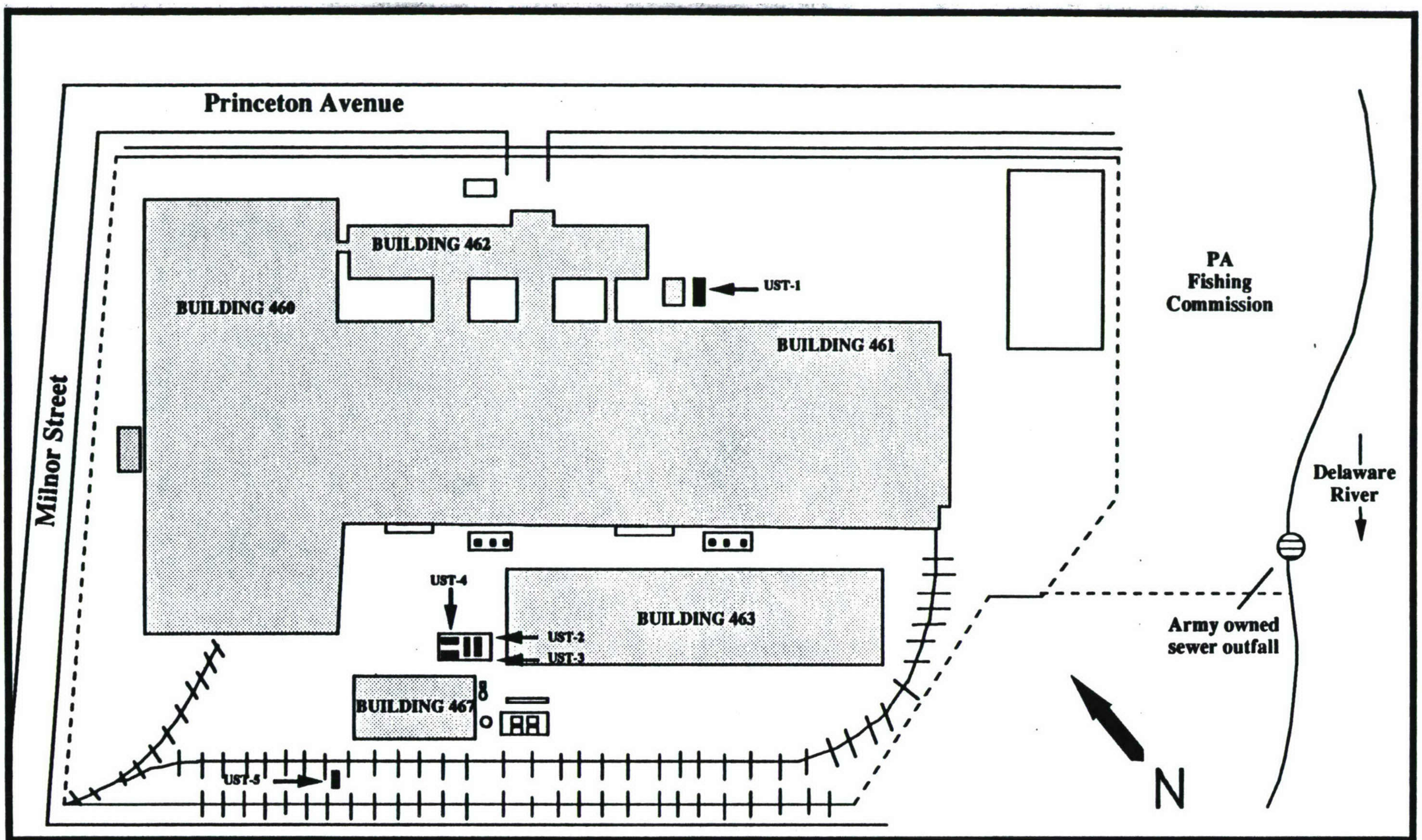
Three monitoring wells at the TW site were selected for slug testing, to measure the local hydraulic conductivity in the aquifer system. Monitoring wells MW-4, MW-7, and MW-9 were chosen because it is believed these wells represent the broadest cross section of aquifer materials, and also due to their location in areas of identified ground water contamination.

Slug testing was performed using a 4' PVC slug. The slug was placed in the well and the static water level was allowed to return to the initial level. After the water level equilibrated (measurements were made by pressure transducer), the slug was removed from the well. Rising head water table elevations were recorded on an In-Situ® hermit, then downloaded to a lap-top computer. Drawdown data was transferred as an ASCII file to AQTESOLV®, an aquifer test interpretation software program for final interpretation.

Slug testing was performed several days subsequent to sampling of monitoring wells, and the slug was decontaminated prior to insertion in successive wells.

3.5 TANK CONTENT INVESTIGATION

Liquid product samples were collected from the five underground storage tanks located at the TW site (see Figure 3-8). The purpose of this sampling was to determine the nature of the materials contained in each tank. The samples were collected using a peristaltic pump and teflon tubing, due to the limited volume in each tank. Sufficient sample volume was collected to allow the CLASS laboratory to perform a GC fingerprint analysis on the subject materials. Liquid product present in the four 9,000-gallon above ground tanks was visually inspected by a USATHAMA chemist and determined to be No. 6 fuel oil. Therefore, samples were not obtained from these tanks. A 300-gallon, skid-mounted above ground tank located on the property was found to be empty during the investigation.



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SCALE: 1-INCH APPROX 150 FEET

■ TANK SAMPLING LOCATION

FIGURE 3-8
TANK SAMPLE
LOCATION MAP

SECTION 4.0

SUMMARY OF RESULTS

4.1 ANALYTICAL RESULTS

This section presents the data available from the analysis of samples collected during the EI, primarily reported by Arthur D. Little, Inc. Chemical analyses were performed using EPA and USATHAMA certified methods. Asbestos analytical data was prepared by Versar, Inc. Relevant information has been extracted from the raw data for use in the following discussions. This information has been prepared by reorganization of the reported analyses and by segregation of species of the chemical parameters by environmental medium. Consideration of the sampling and analytical program of the EI indicates that the sampling and analyses are appropriate for the discussions needed to characterize the current conditions at the TW site.

Summary tables in the following sections present the data extracted from the main body of analytical results. These discussions are limited to detected compounds. In addition to identifiable compounds, the raw data contained a number of tentatively identified compounds (TICs). Tentative identification is based upon the peak in the chromatogram for the sample. Since standards were not run for TICs, the identification is only tentative and would need to be verified by running concurrent standards. Because of the low reliability associated with TICs, these compounds are generally not discussed in the text. Raw analytical data, including TICs, are reported in Appendices E through K. USATHAMA Chemical Test Codes are presented in Appendix D.

4.1.1 Asbestos

During completion of the EI, a total of 66 bulk samples were collected from six buildings and from four above ground storage tanks located on the TW property. No building plans describing the age and types of building materials used in construction were available for review. Therefore, each building was considered to be a separate area that was sampled individually, even though similar types of suspected asbestos containing material (ACM) were present throughout the TW site. The following types of suspect materials were collected:

- Preformed thermal insulation products (e.g., pipe insulation, tank insulation, boiler insulation);
- Concrete-like products (e.g., corrugated siding, exterior shingles, transite panel board);
- Asbestos-containing products (e.g., floor tile mastic, caulking, joint compound, insulation cement);
- Floor tile and sheet goods (e.g., vinyl and asphalt tile);
- Wall coverings (e.g., sheetrock, particle board);
- Textiles (e.g., curtains); and
- Paint

Bulk-sample analytical results and a summary of sample locations and materials are included in Tables 4-1 through 4-5. Raw analytical data for each bulk sample collected is included in Appendix E. Materials containing equal to or greater than one percent asbestos by weight are considered ACM. Each individual building was surveyed during this sampling event, and the findings for each building are discussed below.

A total of 15 asbestos samples, including one duplicate sample, were collected in Building 467 (see Table 4-1). Analytical results indicated that 10 of the 15 samples contained greater than one percent asbestos by weight, in either the chrysotile or chrysotile/amosite forms. Both friable and non-friable ACM were identified. Non-friable asbestos, in the form of floor tile, was located in the boiler room office. Friable ACM was noted throughout the building in the form of pipe insulation, tank insulation, boiler insulation, ash flue insulation, and boiler stack insulation. The majority of the pipe and tank insulation was wrapped in canvas and intact, or had some localized damage, and was not located in a area within the reach of warehouse workers. However, when the boiler is operating, the pipes and tank may be influenced by vibrations, thus causing release of asbestos fibers. Therefore, the pipe and tank insulation is determined to have a medium relative risk. The remaining friable insulation (i.e., boiler insulation, boiler stack insulation, and ash

TABLE 4-1: BUILDING 467 (STEAM PLANT)

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% & TYPE ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RISK	QUANTITY
				CH=Chrysotile AM=Amosite	I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF=Square Feet LF=Linear Feet EA=Each
ASB-1	STORAGE ROOM (1)	PAINT (SILVER)	NO	—	—	—	—	—
ASB-2A	BOILER ROOM OFFICE (2)	FLOOR TILE- 9"x 9"-BROWN	YES	1 - 5 CH	LD	G	NF	500 SF
ASB-2B	ABOVE BOILER ROOM OFFICE (2)	FLOOR TILE MASTIC	NO	—	—	—	—	—
ASB-3	ABOVE BOILER ROOM OFFICE (2)	PIPE INSULATION	YES	1 - 5 CH 30-45 AM	LD	R	M	1,050 LF
ASB-4	ABOVE BOILER ROOM OFFICE (2)	TANK INSULATION	YES	75-85 CH 1 - 5 AM	LD	R	M	250 SF
ASB-5	ABOVE BOILER ROOM OFFICE (2)	ELBOW INSULATION	YES	45-50 CH 5 -10 AM	LD	R	M	117 EA
ASB-6	BOILER ROOM OFFICE (3)	PIPE INSULATION	YES	20-25 CH 30-35 AM	LD	R	M	ASB-3
ASB-7	BOILER ROOM OFFICE (3)	SHEETROCK	NO	—	—	—	—	—
ASB-8	BOILER ROOM (2)	CEILING TILE	NO	—	—	—	—	—
ASB-9	BOILER ROOM (2)	ASH FLUE INSULATION	YES	35-40 CH	DD	G	H	240 SF
ASB-10	BOILER ROOM (2)	BOILER STACK INSULATION	YES	60-65 CH	DD	G	H	1,200 SF
ASB-11	BOILER ROOM (2)	BOILER INSULATION	YES	70-75 CH 1 - 5 AM	DD	G	H	1,080 SF
ASB-12	STORAGE ROOM (1)	CEMENT PLASTER-EXTERIOR WALL	NO	—	—	—	—	—
ASB-13	STORAGE ROOM (1)	PIPE INSULATION	YES	25-30 CH 35-40 AM	LD	G	M	160 LF
ASB-14	DUPLICATE OF ASB-10	BOILER STACK INSULATION	YES	65-70 CH	LD	G	H	ASB-10

flue insulation), was noted to have distributed damage, is within reach of warehouse workers, and is highly influenced by vibrations during boiler operations. Therefore, this ACM is determined to have a high relative risk factor.

A total of 33 asbestos samples, including 3 duplicate samples, were collected from the Administration Building (see Table 4-2). Results of the sample analysis indicated that 16 of the 33 samples contained greater than one percent asbestos by weight. Both friable and non-friable ACM were found in the building. Non-friable asbestos, in the form of floor tile and associated mastic, asphalt roof shingles, and exterior siding panels, were found throughout the interior and exterior of the building.

Two different types and sizes of floor tiling were found on both levels of the Administration Building. Asbestos samples were collected on both levels from 9"X 9" brown floor tile and 12"X 12" light brown floor tile. All samples indicated the floor tiles contain greater than one percent chrysotile asbestos. The associated floor tile mastic were also sampled on both levels from beneath the two different types of floor tile. Results of the sampling indicated that the mastic from only one location (ASB-36, Lobby, first level) contained chrysotile asbestos. Analysis of the other floor tile mastic samples indicated that they contained less than one percent asbestos.

Non-friable exterior siding panels and asphalt roof shingles cover the entire exterior of the Administration Building. During the inspection, these materials were intact and determined to pose little threat to warehouse workers due to their non-friable characteristics.

Friable ACM, in the form of pipe insulation, was found in small quantities (150 linear feet) on the first level in the Administrative Building. The pipe insulation was located primarily on the hot water heating pipes in the building's offices. The ACM was observed to have distributed damage and considered to be located in an area with potential for personal contact. Additionally, approximately 1,500 linear feet of friable pipe insulation was located in the crawlspace, beneath the first level of the

TABLE 4-2: BUILDING 462 (ADMINISTRATION BUILDING)

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RRISK	QUANTITY
				CH=Chrysotile AM=Amosite	I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF=Square Feet LF=Linear Feet EA=Each
ASB-15	CONFERENCE ROOM SOUTH (2)	FLOOR TILE-12"x 12"- LIGHT BROWN	YES	5 -10 CH	LD	G	NF	1,200 SF
ASB-16	CONFERENCE ROOM SOUTH (2)	FLOOR TILE MASTIC	NO	—	—	—	—	—
ASB-17	CONFERENCE ROOM SOUTH (2)	CEILING TILE-12"x 12"-WHITE	NO	—	—	—	—	—
ASB-18	CONFERENCE ROOM SOUTH (2)	CEILING TILE-12"x 12"-WHITE	NO	—	—	—	—	—
ASB-19	STORAGE ROOM SOUTH (2)	FLOOR TILE-9"x 9"-BROWN	YES	5 -10 CH	LD	G	NF	3,500 SF
ASB-20	STORAGE ROOM SOUTH (2)	FLOOR TILE MASTIC	NO	—	—	—	—	—
ASB-21	STORAGE ROOM SOUTH (2)	SHEETROCK	NO	—	—	—	—	—
ASB-22	STORAGE ROOM SOUTH (2)	SHEETROCK JOINT COMPOUND	YES	1 - 5 CH	I	G	L	UNKNOWN
ASB-23	STORAGE ROOM SOUTH (2)	SHEETROCK TAPE	YES	1 - 5 CH	I	G	L	UNKNOWN
ASB-24	ROOF	ASPHALT ROOF SHINGLES	YES	5 -10 CH	1	R	NF	12,900 SF
ASB-25	ROOF	ROOF FELT	NO	—	—	—	—	—
ASB-26	ROOF	ROOF CEMENT	NO	—	—	—	—	—
ASB-27	CONFERENCE ROOM SOUTH (2)	WINDOW CAULK	NO	—	—	—	—	—
ASB-28	ASST. MANAGER'S OFFICE (2)	CEILING TILE-12"x 12"-WHITE W/DOTS	NO	—	—	—	—	—
ASB-29	SECRETARY'S OFFICE (2)	CEILING TILE-12"x 12"-WHITE W/GOLD LINES	NO	—	—	—	—	—
ASB-30	MEN'S RESTROOM (2)	PARTIAL BOARD	NO	—	—	—	—	—
ASB-31	CONFERENCE ROOM SOUTH (2)	WINDOW CURTAINS	NO	—	—	—	—	—
ASB-32	DUPLICATE OF ASB-19	FLOOR TILE-9"x 9"-BROWN	YES	5 -10 CH	LD	G	NF	ASB-19

TABLE 4-2: BUILDING 462 (CON'T)

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RISK	QUANTITY
				CH=Chrysotile AM=Amosite	I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF= Square Feet LF= Linear Feet
ASB-33	STORAGE AREA NORTH (1)	FLOOR TILE-9"x 9"-BROWN	YES	5 -10 CH	LD	G	NF	6,000 SF
ASB-34	STORAGE AREA NORTH (1)	FLOOR TILE MASTIC	NO	—	—	—	—	—
ASB-35	LOBBY (1)	FLOOR TILE-12"x 12"-LIGHT BROWN	YES	1 - 5 CH	LD	G	NF	7,060 SF
ASB-36	LOBBY (1)	FLOOR TILE MASTIC	YES	5 -10 CH	I	N	NF	7,060 SF
ASB-37	OFFICE NORTH (1)	SHEETROCK	NO	—	—	—	—	—
ASB-38	OFFICE NORTH (1)	SHEETROCK JOINT COMPOUND	YES	5 -10 CH	I	N	L	UNKNOWN
ASB-39	CONFERENCE ROOM SOUTH (1)	PANEL BOARD	NO	—	—	—	—	—
ASB-40	EXTERIOR SIDING NORTH	EXTERIOR SIDING PANELS	YES	30-35 CH	I	G	NF	13,000 SF
ASB-41	EXTERIOR SIDING SOUTH	EXTERIOR SIDING PANELS	YES	30-35 CH	I	G	NF	ASB-40
ASB-42	OFFICE NORTH (1)	PIPE INSULATION	YES	25-30 CH 15-20 AM	DD	G	H	150 LF
ASB-43	OFFICE NORTH (1)	WALL BOARD	NO	—	—	—	—	—
ASB-44	CONFERENCE ROOM SOUTH (1)	WINDOW CAULKING	NO	—	—	—	—	—
ASB-45	CRAWLSPACE SOUTH (1)	PIPE INSULATION-CORRUGATED	YES	35-40 CH	DD	R	M	1,500 LF
ASB-46	DUPLICATE OF ASB-35	FL. TILE-12"x 12"-LIGHT BROWN	YES	1 - 5 CH	I	G	NF	ASB-35
ASB-47	DUPLICATE OF ASB-33	FLOOR TILE-9"x 9"-BROWN	YES	10-15 CH	LD	G	NF	ASB-33

building. This ACM was observed to have significant distributed damage, by air erosion, with most of the insulation resting on the dirt floor of the crawlspace. However, because of the inaccessibility of the crawlspace, this ACM poses little threat to warehouse workers.

Sheetrock joint compound, located throughout the entire building, was sampled at two locations. Results of the sampling indicated that both samples contained chrysotile asbestos. The sheetrock joint compound is considered to be friable, however, it was observed to be intact with low relative risk to warehouse workers in its current condition.

A total of 6 asbestos samples, including 1 duplicate sample, were collected from Building 461 (see Table 4-3). Results of the sample analysis indicated that 5 of the 6 samples contained greater than one percent chrysotile asbestos by weight. Both friable and non-friable ACM were found in the building. Non-friable asbestos, in the form of floor tile, exterior corrugated siding, and transite panel board, were located throughout the interior and exterior of the building. During the survey, floor tile was observed in the small warehouse office located near the southeast corner of the building. Corrugated siding was observed to be surrounding the upper section of the interior/exterior wall, and transite panel board was located between the structural support members for the roof. All non-friable ACM observed in building 461 was intact, with some very minor localized damage noted.

Friable pipe and elbow insulation was located throughout Building 461, primarily in the upper structural support members near the roof. The pipe insulation was canvas wrapped with only minor localized damage. The pipe insulation was not subjected to vibration, or air and water erosion, and was not within the reach of any warehouse workers. Therefore, the relative risk associated with the pipe insulation is considered to be medium.

A total of 7 asbestos samples, were collected from Building 460 (see Table 4-4). Results of the sample analysis indicated that 5 of the 7 samples contained greater than one percent chrysotile and/or amosite asbestos by weight. Both friable and non-friable ACM were found in the building. Non-

TABLE 4-3: BUILDING 461 (WAREHOUSE)

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RISK	QUANTITY
				CH=Chrysotile AM=Amosite	I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF=Square Feet LF=Linear Feet
ASB-53	WAREHOUSE	PIPE AND ELBOW INSULATION	YES	45-50 CH	LD	R	M	3,600 LF
ASB-54	WAREHOUSE	CORRUGATED SIDING-INTERIOR/EXTERIOR WALL	YES	35-40 CH	I	G	NF	27,600 SF
ASB-55	WAREHOUSE	SHEETROCK (CEILING)	NO	—	—	—	—	—
ASB-56	WAREHOUSE	TRANSITE PANEL BOARD	YES	35-40 CH	I	G	NF	4,000 SF
ASB-57	WAREHOUSE OFFICE	FLOOR TILE-12"x 12"-BROWN	YES	1 - 5 CH	I	G	NF	1,100 SF
ASB-58	DUPLICATE OF ASB-54	TRANSITE SIDING-INTERIOR/EXTERIOR WALL	YES	45-50 CH	I	G	NF	ASB-54

TABLE 4-4: BUILDING 460 (WAREHOUSE)

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RISK	QUANTITY
				CH=Chrysotile AM=Amosite	I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF=Square Feet LF=Linear Feet
ASB-59	WAREHOUSE	PIPE AND ELBOW INSULATION	YES	25-30 CH 15-20 AM	LD	R	M	3,800 LF
ASB-60	WAREHOUSE	SHEETROCK	NO	—	—	—	—	—
ASB-61	WAREHOUSE	TRANSITE PANEL BOARD	YES	35-40 CH	I	G	NF	6,150 SF
ASB-62A	WAREHOUSE	FLOOR TILE-9"x 9"-BROWN	YES	5 -10 CH	I	G	NF	2,250 SF
ASB-62B	WAREHOUSE	FLOOR TILE MASTIC	NO	—	—	—	—	—
ASB-63	WAREHOUSE	EXTERIOR CORRUGATED SIDING	YES	40-45 CH	I	G	NF	19,765
ASB-64	WAREHOUSE-HVAC ROOM	BOILER INSULATION	YES	55-60 CH 10-15 AM	LD	G	M	300 S

friable asbestos, in the form of floor tile, exterior corrugated siding, and transite panel board, were located throughout the interior and exterior of the building. During the survey, approximately 2,250 square feet of floor tile was observed in the center of the warehouse, where offices were once located. Corrugated siding was observed to be surrounding the upper section of the interior/exterior wall, and transite panel board was located between the structural support members for the roof and surrounding the small HVAC room in Building 460. All non-friable ACM observed in the building was intact with some very minor localized damage.

Friable pipe and elbow insulation was located throughout building 460, mainly in the upper structural support members near the roof. Friable tank insulation was also identified in the small HVAC room. The pipe insulation was canvas wrapped with only some minor localized damage. The pipe insulation was not subjected to vibration, or air and water erosion, and was not within the reach of any warehouse workers. Therefore, the relative risk associated with the pipe insulation is considered to be medium. The boiler insulation and associated pipe insulation, located in the HVAC room, showed some localized damage, and could be influenced by vibration during the normal operation of the boiler.

The remaining sample locations (see Table 4-5) surveyed at the TW site included building 464 (Heat Plant), the north and south basement of building 461, and the above ground storage tanks located near building 467. Two samples were collected from building 464. Only one sample, the transite panel board covering the entire interior of the building, was determined to contain greater than one percent chrysotile asbestos by weight. The transite panel board is non-friable and intact, with no influences of vibration or air and water erosion. Therefore, the ACM is considered to represent a low relative risk, and it poses little threat to warehouse workers. Additionally, it was observed that exterior siding panels, similar to those found on the Administration Building (ASB-40 and 41), surrounded the exterior of building 464. Therefore, this material was considered to be ACM.

TABLE 4-5: MISCELLANEOUS SAMPLE LOCATIONS

SUMMARY OF ASBESTOS SAMPLING AND QUANTIFICATION OF ACM

SAMPLE #	LOCATION (FLOOR LEVEL)	MATERIAL TYPE	ASBESTOS PRESENT	% ASBESTOS	CONDITION	POTENTIAL FOR PHYSICAL CONTACT	RELATIVE RISK	QUANTITY
					I=Intact LD=Localized Damage DD=Distributed Damage	N=None R=Rarely G=General	NF=Non-friable L=Low M=Medium H=High	SF=Square Feet LF=Linear Feet
ASB-48	BLDG. 464-HEAT PLANT	TANK INSULATION	NO	—	—	—	—	—
ASB-49	BLDG. 464-HEAT PLANT	TRANSITE PANEL BOARD	YES	35-40 CH	I	G	NF	600 SF
ASB-50	ABOVE GROUND STORAGE TANK NEAR BUILDING 467	TANK INSULATION	YES	10-15 CH	DD	G	H	1,400 SF
ASB-51	BLDG. 461-SOUTH BASEMENT	PIPE AND ELBOW INSULATION	YES	35-40 CH 15-20 AM	LD	R	M	25 LF
ASB-52	BLDG. 461-NORTH BASEMENT	PIPE AND ELBOW INSULATION	YES	50-55 CH	LD	R	M	600 LF

One sample was collected from the friable tank insulation on the four above ground storage tanks (ASTs) located near building 467. Results of the analysis indicated that the tank insulation contained greater than one percent chrysotile asbestos by weight. During the survey, it was observed that two of the four tanks had insulation that had fallen from the tanks into the containment barriers. The remaining two tanks were clean with no insulation in their containment barriers. Therefore, the tank insulation is considered to have significant distributed damage.

Two samples were collected from friable pipe insulation located in both the north and south basement of building 461. Results of the analysis indicated that both samples contained greater than one percent chrysotile or chrysotile/amosite asbestos by weight. The pipe insulation in both basements was observed to be lightly damaged and not subjected to vibrations or air and water erosion. The insulation could be further damaged should use of the basement resume.

4.1.2 Transformers

Analysis of the six transformer fluid samples revealed total PCB concentrations between 200 and 1,520 parts per million (ppm). Analytical results are presented in Table 4-6. Under the Toxic Substances Control Act (TSCA), three categories were established for transformers. Transformers with fluid containing less than 50 ppm PCBs are considered "non PCB". Transformers with fluid containing between 50 and 500 ppm PCBs are considered "PCB contaminated," and transformers with fluid containing greater than 500 ppm are considered "PCB containing". Based on the analytical results, transformers 1, 2, 3, and 5 are PCB contaminated, and transformers 4 and 6 are PCB containing (see Figure 3-1). TSCA regulations include a number of labeling, containment, and inspection requirements for PCB containing and contaminated transformers. The analytical results, as well as visual observations, indicate that the transformers at the TW site have not met the regulatory requirements, and are therefore in violation of TSCA.

TABLE 4-6
TRANSFORMER FLUID ANALYTICAL DATA (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	**TF-1**	**TF-2**	**TF-3**	**TF-4**	**TF-5**	**TF-6**
PCB 1016	**2.77**	**3.09**	**1.44**	**1.15**	**ND**	**7.56**
PCB 1260	**330**	**320**	**200**	**580**	**340**	**1,520**

ND - Not Detected

4.1.3 Spills

A total of ten wipe samples were collected during completion of the EI fieldwork. A summary of the compounds detected is presented in Table 4-7. Two samples (WP-1 and WP-2) were obtained from the areas of hydraulic fluid spills on the concrete floors of the basements in building 461. As would be expected, high levels of total petroleum hydrocarbons (TPHC) were detected at both locations. Sample WP-2 also exhibited levels of chlordane (5.65 ug/100cm^2) and PCB 1260 (2.6 ug/100cm^2). Sample locations WP-3 and WP-4 were within the former pesticide storage building, on the concrete floor and brick wall, respectively. Compounds identified in the highest concentrations at these two locations include 2,4-D (10.1 ug/100cm^2), endosulfan sulfate (1.5 ug/100cm^2), and PCB 1260 (0.652 ug/100cm^2).

The remaining six wipe samples (WP-5 through WP-10) were collected from in or around the structures housing the pad-mounted transformers at the site. Two of the samples, WP-6 and WP-8, exhibited low concentrations of PCB 1260 (0.763 and 1.24 ug/100cm^2, respectively). WP-6 was collected from the interior brick wall of the south transformer station. WP-8 was collected from the interior brick wall of the north transformer station.

4.1.4 Surface and Subsurface Soils

A total of six surface soils samples and 25 subsurface soil samples were collected from discrete locations at the study property during the EI (see Figures 3-3 and 3-4). Surface soil samples were analyzed for pesticides/PCBs, TCL inorganics, and TPHC. Subsurface soil samples were analyzed for TCL organics, inorganics, and TPHC. The purpose in collecting the surface soil samples was to evaluate the effects of past weed control activities on soils along the railroad tracks. The subsurface soil samples were collected to evaluate soil conditions adjacent to underground tanks and piping, and in the area of a former spray pond at the property. Compounds detected in surface and subsurface soils are summarized in Tables 4-8 through 4-11.

4.1.4.1 Surface soils

Analysis of the initial four surface soil samples revealed low levels of pesticides and PCBs at all four locations. Substances detected in the highest

TABLE 4-7
ORGANIC COMPOUNDS DETECTED IN SPILL/WIPE SAMPLES (ug/100 cm^2)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION									
COMPOUND	WP-1	WP-2	WP-3	WP-4	WP-5	WP-6	WP-7	WP-8	WP-9	WP-10
TPHC	68,000	112,000	NA	NA	ND	ND	ND	ND	ND	ND
Chlordane	NA	5.65	ND	ND	NA	NA	NA	NA	NA	NA
2,4-D	NA	NA	10.1	ND	NA	NA	NA	NA	NA	NA
Hexachloro-cyclohexane	NA	NA	0.38	ND	NA	NA	NA	NA	NA	NA
Dieldrin	NA	NA	0.345	ND	NA	NA	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	1.5	0.596	NA	NA	NA	NA	NA	NA
Endrin	NA	NA	ND	0.103	NA	NA	NA	NA	NA	NA
Heptachlor	NA	NA	0.07	ND	NA	NA	NA	NA	NA	NA
PPDDE	NA	NA	ND	0.167	NA	NA	NA	NA	NA	NA
PCB 1260	NA	2.6	0.652	ND	ND	0.763	ND	1.24	ND	ND

NA = Not Analyzed
ND = Not Detected

concentrations include b-hexachlorocyclohexane (0.0543 ppm) and endrin aldehyde (0.0522 ppm). PCB concentrations ranged from 0.232 ppm to 0.466 ppm. During the confirmatory phase of the investigation, two background samples (SS-5 and SS-6) were collected from onsite, unpaved areas outside the area of concern. SS-5 was approximately 50 feet from the area of concern, and SS-6 was on the opposite side of the site. Data from SS-5 was not clearly distinguishable from that of site samples SS-1 through SS-4. Therefore, a conservative approach was taken and data from SS-6 was used as background. Since SS-5 was designed to be a background sample, it was eliminated from further consideration.

Most inorganic compounds were detected at concentrations above background levels (SS-6). Compounds detected substantially above background concentrations (>2 times background) include arsenic, barium, beryllium, calcium, cadmium, chromium, copper, lead, magnesium, nickel, silver, and zinc. A discernible pattern of elevated metals concentrations could not be determined from location to location. For example, the highest concentrations of lead were detected at locations where the lowest levels of arsenic were detected. Tables 4-8 and 4-9 present the compounds detected in surface soils during the EI.

4.1.4.2 Subsurface Soils

During the initial phase of the EI, 8 discrete subsurface soil samples were collected from 7 of the soil borings installed at the site. During the follow-on phase of the EI, a total of 13 samples were collected from the 11 borings installed during follow-on field activities. Four samples were collected from the six borings installed during the confirmatory investigation. Tables 4-10 and 4-11 summarize the compounds detected in subsurface soil samples analyzed during the investigation.

Analyses of samples collected during the initial phase of the investigation revealed appreciable levels of TCL organics at two boring locations. Sample SB-5 contained tetrachloroethane (209 ppb). The two samples obtained from location SB-10, collected at depths of 4 feet and 10 feet, exhibited high concentrations of Polycyclic Aromatic Hydrocarbons

TABLE 4-8
ORGANIC COMPOUNDS DETECTED IN SURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION				PROPOSED RCRA ACTION LEVEL
COMPOUND	SS-1	SS-2	SS-3	SS-4	
Aldrin	LT	LT	LT	0.0225	0.04
b-hexachloro-cyclohexane	ND	ND	ND	0.0543 S	-
Endosulfan II	ND	ND	ND	0.0066 S	4.0
Endrin aldehyde	0.045 S	0.0481 S	0.0522 S	0.0489 S	20
gamma-Chlordane	0.0111	LT	LT	LT	0.5
PCB 1260	0.232	0.252	0.293	0.466	0.09
PPDDT	0.0277 S	0.0169 S	0.0252 S	0.0299 S	2.0
TPHC	ND	544	ND	23,000	-

ND = Not Detected
LT = Less than Certified Reporting Limit
S = Results based on internal standard

TABLE 4-9
INORGANIC COMPOUNDS DETECTED IN SURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION						PROPOSED RCRA ACTION LEVEL
COMPOUND	SS-1	SS-2	SS-3	SS-4	SS-5	SS-6	
Aluminum	8,700	5,000	16,000	10,000	22,000	15,000	-
Arsenic	75.9	111	135	96.3	27	4.5	80
Barium	150 X	240	74.9	160	110	80	4,000
Beryllium	0.62	0.303	0.325	1.18	LT	LT	0.2
Calcium	3,900	3,000	2,200	28,000	2,000	2,200	-
Cadmium	2.37	LT	LT	LT	LT	LT	40
Chromium	110	30.8	16.5	39.6	29	16.6	400
Copper	150	79	160	280	43	28 X	400
Iron	15,000	21,000	21,000	2,800	34,000	19,000	-
Lead	574	103	170	532	84	110	500[(a)]
Magnesium	2,200	1,700	2,800	11,000	4,300	3,300	-
Manganese	190	86	130	300	560	230	-
Mercury	0.107 L	0.138 L	0.0601 L	LT	0.282	0.175	20
Nickel	8.75	8.41	LT	10.5	LT	LT	2,000
Silver	0.127	ND	0.213	0.241	0.296	0.0575	200
Thallium	LT	LT	25.3	LT	LT	LT	-
Vanadium	30.4	26.2	23	32.8	71	27.2	700
Zinc	190	LT	120	LT	150	10.2	4,000

ND = Not Detectable
LT = Less than the Certified Reporting Limit
L = Missed holding time for analysis
X = Analyte recovery outside of certified range but within acceptable limits

[(a)] From OSWER Directive 9355.4-02, September 7, 1989

TABLE 4-10
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION									
COMPOUND	SB-2	SB-3	SB-4	SB-5	SB-8	SB-9	SB-10 (4ft)	SB-10 (10ft)	SB-11	SB-12
Acetone	ND	ND	ND	ND	ND	ND	0.0167 S B	0.0126 S B	ND	0.0133 S B
Benzene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
1,2-Dichloroethylene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
2-Hexanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Methylene Chloride	LT	LT	LT	LT	0.0397 B	0.091 B	0.133 B	0.215 X B	LT	LT
Tetrachloroethane	LT	LT	LT	0.209 S B	LT	LT	LT	LT	LT	LT
Tetrachloroethene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Trichloroethene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	8.34 S	3.88 S	ND	ND
Acenaphthalene	LT	LT	LT	LT	LT	LT	11.7	3.77	LT	LT
Anthracene	LT	LT	LT	LT	LT	LT	37.1	10.5	LT	LT
Benzo[A]anthracene	LT	LT	LT	LT	LT	LT	32.3	12.4	LT	LT
Benzo[A]pyrene	LT	LT	LT	LT	LT	LT	56.2	13.5	LT	LT

B = Analyte found in blank as well as sample
LT = Less than Certified Reporting Limit
ND = Not Detected
S = Results based on internal standard
X = Analyte recovery outside of certified range but within acceptable limits

TABLE 4-10 (continued)
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION									
COMPOUND	SB-2	SB-3	SB-4	SB-5	SB-8	SB-9	SB-10 (4ft)	SB-10 (10ft)	SB-11	SB-12
Benzo[B]fluoranthene	LT	LT	LT	LT	LT	LT	26.1	7.95	LT	LT
Benzo[G,H,I]perylene	LT	LT	LT	LT	LT	LT	22.3	5.08	LT	LT
Benzo[K]fluoranthene	LT	LT	LT	LT	LT	LT	48.4	13.6	LT	LT
Chrysene	LT	LT	LT	LT	LT	LT	34.8	13.4	LT	LT
Dibenzoanthracene	LT	LT	LT	LT	LT	LT	5.3	LT	LT	LT
Dibenzofuran	ND	ND	ND	ND	ND	ND	7.79 S	2.23 S	ND	ND
Fluoranthene	LT	LT	LT	LT	LT	LT	92.4	22.8	LT	LT
Fluorene	ND	ND	ND	ND	ND	ND	13.3 S	4.68 S	ND	ND
Indenopyrene	LT	LT	LT	LT	LT	LT	13.4	3.07	LT	LT
Dimethylnaphthalene	LT	LT	LT	LT	LT	LT	33.4 S	11.4 S	LT	LT
Trimethylnaphthalene	LT	LT	LT	LT	LT	LT	22.2 S	17.1 S	LT	LT
Naphthalene	LT	LT	LT	LT	LT	LT	8.56	LT	LT	LT
Phenanthrene	LT	LT	LT	LT	LT	LT	172	27.4	LT	LT
Pyrene	LT	LT	LT	LT	LT	LT	89.9	36.9	LT	LT
alpha-Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-Endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PPDDT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
TPHC	ND	ND	ND	ND	319	ND	16,700	353	ND	ND

LT = Less than Certified Reporting Limit
ND = Not Detected
S = Results based on internal standard

TABLE 4-10 (continued)
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION										
COMPOUND	SB-13 (4ft)	SB-13 (10ft)	SB-14	SB-15	SB-16	SB-17 (4ft)	SB-17 (10ft)	SB-19	SB-20	SB-21	SB-22
Acetone	ND	ND	ND	ND	ND	0.0185 S	ND	ND	ND	ND	ND
Benzene	LT	LT	LT	LT	LT	0.00405	LT	LT	LT	LT	LT
1,2-dichloroethylene	LT	LT	LT	LT	LT	LT	LT	LT	0.361 S	0.0275 S	LT
2-Hexanone	ND	ND	ND	ND	ND	0.0136 S	ND	ND	ND	ND	ND
Methylene Chloride	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Tetrachloroethane	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Tetrachloroethene	LT	LT	LT	LT	LT	LT	LT	0.126	0.172	0.0279	LT
Trichloroethene	LT	LT	LT	LT	LT	LT	LT	LT	0.00674	0.0107	LT
2-Methylnaphthalene	6.01 S	ND	ND	ND	ND	3.09 S	ND	ND	ND	ND	ND
Acenaphthene	LT	LT	LT	LT	0.261 P	LT	LT	LT	LT	LT	LT
Acenaphthylene	LT	LT	LT	LT	0.137 P	LT	LT	LT	LT	LT	LT
Anthracene	LT	LT	LT	LT	LT	LT	0.436 P	LT	LT	LT	LT
Benzo[A]anthracene	3.49	LT	LT	LT	1.17	7.18	0.542	LT	LT	LT	5.53
Benzo[A]pyrene	ND	ND	ND	ND	1.01	7.28	0.461 P	ND	1.22 P	ND	5.71

LT = Less than Certified Reporting Limit (CRL)
ND = Not Detected
S = Results based on Internal standard
P = Results less than CRL but greater than Criteria of Detection

TABLE 4-10 (continued)
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION										
COMPOUND	SB-13 (4ft)	SB-13 (10ft)	SB-14	SB-15	SB-16	SB-17 (4ft)	SB-17 (10ft)	SB-19	SB-20	SB-21	SB-22
Benzo[B]fluoranthene	LT	LT	LT	LT	0.672	5.27	0.353 P	LT	1.03 P	LT	3.61
Benzo[G,H,I]perylene	LT	LT	LT	LT	0.391	2.33	LT	LT	0.605 P	LT	2.66
Benzo[K]fluoranthene	LT	LT	LT	LT	1.03 P	LT	0.46 P	LT	2.62 P	LT	5.53 P
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	1.22 P
Chrysene	4.7	LT	LT	LT	1.34	7.73	LT	LT	1.51 P	LT	6.62
Dibenzoanthracene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	LT	LT	LT	LT	4.34	20.5	1.92	LT	2 P	LT	14.1
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Indenopyrene	LT	LT	LT	LT	0.239 P	1.78	LT	LT	LT	LT	2.44
Dimethylnaphthalene	30 S	LT	LT	LT	24.7 S	LT	LT	LT	LT	LT	LT
Trimethylnaphthalene	30 S	LT	LT	LT	24.7 S	LT	LT	LT	LT	LT	LT
Methyl phenol	LT	LT	LT	LT	LT	LT	LT	LT	0.723 S	LT	LT
Naphthalene	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
Phenanthrene	9.32	LT	LT	LT	3.28	19.2	1.33	LT	1.49 P	LT	6.57
Pyrene	9.71	LT	LT	LT	2.82	20	1.13	LT	1.95	LT	13.7
alpha-Chlordane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-Endosulfan	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PPDDT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT	LT
TPHC	1,140	ND	207	ND	ND	307	647	ND	ND	ND	199

LT = Less than Certified Reporting Limit (CRL)

ND = Not Detected

S = Results based on Internal standard

P = Less than CRL but greater than Criteria of Detection

TABLE 4-10 (continued)
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION				PROPOSED RCRA ACTION LEVEL
COMPOUND	SB-23	SB-24	SB-27	SB-28	
Acetone	ND	ND	0.0196 S B	0.0265 S B	8,000
Benzene	LT	LT	LT	LT	-
1,2-dichlorobenzene	LT	LT	0.00065	LT	-
1,4-dichloroethylene	LT	LT	LT	LT	10
Carbon Disulfide	ND	ND	0.00311	ND	8,000
2-Hexanone	ND	ND	ND	ND	4,000
Methylene Chloride	0.017 B	0.012 B	0.00906 B	0.0121 B	90
Tetrachloroethane	LT	LT	LT	LT	300
Tetrachloroethene	LT	LT	0.0147	LT	10
Trichloroethene	LT	LT	0.00528	LT	60
2-Methylnaphthalene	ND	ND	ND	ND	-
Acenaphthene	LT	LT	LT	LT	-
Acenaphthylene	LT	LT	LT	LT	-
Anthracene	LT	LT	LT	LT	-
Benzo[A]anthracene	LT	LT	LT	6.6	-
Benzo[A]pyrene	LT	LT	LT	6.38	-

B = Analyte found in blank as well as sample
LT = Less than Certified Reporting Limit (CRL)
ND = Not Detected
S = Results based on internal standard
P = Results less than CRL but greater than Criteria of Detection

TABLE 4-10 (continued)
ORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION				PROPOSED RCRA ACTION LEVEL
COMPOUND	SB-23	SB-24	SB-27	SB-28	
Benzo[B]fluoranthene	LT	LT	LT	6.46	-
Benzo[G,H,I]perylene	LT	LT	LT	3.8	-
Benzo[K]fluoranthene	LT	LT	LT	8.23 P	-
Bis(2-ethylhexyl)phthalate	LT	LT	LT	LT	50
Butylbenzylphthalate	LT	0.453	0.288 S	LT	20,000
Chrysene	LT	LT	LT	10.7	-
Dibenzoanthracene	LT	LT	LT	1.55	-
Dibenzofuran	ND	ND	ND	ND	-
Fluoranthene	LT	LT	LT	12.6	-
Fluorene	ND	ND	ND	ND	-
Indenopyrene	LT	LT	LT	2.91	-
Dimethylnaphthalene	LT	LT	LT	LT	-
Trimethylnaphthalene	LT	LT	LT	LT	-
Methyl phenol	LT	LT	LT	LT	-
Naphthalene	LT	LT	LT	LT	-
Phenanthrene	LT	LT	LT	8.22	-
Pyrene	LT	LT	LT	12.2	-
alpha-Chlordane	LT	LT	LT	0.0077U	0.5
beta-Endosulfan	LT	LT	LT	0.0366U	4.0
PPDDT	0.283U	0.342U	0.271U	0.137U	2.0
TPHC	LT	LT	69.3	409	-

LT = Less than Certified Reporting Limit (CRL)
ND = Not Detected
S = Results based on Internal standard
P = Less than CRL but greater than Criteria of Detection
U = Analysis is unconfirmed

TABLE 4-11
INORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION							
COMPOUND	SB-2	SB-3	SB-4	SB-5	SB-8	SB-9	SB-10(4ft)	SB-10(10ft)
Aluminum	5,300 X	10,000	5,100	8,700	7,000	6,200	13,000	8,000
Arsenic	LT	2.59	4.08	3.29	5.51	5.27	6.99	LT
Barium	22.8	47	19.4	41	160	40	48	37
Beryllium	0.117	0.179	0.161	0.15	0.171	0.168	LT	0.139
Calcium	160	360	160	1,700	5,500	360	2,400	9,100
Chromium	7.98	10.8	5.77	15	6.77	8.63	12.5	8.6
Copper	3.6	8.02	4.32	12.9	7.95	5.01	21.5	7.6
Iron	61,000	9,500	12,000	15,000	11,000	12,000	20,000	8,600
Lead	8.43	7.23	11	11.5	6.68	8.02	24.5	17.1
Magnesium	1,200	1,600	630	2,000	1,800	940	3,400	4,800
Manganese	31	73	150	390	170	94	170	74
Nickel	LT	LT	LT	4	4.02	LT	LT	LT
Silver	ND	ND	ND	0.156	ND	ND	ND	ND
Thallium	LT	LT	39.8	38.3	LT	36.5	33.7	LT
Vanadium	6.71	12.2	4.3	9.66	7.15	6.36	20.7	8.32
Zinc	14.1	25.1 X	18	17	22	14.4	24.6 X	17

LT = Less than Certified Reporting Limit

ND = Not Detected

X = Analyte recovery outside of the certified range but within acceptable limits

TABLE 4-11 (continued)
INORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION						
COMPOUND	SB-11	SB-12	SB-13(4ft)	SB-13(10ft)	SB-14	SB-15	SB-16
Aluminum	5,800	16,000	16,000	5,900	16,000	14,000	19,000
Arsenic	3.6	5.7	13	6	6.3	4.8	3.9
Barium	16	35	57	15.3	47	30	44
Beryllium	0.146	0.247	0.173	0.376	0.23	0.208	LT
Calcium	410	1,400 X	13,000	260	26,000	680	2,100
Chromium	6.64	22.3	17.7	11.2	52.3	18.6	21
Copper	3.35	8.71	9.77	3.89	18.2	8.04	4.38
Iron	12,000	35,000	20,000	21,000	28,000	30,000	26,000
Lead	LT	11	337	LT	63.3	9.4	12.5
Magnesium	1,300	3,100	9,300	1,100	2,500 GT	3,400	3,600
Manganese	160	510	160	210	250	210	170
Nickel	LT	4.13	LT	LT	20.1	4.02	LT
Silver	ND	ND	0.144	ND	5.56	ND	ND
Thallium	90.8	253	160	167	197	234	179
Vanadium	6.84	31.8	22.7	11.8	26.3	28	26.9
Zinc	19.9	LT	LT	17.9	LT	LT	LT

GT = Greater Than Maximum Certified Concentration
LT = Less than Certified Reporting Limit
ND = Not Detected
X = Analyte recovery outside of certified range but within acceptable limits

TABLE 4-11 (continued)
INORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	SB-17(4ft)	SB-17(10ft)	SB-19	SB-20	SB-21	SB-22
Aluminum	28,000	22,000	16,000	16,000	25,000	10,000
Arsenic	9.2	8.6	3.5	4.4	4.2	6.4
Barium	70	58	55	80	87	29
Beryllium	LT	0.283	0.175	0.387	0.329	0.28
Calcium	3,700	1,500	1,000	1,600 X	1,800	3,300
Chromium	LT	29	13	18.4	25.8	23.2
Copper	LT	15.1	10.2	18	20.4	7.4
Iron	39,000	31,000	23,000	24,000	30,000	24,000
Lead	23.5	21.1	18	16.9	41.3	10.3
Magnesium	5,000	3,000	2,500	2,800	4,200	4,000
Manganese	540	250	260	160	230	290
Nickel	LT	LT	LT	LT	LT	4.21
Silver	ND	ND	ND	ND	ND	ND
Thallium	290	213	165	193	198	214
Vanadium	49	34.7	26.2	24.7	27.4	22.5
Zinc	LT	LT	LT	190	LT	26.8 X

LT = Less than Certified Reporting Limit
ND = Not Detected
X = Analyte outside of certified range but within acceptable limits

TABLE 4-11 (continued)
INORGANIC COMPOUNDS DETECTED IN SUBSURFACE SOIL SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION				PROPOSED RCRA ACTION LEVEL
COMPOUND	SB-23	SB-24	SB-27	SB-28	
Aluminum	8,600	4,300	14,000	59,000	-
Arsenic	4.2	1.48	4.4	12	80
Barium	2.49	12.9	45	380	4,000
Beryllium	LT	LT	LT	LT	0.2
Calcium	480	114	750	4,700	-
Chromium	9.92	LT	10.8	42.9	400
Copper	10.3	LT	7.94	17.7	400
Iron	16,000	12,000	19,000	31,000	-
Lead	6.2 X	2.59	12	110	500[a]
Magnesium	2,600	830	1,900	5,500	-
Manganese	350	120	160	380	-
Mercury	LT	LT	LT	0.179	20
Nickel	5.27	LT	LT	LT	2,000
Selenium	0.156	0.0225	LT	LT	-
Silver	0.026	LT	LT	0.21	200
Thallium	LT	LT	LT	LT	-
Vanadium	15.6	6.3	21.6	63.8	700
Zinc	36.2	15	28.1 X	130	4,000

LT = Less than Certified Reporting Limit
ND = Not Detected
X = Analyte outside of certified range but within acceptable limits

(a) From OSWER Directive 9355.4-02, September 7, 1989

(PAHs). Compounds detected at the highest concentrations include phenanthrene (172 ppm), fluoranthene (92.4 ppm), pyrene (89.9 ppm), benzo[A]pyrene (56.2 ppm), and benzo[K]fluoranthene (48.4 ppm). Total PAH concentrations were significantly higher in the sample obtained from 4 feet below ground surface (735.5 ppm) than in the sample obtained from 10 feet (209.7 ppm), although the actual compounds detected were almost identical. In addition to TCL organics, TPHC was detected at two boring locations. These were SB-8 (319 ppm) and SB-10 at both the 4 and 10 foot depths (16,700 and 353 ppm, respectively).

Subsequent to the initial sampling, eight soil borings (SB-11 through SB-17, and SB-22) were installed to further evaluate the extent and magnitude of the organics detected in SB-10. Ten samples were collected from the 8 borings. Analyses of these samples revealed the presence of TCL organics at 4 boring locations. Compounds detected were generally limited to PAHs found earlier in boring SB-10, although at varied concentrations. Total PAH concentrations ranged from 6.6 ppm (SB-17 at 10 feet) to 94.4 ppm (SB-17 at 4 feet). In addition, benzene (4 ppb) and 2-hexanone (13.6 ppb) were detected at low levels in sample SB-17 (4 feet). TPHC was detected in five of the samples. Concentrations ranged from 199 ppm in sample SB-22 to 1,140 ppm in sample SB-13 (4 feet).

An additional three soil borings were installed during the follow-on investigation. These borings were designed to evaluate conditions around the abandoned underground storage tank in an area of the site not previously addressed. Analyses of the samples from borings SB-19, SB-20, and SB-21 revealed levels of volatile organic compounds (VOCs) at all three locations. Only tetrachloroethene (126 ppb) was detected in SB-19. Tetrachloroethene, trichloroethene, and 1,2-dichloroethylene were detected in SB-20 and SB-21 at concentrations between 361 ppb and 6.7 ppb. In addition to VOCs, PAHs were detected in SB-20 at a total concentration of 13.1 ppm. No TPHC was detected in these samples.

During the confirmatory investigation, an additional six soil borings were installed. Samples were obtained from the four borings converted to monitoring wells. Analysis of samples from borings SB-23, SB-24, SB-27, and SB-28 revealed levels of VOCs at all four locations. Methylene chloride was the only VOC detected at locations SB-23 and SB-24. Methylene chloride and acetone, detected in SB-27 and SB-28, were also detected in QC samples. In addition, 1,2-dichlorobenzene (0.65 ppb), carbon disulfide (3.11 ppb), tetrachloroethylene (14.7 ppb), and trichloroethylene (5.28 ppb) were detected in SB-27.

PAH's were identified in samples SB-24, SB-27, and SB-28. Butylbenzylphthalate was the only PAH detected in SB-24 and SB-27 (0.453 and 0.288 ppm, respectively). The total concentration of PAHs in SB-28 equaled 79.65 ppm. Several pesticides were detected in the four samples. Confirmatory analysis performed by the laboratory did not support the presence of the compounds in the samples. The compounds detected were alpha-chlordane, beta-endosulfan, and PPDDT. TPHC was detected in samples SB-27 and SB-28 at concentrations of 69.3 and 409 ppm, respectively.

Many TCL inorganics were present in samples collected during all phases of the EI investigation. Metals concentrations were consistently above the levels identified in the background sample (SB-2). Metals detected significantly above background (> 2 times background), the values noted being the maximum concentrations detected, include aluminum (59,000 ppm), arsenic (13 ppm), barium (380 ppm), beryllium (0.387 ppm), calcium (26,000 ppm), chromium (52.3 ppm), copper (21.5 ppm), lead (337 ppm), magnesium (9,300 ppm), manganese (540 ppm), nickel (20.1 ppm), silver (5.56 ppm), thallium (290 ppm), vanadium (63.8 ppm), and zinc (190 ppm). A consistent pattern of elevated metals concentrations could not be established throughout the site, although borings SB-14, SB-20, SB-21, and SB-28 showed consistently higher metals concentrations.

4.1.5 Surface Water and Sediments

A total of 12 surface water and 12 sediment samples were collected during completion of the EI. Sample locations consisted of storm drains, floor drains, sumps, containment structures, and surficial spills. The sampling locations are depicted on Figure 3-6. Compounds detected in surface water and sediment samples collected are summarized in Tables 4-12 through 4-15.

TABLE 4-12
ORGANIC COMPOUNDS DETECTED IN SURFACE WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6
Acetone	ND	ND	11 S B	13 S B	ND	ND
Chloromethane	LT	1.22 B	LT	LT	1.61 B	LT
Methylene Chloride	LT	LT	LT	LT	LT	LT
2-Butanone	ND	ND	ND	ND	ND	ND
2-Butoxyethanol	NR	NR	NR	5 S	NR	NR
Butylbenzyl phthalate	17 S B	20 S B	22 S B	12 S B	ND	ND
Di-N-butyl phthalate	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	7 S	LT	LT	4 S	LT	6 S
TPHC	ND	7,530	ND	5,250	ND	3,320

	LOCATION						DRINKING WATER STANDARD
COMPOUND	SW-7	SW-8	SW-9	SW-10	SW-11	SW-12	
Acetone	28 S B	18 S B	14 S B	22 S B	140 S B	18 S B	-
Chloromethane	20.3 L B	1.49 L B	10.8 L B	4.93 L B	18.9 B	11.5 B	-
Methylene Chloride	9.02 L B	7.25 L B	7.65 L B	6.47 L B	16.7 B	7.65 B	-
2-Butanone	ND	ND	ND	ND	46 S	ND	-
2-Butoxyethanol	NR	NR	NR	NR	NR	NR	-
Butylbenzyl phthalate	ND	ND	ND	ND	ND	15 S	-
Di-N-butyl phthalate	ND	ND	ND	ND	ND	17 S	-
1,1,2,2-Tetrachloroethane	LT L	10 S	LT L	LT L	LT	LT	5.0
TPHC	ND	ND	ND	3,000	ND	ND	-

B = Analyte found in blank as well as sample
LT = Less than Certified Reporting Limit
ND = Not Detected
NR = Not Reported
S = Result based on internal standard
X = Analyte recovery outside of the certified range but within acceptable limits
L = Missed holding time for analysis

TABLE 4-13
INORGANIC COMPOUNDS DETECTED IN SURFACE WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	SW-1	SW-2	SW-3	SW-4	SW-5	SW-6
Aluminum	1,290	1,040	250,000 X	1,510	340	129
Arsenic	LT	LT	313	3.96	5.92	LT
Barium	120	110	3,600	140	120	40.9 X
Beryllium	LT	LT	32	LT	LT	LT
Calcium	36,000	27,000	600,000	52,000	140,000	27,000
Cadmium	LT	LT	740	LT	LT	8.77
Chromium	21.2	73.1	2,100	22.3	28.4	6.68
Copper	82.4	103 X	25,000	190	102 X	47.2
Iron	4,200	4,700	5,000,000 GT	15,000	6,900	1,200
Lead	139	629	25,100	1,010	201	59.4
Mercury	0.975	LT	2.72	LT	LT	LT
Magnesium	14,000	4,300	340,000	8,600	19,000	3,100
Manganese	109	66.7	10,000	580	1,200	14.4
Nickel	16.8	11.9	2,700	25.8	14.8	LT
Silver	LT	LT	22.9	LT	0.315	LT
Thallium	LT	LT	3,600	LT	LT	LT
Vanadium	13.9	6.73	1,400	16	13.3	LT
Zinc	310	360	72,000	1,600	520	65.1

GT = Greater than the Maximum Certified Concentration
ND = Not Detected
LT = Less than the Certified Reporting Limit
X = Analyte outside of certified range but within acceptable limits

TABLE 4-13 (continued)
INORGANIC COMPOUNDS DETECTED IN SURFACE WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION						DRINKING WATER STANDARD
COMPOUND	SW-7	SW-8	SW-9	SW-10	SW-11	SW-12	
Aluminum	1,540	519	672	LT	2,530 X	146	200*
Arsenic	LT	LT	4.94	LT	10.9	3.69	50
Barium	85	27.2	210	36.9	110	32.9	2,000
Beryllium	0.59	LT	0.427	LT	0.577	LT	1.0
Calcium	36,000	13,000	54,000	46,000	36,000	28.000	-
Cadmium	LT	LT	LT	LT	4.06	LT	5.0
Chromium	18.4	7.64	21.5	11.1	35.4	11.5	100
Copper	220	6.34	11.4 X	15.8	400	61.4	1,000*
Iron	6,300	3,000	37,000	2,000	11,000	1,300	300*
Lead	434	154	114	29.7	617	28.1	15
Mercury	LT	LT	LT	LT	LT	LT	2.0
Magnesium	5,000	2,500	17,000	8,000	8,800	2,800	-
Manganese	143	42	3,100	420	310	20.5	50*
Nickel	19.9	11.4	12.5	LT	40.2	LT	100
Silver	LT	LT	LT	LT	0.36	LT	100*
Thallium	LT	LT	244	LT	LT	LT	1.0
Vanadium	9.72	LT	43.3	LT	27.4	7.15	-
Zinc	560	290	650	104	770	44.3	5,000*

ND = Not Detected

LT = Less than the Certified Reporting Limit

X = Analyte outside of certified range but within acceptable limits

* Secondary MCL

TABLE 4-14
ORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION												PROPOSED RCRA ACTION LEVEL
COMPOUND	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6	SD-7	SD-8	SD-9	SD-10	SD-11	SD-12	
Acetone	ND	0.576 S B	0.0461 S B	0.0197 S B	NA	NA	ND	ND	ND	ND	ND	0.057 S B	8,000
Benzene	LT	0.0138	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	-
Carbon Disulfide	ND	0.0273 S	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	8,000
Chlorobenzene	0.0227 B	LT	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	2,000
1,2-Dichlorobenzene	0.00285	LT	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	-
1,3-Dichlorobenzene	0.00503	LT	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	-
1,4-Dichlorobenzene	0.0209	0.00366	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	-
1,2-Dimethylbenzene	ND	0.0879 S	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	-
1,3-Dimethylbenzene	ND	0.0485 S	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	-
Ethylbenzene	LT	0.0475	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	8,000
Methylbenzene	LT	0.0284	LT	LT	NA	NA	LT	LT	LT	LT	LT L	LT	-
2-Butanone	ND	0.152 S	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	4,000
Octane	LT	0.0242 S	LT	LT	NA	NA	NA	NA	NA	NA	NA	NA	-
2-Butoxyethanol	LT	LT	LT	4.93 S	NA	NA	LT	LT	LT	LT	LT	LT	-
Benzyl alcohol	ND	ND	ND	ND	NA	NA	ND	4.63 S	ND	ND	ND	ND	-
Benzo[A]anthracene	LT	LT	LT	LT	NA	NA	4.16	LT	LT	LT	LT	4.42	-
Benzo[G,H,I]perylene	LT	LT	LT	LT	NA	NA	LT	LT	LT	LT	2.79	2.96	-
Bis (2-ethylhexyl) phthalate	6.04	217	20.9	18.9	NA	NA	24.4	9.72	LT	7.41	34.1	16.9	50
Butylbenzyl phthalate	ND	65.2 S	14.6 S	41.9 S	NA	NA	ND	ND	ND	ND	ND	ND	20,000
Chrysene	LT	LT	LT	LT	NA	NA	6.72	LT	LT	LT	LT	LT	-

B = Analyte found in blank as well as sample
L = Missed holding time for analysis
LT = Less than the Certified Reporting Limit
NA = Not Analyzed
ND = Not Detected

S = Results based on internal standard

TABLE 4-14 (continued)
ORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION												PROPOSED RCRA ACTION LEVEL
COMPOUND	SD-1	SD-2	SD-3	SD-4	SD-5	SD-6	SD-7	SD-8	SD-9	SD-10	SD-11	SD-12	
Dimethylnaphthalene	4.27 S	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	-
Di-N-butyl phthalate	ND	39.4 S	4.13 S	ND	NA	NA	ND	ND	ND	ND	153 S	ND	-
Fluoranthene	LT	LT	LT	LT	NA	NA	12.9	8.83	LT	LT	LT	LT	-
Palmitic Acid	ND	ND	ND	ND	NA	NA	ND	51.5 S B	ND	ND	15.3 S B	ND	-
Phenanthrene	LT	LT	LT	LT	NA	NA	11.3	7.58	LT	LT	4.99	7.31	-
Pyrene	LT	16.2	LT	6.38	NA	NA	14.5	12.1	LT	LT	8.78	19	-
Trimethylnaphthalene	12.2 S	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND	-
Aldrin	LT	LT	LT	LT	1.01	NA	LT	LT	LT	LT	LT	LT	0.04
alpha-Chlordane	ND	ND	ND	ND	0.279	NA	ND	ND	ND	ND	ND	ND	0.5
gamma-Chlordane	ND	ND	ND	ND	0.391	NA	ND	ND	ND	ND	ND	ND	0.5
Heptachlor	LT	LT	LT	LT	0.1 GT	NA	ND	ND	ND	ND	ND	ND	0.2
Heptachlor epoxide	LT	LT	LT	LT	0.375	NA	LT	LT	LT	LT	LT	LT	0.08
Isodrin	NA	NA	NA	NA	0.292	NA	NA	NA	NA	NA	NA	NA	-
PCB 1260	ND	ND	ND	ND	44.4	ND	ND	ND	ND	ND	ND	ND	0.09
TPHC	4,760	839	4,220	5,430	NA	456,000	ND	ND	6.3	0.61	4.92	5.15	-

GT = Greater than the Maximum Certified Concentration
LT = Less than the Certified Reporting Limit
NA = Not Analyzed
ND = Not Detected
NR = Not Reported
S = Results based on internal standard

TABLE 4-15
INORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	SD-1	SD-2	SD-3	SD-4	SD-7	SD-8
Aluminum	3,900	18,000	18,000	7,100	11,000	6,700
Arsenic	4.21	13.8	17.5	14	50.9	13.9
Barium	67	1,800	LT	ND	220	330
Beryllium	1.25	1.08	1.6	LT	3.8	1.71
Calcium	22,000	33,000 X	17,000	10,000	17,000	7,700
Cadmium	LT	10.8	10.3	LT	LT	LT
Chromium	18.7	1,100	360	120	62.4	140
Copper	55	730	830	410	1,700	390
Iron	16,000	61,000	44,000	6,600	34,000	17,000
Lead	189	5,150	2,430	1,480	717	789
Magnesium	12,000	8,800	10,000	4,400	8,400	6,000
Manganese	150	330	290	200	290	120
Mercury	LT	0.05 GT	0.506	LT	0.22	LT
Nickel	6.43	110	70.1	63	45	110
Silver	ND	2.88	1.7	0.336	1.08	0.353
Thallium	33.9	163	84.5	LT	65.4	31.7
Vanadium	23.8	59.4	70.4	95	90	31.4
Zinc	270 X	3,300	2,000	LT	1,800	LT

GT = Greater than the Maximum Certified Concentration
LT = Less than the Certified Reporting Limit
ND = Not Detected
X = Analyte recovery outside of certified range but
within acceptable limits

TABLE 4-15 (continued)
INORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES (ppm)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION				PROPOSED RCRA ACTION LEVEL
COMPOUND	SD-9	SD-10	SD-11	SD-12	
Aluminum	15,000	19,000	6,700	5,700	-
Arsenic	28.9	49.1	37.3	91.7 X	80
Barium	630	520	1,200	LT	4,000
Beryllium	LT	LT	LT	0.961	0.2
Calcium	28,000	12,000	10,000	18,000	-
Cadmium	LT	LT	LT	LT	40
Chromium	220	520	770	LT	400
Copper	480 X	840	520	900	400
Iron	110,000	84,000	38,000	290,000	-
Lead	919	1,610	4,590	864	500[a]
Magnesium	5,700	8,700	3,200	5,300	-
Manganese	440	710	1,000	1,100	-
Mercury	0.16	1.35	0.5 GT	0.943	20
Nickel	LT	LT	77	LT	2,000
Silver	0.335	1.15	1.68	2.26	200
Thallium	370	LT	1,000	LT	-
Vanadium	110	290	70	LT	700
Zinc	2,400	LT	1,800	LT	4,000

GT = Greater than the Maximum Certified Concentration
LT = Less than the Certified Reporting Limit
ND = Not Detected
X = Analyte outside of the certified range but
within acceptable limits
[a] From OSWER Directive 9355.4-02, September 7, 1989

4.1.5.1 Surface Water

Analyses of surface water samples for TCL organic substances and TPHC indicated low levels of several compounds at a number of locations. The most consistently detected compound was chloromethane, which was found in three storm drains samples (SW-2, SW-7, and SW-8), the utility tunnel sample (SW-5), both basement sump samples (SW-9 and SW-10), and both samples from the oil/water separator (SW-11 and SW-12). Concentrations of chloromethane ranged from 1.22 ppb to 20.3 ppb. Butylbenzyl phthalate was detected in four storm drain samples (SW-1 through SW-4) and the sample from the oil/water separator inlet (SW-12). Concentrations ranged from 15 ppb to 22 ppb. Chloromethane and butylbenzyl phthalate were also detected in QC samples. Tetrachloroethane was detected at concentrations between 4 ppb and 10 ppb in three storm drains and the sample from the aboveground storage tank basin (SW-6).

Three compounds were detected at low levels at single locations on the site. These compounds are 2-butanone (46 ppb), 2-butoxyethanol (5 ppb), and di-N-butylphthalate (17 ppb). Acetone (11 ppb to 140 ppb) and methylene chloride (6.47 ppb to 16.7 ppb) were also detected in a number of samples, as well as QC samples. In addition to TCL organics, TPHC was detected in SW-2, SW-4, SW-6, and SW-10. Concentrations ranged from 3 ppm to 7.53 ppm.

TCL inorganics were present in all of the surface water samples, at varying concentrations. The metals most frequently detected at elevated concentrations were aluminum, calcium, iron, lead, magnesium, and manganese. SW-3 consistently had the highest concentration for each metal including arsenic (313 ppb), cadmium (740 ppb), chromium (2,100 ppb), lead (25,100 ppb), and mercury (2.72 ppb).

4.1.5.2 Sediment

Analyses of sediment samples for organic substances on the TCL indicated that elevated concentrations of organic compounds were present at all sample locations. The compounds detected were varied and concentrations were generally low. VOCs, with the exception of acetone, were detected in only two samples, SD-1 and SD-2. Chlorobenzene (22.7 ppb) was the only VOC detected in SD-1. VOCs found at the highest concentrations at location SD-2 include 2-

butanone (152 ppb), dimethylbenzenes (136 ppb), and ethylbenzene (47.4 ppb). Acetone was detected at four locations at concentrations ranging from 19.7 ppb to 576 ppb. Acetone and chlorobenzene were also detected in QC samples.

Semivolatile organic compounds (SVOCs) were detected throughout the sediment samples. The concentrations of these compounds were low and the distribution was widely scattered. With the exception of Bis(2-ethylhexyl) phthalate and pyrene, any one compound was not detected in more than five samples. In most cases, individual compounds were detected at only one or two locations. Polycyclic Aromatic Hydrocarbons (PAHs) were prevalent in samples collected from the storm drains (SD-1 through SD-4, SD-7, and SD-8), the building floor drains (SD-11), and the oil/water separator (SD-12). Bis(2-ethylhexyl) phthalate was detected in nine of the 10 samples submitted for full TCL analyses. This compound is a common laboratory contaminant.

Pesticides/herbicides and PCBs were detected in one sample (SD-5), which was collected from the floor drain in the former pesticide storage building. PCB 1260 was identified at 44.4 ppm, while aldrin (1.01 ppm) exhibited the highest pesticide concentration. TPHC was detected in varying concentrations at 9 of the 11 relevant sampling locations. The highest concentration was found in SD-6, which was a sample of sand adsorbent obtained from an area of hydraulic oil spillage; no PCBs were detected in this sample. Concentrations of TPHC in storm drain sediments ranged from 839 ppm to 5,430 ppm. Levels detected in samples from the oil/water separator, building floor drains, and the basement sumps were much lower (0.61 ppm to 6.3 ppm).

Most TCL inorganics were present in sediment samples. Metals concentrations in the storm drains and the oil/water separator were generally within the ranges established for onsite surface soils. However, a number of metals exhibited concentrations consistently above the levels for surface soils. These metals, the concentrations given being the highest observed, included chromium (1,100 ppm), copper (1,700 ppm), iron (290,000 ppm), lead (5,150 ppm), nickel (110 ppm), silver (2.88 ppm), and zinc (3,300 ppm). Elevated levels of some metals were also detected in samples obtained from basement sumps and floor drains. Maximum concentrations of these metals included barium (1,200 ppm), chromium (770 ppm), lead (4,590 ppm), and silver (1.68 ppm).

4.1.6 Ground Water

A total of ten ground water samples were obtained during the initial two rounds of sampling. Samples GW-1 through GW-7 were collected during the initial phase of the EI, and samples GW-8 through GW-10 were collected during the follow-on phase. Based on the ground water contours identified for the site, well MW-1 is considered to monitor background conditions. Analytical results for sample GW-1 were used in comparing compounds detected onsite to background conditions. The analytical results for the initial ten ground water samples are summarized in Tables 4-16 and 4-17.

Analyses for organic substances on the TCL revealed the presence of volatile organic compounds (VOCs) in seven of the samples. GW-9 exhibited the highest concentrations of VOCs, which included tetrachloroethylene (2,530 ppb) and the breakdown products trichloroethylene (189 ppb), dichloroethylenes (202 ppb), dichloroethane (80 ppb), and vinyl chloride (826 ppb). Trichloroethylene was detected in GW-4 (43.3 ppb) and GW-5 (7.74 ppb). Tetrachloroethylene (3.46 ppb) and chloroform (3.32 ppb) were detected in GW-8. Low levels of acetone were found in GW-3 (22 ppb) and GW-7 (13 ppb). Methylene chloride was also identified at low concentrations in two samples, GW-8 (7.25 ppb) and GW-10 (6.47 ppb), and in QC samples.

During the confirmatory investigation, an additional seven ground water samples were collected. Samples GW-11, GW-12, GW-14, and GW-15 were collected from the like numbered monitoring wells installed during the confirmatory investigation. The additional three samples were collected from existing wells MW-4 (GW-4), MW-7 (GW-7), and MW-9 (GW-9). These three wells were resampled to confirm/refute contamination detected during initial sampling. The analytical data for the confirmatory samples are presented in Tables 4-18 and 4-19.

Analysis of the samples for organic compounds on the TCL revealed the presence of VOCs in all seven samples. Methylene chloride was the only VOC detected in GW-7, GW-12, GW-14, and GW-15. Methylene chloride was also detected in the other three samples and QC samples. Analysis of confirmatory sample GW-4 confirmed the presence of trichloroethylene (160 ppb) in well

TABLE 4-16
ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION										DRINKING WATER STANDARD
COMPOUND	GW-1	GW-2	GW-3	GW-4	GW-5	GW-6	GW-7	GW-8	GW-9	GW-10	
Acetone	ND	ND	22 S	ND	ND	ND	13 S	ND	ND	ND	-
1,1-dichloroethylene	LT	LT	LT	LT	LT	LT	LT	LT	1.88 P	LT	7.0
1,1-dichloroethane	LT	LT	LT	LT	LT	LT	LT	LT	80	LT	-
cis-1,2-dichloroethylene	LT	LT	LT	LT	LT	LT	LT	LT	200 S	LT	100
1,2-dichloroethane	LT	LT	LT	LT	LT	LT	LT	10 S	LT	LT	5.0
Chloroform	LT	LT	LT	LT	LT	LT	LT	3.32	LT	LT	100
Methylene chloride	LT	LT	LT	LT	LT	LT	LT	7.25 B	LT	6.47 B	-
Tetrachloroethylene	LT	LT	LT	LT	LT	LT	LT	3.46	2,530	LT	5.0
Trichloroethylene	LT	LT	LT	43.4	7.74	LT	LT	LT	189	LT	5.0
Vinyl Chloride	LT	LT	LT	LT	LT	LT	LT	LT	826	LT	2.0
Caprolactam	70 S	40 S	4 S	30 S	8 S	20 S	40 S	LT	LT	LT	-
TPHC	ND	ND	ND	11,900	ND	ND	6,360	ND	ND	ND	-

B = Analyte found in blank as well as sample
LT = Less than Certified Reporting Limit (CRL)
ND = Not Detected
S = Results based on internal standard
P = Less than CRL but greater than Criteria of Detection

TABLE 4-17
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	GW-1	GW-1F	GW-2	GW-2F	GW-3	GW-3F
Aluminum	6,300	LT	11,000	LT	56,000	LT
Arsenic	55.8	LT	5.76	LT	1,200	LT
Barium	110	50	140	77	670	230
Beryllium	LT	LT	0.453	LT	2.63	LT
Calcium	54,000	56,000	68,000	57,000	64,000	53,000
Chromium	19.7	8.5	29.7	7.36	107 X	7.9
Copper	20	LT	14.7	LT	92.2	LT
Iron	16,000	46.3	19,000	1,700	170,000	4,600
Lead	LT	LT	10.4	LT	57.1	LT
Magnesium	30,000	31,000	28,000	21,000	29,000	13,000
Manganese	1,100	900	1,400	1,200	4,300	3,100
Nickel	LT	LT	14.3	LT	32.7	LT
Selenium	LT	LT	LT	LT	LT	LT
Silver	LT	LT	LT	LT	0.33	LT
Thallium	LT	LT	156	LT	946	LT
Vanadium	38.2	LT	22.9	LT	160	LT
Zinc	27.6	LT	72.3	LT	340	LT
Cyanide	LT	LT	LT	LT	LT	LT

F = Field filtered

LT = Less than the Certified Reporting Limit

X = Analyte recovery outside of the certified range but within acceptable limits

TABLE 4-17 (continued)
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	GW-4	GW-4F	GW-5	GW-5F	GW-6	GW-6F
Aluminum	12,000	LT	7,600	LT	3,900	LT
Arsenic	6.14	LT	6.57	LT	3.79	LT
Barium	160	61	110	70	88	45 X
Beryllium	0.553	LT	LT	LT	LT	LT
Calcium	49,000	44,000	35,000	34,000	18,000	19,000
Chromium	31.1	8.51	23.8	8.03	18.8	7.89
Copper	17.4	LT	16.1	LT	14.4	4.32
Iron	56,000 X	2,300	27,000	4,500	11,000	2,200
Lead	7.54	LT	LT	LT	29.3	LT
Magnesium	13,000	11,000	15,000	14,000	7,000	6,400
Manganese	3,500	3,000	1,700	1,600	670	700
Nickel	LT	LT	8.98	LT	LT	LT
Selenium	LT	4.57	LT	LT	LT	LT
Silver	LT	LT	LT	LT	LT	LT
Thallium	340	LT	199	LT	LT	LT
Vanadium	29.1	LT	16.3	LT	8.57	LT
Zinc	80.5	LT	51.9	23.4	83.1	LT
Cyanide	LT	LT	LT	LT	LT	LT

F = Field filtered

LT = Less than the Certified Reporting Limit

X = Analyte outside of the certified range but within acceptable limits

TABLE 4-17 (continued)
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION					
COMPOUND	GW-7	GW-7F	GW-8	GW-8F	GW-9	GW-9F
Aluminum	19,000	LT	20,000	LT	33,000	LT
Arsenic	11.6	LT	10.3	LT	12.7	6.56
Barium	260	160	180	78	320	160
Beryllium	LT	LT	1.89	LT	1.35	LT
Calcium	28,000	29,000	67,000	70,000	82,000	74,000
Chromium	33.1	6.24	50.2	LT	55	6.09
Copper	39.8	LT	40.5	LT	55.1	LT
Iron	41,000	520 X	56,000	790 X	50,000 GT	7,300
Lead	54.9	LT	51 X	LT	69	LT
Magnesium	8,300	4,700	23,000	17,000	24,000	16,000
Manganese	1,800	1,500	1,500	1,100	1,900	1,400
Nickel	14.2	LT	15.3	LT	LT	LT
Selenium	LT	LT	LT	LT	LT	LT
Silver	LT	LT	0.369	LT	LT	LT
Thallium	283	LT	LT	LT	LT	LT
Vanadium	35	LT	54.6	LT	63.2	LT
Zinc	85.8	LT	100	LT	182	LT
Cyanide	LT	LT	LT	LT	LT	LT

F = Field filtered

LT = Less than the Certified Reporting Limit

X = Analyte outside of the certified range but within acceptable limits

TABLE 4-17 (continued)
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION		DRINKING WATER STANDARD
COMPOUND	GW-10	GW-10F	
Aluminum	25,000 X	LT	200*
Arsenic	17	LT	50
Barium	440 X	73	2,000
Beryllium	3.21	LT	1.0
Calcium	57,000	48,000	-
Chromium	60	6.68	100
Copper	80.7	LT	1,000*
Iron	50,000 GT	32.8	300*
Lead	51.9	LT	15
Magnesium	16,000	9,600	-
Manganese	3,200	1,100	50*
Nickel	15.8	LT	100
Selenium	LT	LT	50
Silver	LT	LT	100*
Thallium	LT	LT	1.0
Vanadium	85.5 X	LT	-
Zinc	133	LT	5,000*
Cyanide	6.38	LT	200

GT = Greater than the Maximum Certified Concentration
F = Field filtered
LT = Less than the Certified Reporting Limit
X = Analyte outside of the certified range but within acceptable limits
* = Secondary MCL

TABLE 4-18
ORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
CONFIRMATORY INVESTIGATION
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION							DRINKING WATER STANDARD
COMPOUND	GW-4	GW-7	GW-9	GW-11	GW-12	GW-14	GW-15	
Acetone	ND	ND	ND	ND	ND	ND	ND	-
1,1-dichloroethylene	LT	LT	1.6	LT	LT	LT	LT	7.0
1,1-dichloroethane	LT	LT	0.7	LT	LT	LT	LT	-
cis-1,2-dichloroethylene	LT	LT	2,000	LT	LT	LT	LT	100
1,2-dichloroethane	LT	LT	LT	LT	LT	LT	LT	5.0
Chloroform	LT	LT	LT	LT	LT	LT	LT	100
Methylene chloride	6.4 B	6.4 B	6.1 B	6.7 B	6.6 B	6.3 B	6 B	-
Tetrachloroethylene	LT	LT	4,000	0.65	LT	LT	LT	5.0
Trichloroethylene	160	LT	200	LT	LT	LT	LT	5.0
Vinyl Chloride	LT	LT	2,000	LT	LT	LT	LT	2.0
Caprolactam	LT	LT	LT	LT	LT	LT	LT	-
ABHC	0.0218 U	LT	0.0645 U	LT	0.0157 U	0.0133 U	LT	-
PPDDT	0.263 U	0.264 U	0.265 U	0.196 U	0.13 U	0.184 U	0.234 U	-
TPHC	LT	LT	LT	LT	LT	LT	LT	-

B = Analyte found in blank as well as sample
LT = Less than Certified Reporting Limit (CRL)
ND = Not Detected
S = Results based on Internal standard
P = Less than CRL but greater than Criteria of Detection
U = Analysis is unconfirmed

TABLE 4-19
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
CONFIRMATORY INVESTIGATION
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION							
COMPOUND	GW-11	GW-11F	GW-12	GW-12F	GW-14	GW-14F	GW-15	GW-15F
Aluminum	160	LT	1,440	LT	326	LT	1,720	LT
Arsenic	LT	LT	LT	LT	LT	LT	4.91	LT
Barium	25.2	24.9	53	51	98	92	190	170
Beryllium	LT	LT	LT	LT	LT	LT	LT	0.43
Cadmium	LT	3.41	LT	LT	3.36	LT	LT	LT
Calcium	54,000	55,000	54,000	52,000	74,000	74,000	81,000	81,000
Chromium	LT	LT	4.91	LT	LT	LT	4.72	LT
Copper	LT	LT	5.11	LT	LT	LT	5.39	LT
Iron	1,200	LT	4,200	25.4	3,500	1,400	10,000	2,200
Lead	LT	LT	LT	LT	LT	LT	7.43	8.11
Magnesium	15,000	15,000	8,800	9,000	24,000	23,000	21,000	21,000
Manganese	105	94.3	290	196	2,000	1,900	4,200	4,200
Nickel	LT	LT	9.62	LT	LT	LT	12	LT
Selenium	LT	4.02	LT	LT	LT	LT	LT	LT
Silver	LT	LT	LT	LT	LT	LT	LT	LT
Thallium	LT	LT	LT	LT	LT	LT	LT	LT
Vanadium	LT	LT	LT	LT	LT	LT	LT	LT
Zinc	LT	LT	LT	23	LT	LT	LT	LT
Cyanide	LT	NA	LT	NA	LT	NA	LT	NA

F = Field filtered
LT = Less than the Certified Reporting Limit
X = Analyte recovery outside of the certified range but
within acceptable limits
NA = Not Analyzed

TABLE 4-19 (continued)
INORGANIC COMPOUNDS DETECTED IN GROUND WATER SAMPLES (ppb)
CONFIRMATORY INVESTIGATION
TACONY WAREHOUSE ENVIRONMENTAL INVESTIGATION

	LOCATION						DRINKING WATER STANDARD
COMPOUND	GW-4	GW-4F	GW-7	GW-7F	GW-9	GW-9F	
Aluminum	373	LT	56,000	LT	15,000	LT	200*
Arsenic	LT	LT	29	4.02	9.82	8.84	50
Barium	65	54	510	230	240	130	2,000
Beryllium	LT	LT	0.506	LT	LT	0.366	1.0
Cadmium	LT	LT	LT	LT	LT	LT	5.0
Calcium	44,000	41,000	190,000	130,000	93,000	90,000	-
Chromium	LT	LT	71.4	LT	17.2	LT	100
Copper	LT	LT	130	LT	36.1	26.4	1,000*
Iron	9,300	3,200	140,000	4,300	52,000	3,100	300*
Lead	LT	LT	240	LT	21.7	LT	15
Magnesium	12,000	9,100	23,000	9,100	19,000	17,000	-
Manganese	800	730	5,300	2,400	1,900	1,400	50*
Nickel	LT	LT	20.2	LT	9.67	LT	100
Selenium	LT	LT	LT	LT	LT	LT	50
Silver	LT	LT	LT	LT	LT	LT	100*
Thallium	LT	LT	LT	LT	LT	LT	1.0
Vanadium	LT	LT	150	LT	12.3	LT	-
Zinc	105	112	370	LT	106	LT	5,000*
Cyanide	LT	NA	LT	NA	LT	NA	NA

F = Field filtered

* Seconday MCL

LT = Less than the Certified Reporting Limit

X = Analyte recovery outside of the certified range but within acceptable limits

NA = Not Analyzed

MW-4. Contaminants previously identified in well MW-9 were also confirmed. Analysis of confirmatory sample GW-9 reiterated the presence of tetrachloroethylene (4,000 ppb) and the breakdown products trichloroethylene (200 ppb), dichloroethylenes (2,000 ppb), dichloroethane (0.7 ppb), and vinyl chloride (2,000 ppb). A low level of tetrachloroethylene (0.65 ppb) was also detected in GW-11.

The only semivolatile compound identified in the initial ground water samples was caprolactam. This compound was found in all ground water samples collected during the initial phase of the EI. The highest concentration (70 ppb) was identified in a sample from an upgradient well, GW-1. This compound may be associated with the use of nylon rope during initial sampling activities at the site. Caprolactam was not detected during the follow-on or confirmatory sampling events.

Total petroleum hydrocarbons (TPHC) were identified in two ground water samples, GW-4 (11,900 ppb) and GW-7 (6,360 ppb) during the initial sampling event. No TPHC was identified in the three wells sampled during the follow-on investigation. TPHC was also not identified in confirmatory samples, and thus the presence of TPHC in wells MW-4 and MW-7 was not confirmed.

Ground water samples were submitted for both total metals and dissolved metals analyses during all phases of the investigation. Metals detected in unfiltered ground water samples, at concentrations in excess of levels detected in the background well at the site (MW-1) include aluminum (7,600 to 56,000 ppb), arsenic (1,200 ppb), barium (160 to 670 ppb), beryllium (0.453 to 3.21 ppb), calcium (57,000 to 82,000 ppb), copper (39.8 to 92.2 ppb), iron (19,000 to 170,000 ppb), lead (7.54 to 69 ppb), manganese (1,400 to 4,300 ppb), nickel (8.98 to 32.7 ppb), selenium (4.57 ppb), silver (0.33 and 0.369 ppb), thallium (156 to 946 ppb), vanadium (54.6 to 160 ppb), and zinc (51.9 to 340 ppb). Cyanide was detected in one sample, GW-10 (6.38 ppb).

Metals detected in field filtered samples at concentrations in excess of levels detected in the background well at the site include arsenic (4.02 to 8.84 ppb), barium (51 to 230 ppb), calcium (57,000 to 130,000 ppb), copper (4.32 to 26.4 ppb), iron (520 to 7,300 ppb), lead (8.11 ppb), manganese (1,100 to 4,200 ppb), and zinc (23.4 to 112 ppb). No discernable pattern for total and dissolved metals was indicated for the site.

4.1.7 Tank Contents

Liquid samples were collected from each of the five underground storage tanks at the TW site. A GC fingerprint analysis was performed on each sample. The chromatogram for each sample was compared to standards for No. 2 and No. 6 fuel oil. UST-1, UST-2, and UST-4 had GC patterns very similar to the No. 2 fuel oil standard. UST-3 also had a pattern similar to No. 2 fuel oil, but also appeared to contain water. UST-5 had a pattern that did not match either standard and also appeared to contain water.

4.2 RADIOLOGICAL SURVEY

A geiger-counter sweep was performed in building 461. No anomalies were detected during the survey.

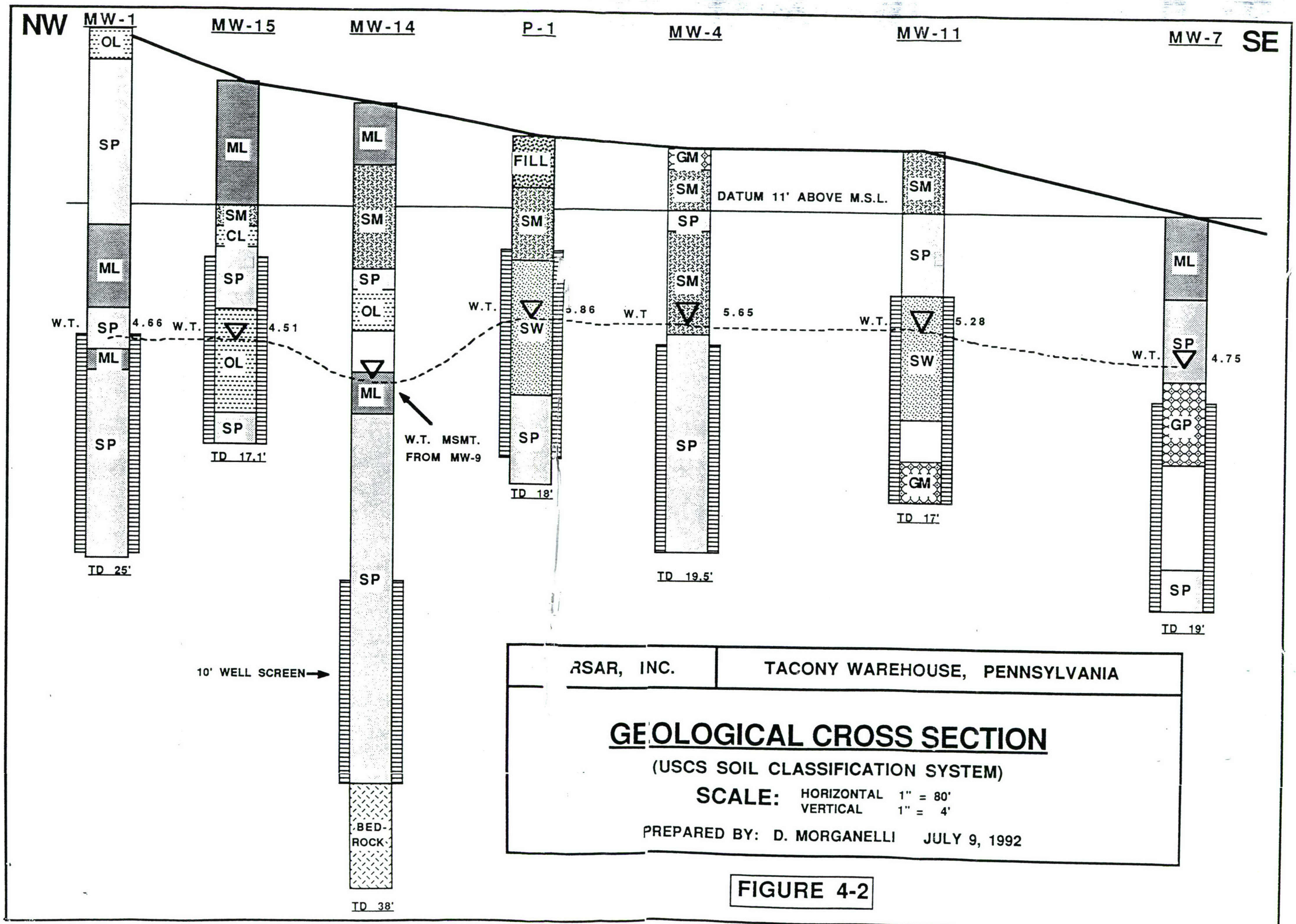
Radon monitoring within the basements of building 461 revealed radon concentrations of between 0.8 and 3.4 picoCuries per liter of air (pCi/l). Radon test data is presented in Appendix K. Therefore, radon concentrations within the basements are below the EPA Recommended Action Guideline of 4.0 pCi/l for radon remediation.

4.3 HYDROGEOLOGIC INVESTIGATION

4.3.1 Aquifer Characteristics

The aquifer system underlying the Tacony Warehouse (TW) site is composed chiefly of sands and gravels of the Trenton Formation which overlies pre-Cretaceous bedrock. The total thickness of unconsolidated sediments overlying bedrock at the site was originally estimated from regional mapping to be 55 feet. Installation of monitoring well MW-14 in June 1992 indicated that bedrock actually occurs at a depth of only 35 feet below grade. On the average, the water table is at a depth of 10 feet below grade making, total aquifer thickness approximately 25 feet.

Aquifer soil classifications are depicted in cross sections presented in Figures 4-2 and 4-3. The location of these cross sections are indicated in Figure 4-1, the Water Table Elevation Map (see Appendix M). Aquifer soil



RSAR, INC.

TACONY WAREHOUSE, PENNSYLVANIA

GEOLOGICAL CROSS SECTION

(USCS SOIL CLASSIFICATION SYSTEM)

SCALE: HORIZONTAL 1" = 80'
VERTICAL 1" = 4'

PREPARED BY: D. MORGANELLI JULY 9, 1992

FIGURE 4-2

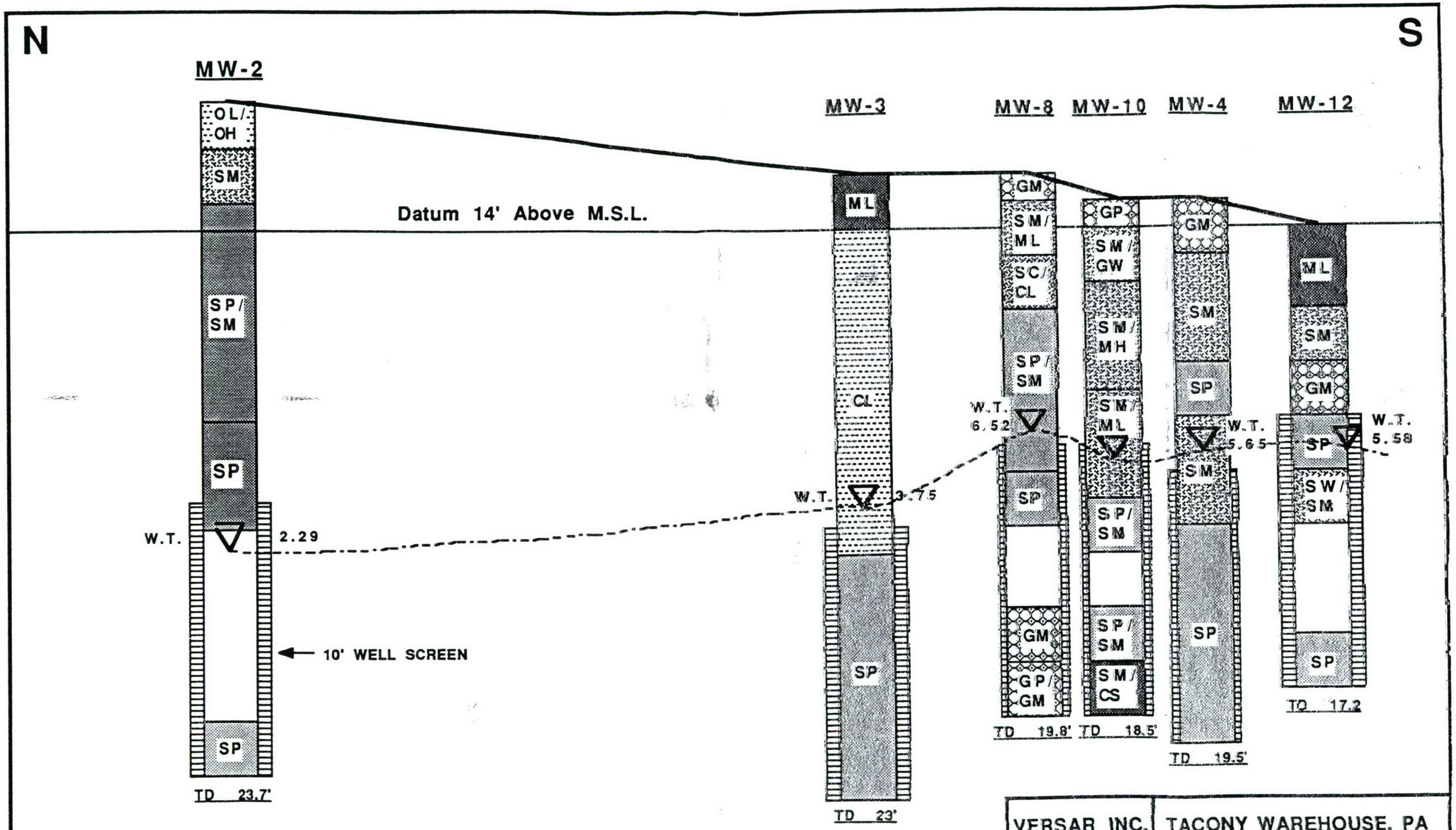


FIGURE 4-3

VERSAR INC. | TACONY WAREHOUSE, PA

GEOLOGICAL CROSS SECTION

(USCS SOIL CLASSIFICATION SYSTEM)

SCALE: HORIZONTAL 1" = 80'
VERTICAL 1" = 4'

PREPARED BY: D. MORGANELLI JULY 22, 1992 types as described through the Unified Soil Classification System (USCS) range from clays (CL) to gravels (GM) with no obvious correlative units being present within the 35 foot thick regolith. Clays (CL) and silts (ML) do appear to be more prevalent at the northwest portion of the TW site. Thus, there is a general coarsening of aquifer materials towards the Delaware River. The effect of this subtle aquifer heterogeneity on hydraulic conductivities and ground water flow is discussed later in this report section.

Inspection of Figure 4-1 (Appendix M), the water table elevation map for the TW site, reveals a regional hydraulic gradient of 0.005 which, for the most part, slopes toward coves and inlets of the Delaware River or the river itself. An exception to this pattern is a locally steeper hydraulic gradient of 0.025 at the west/northwest portion of the site that is associated with ground water mounding that occurs in this area. The ground water mound exerts a significant influence on aquifer flowpaths and is further discussed in Section 4.3.3. Water table elevations have been measured on five different occasions during 1991 and 1992, including two rounds of measurements taken through tidal cycles. These elevations, reported in Table 4-20, have ranged from a low of 1.98 feet above mean sea level (MSL) in MW-2 to a high of 6.52 above MSL in MW-8, the latter well being located at the apex of the ground water mound described above. Tidal cycles show little effect on water table elevations, with the exception of MW-6, located at the southeast part of the site nearest the Delaware River. This well shows an increase of about 0.5 feet from low to high tide.

Hydraulic conductivities at the TW site were evaluated through slug testing conducted during June 1992. Monitoring wells MW-4, MW-7 and MW-9 were selected for rising head slug tests. These particular wells were chosen due to their location in areas of TPHC and PCE impacted ground water, and because they were installed in slightly different aquifer materials. Hydraulic conductivities for this group of wells are summarized below, with time-drawdown curves and raw data presented in Appendix N.

TABLE 4-20

SYNOPTIC WATER TABLE ELEVATIONS AT THE TACONY WAREHOUSE SITE FOR THE PERIOD JUNE, 1991 THROUGH JUNE, 1992

WATER TABLE ELEVATIONS IN HEIGHT ABOVE MEAN SEA LEVEL

MW#	6/16/91		7/11/91	10/18/91	5/18/92	6/15/92	
	HIGH	LOW				HIGH	LOW
1	4.66	4.65	4.40	5.01	4.03	4.66	4.66
2	2.31	2.33	2.23	3.15	1.98	2.30	2.29
3	3.81	3.79	3.53	4.02	3.28	3.88	3.85
4	5.58	5.61	5.02	5.13	4.88	5.65	5.65
5	3.82	3.82	3.38	3.12	3.35	3.93	3.93
6	2.87	4.31	2.78	3.01	2.79	3.39	2.92
7	4.99	3.04	4.20	4.00	4.67	4.77	4.75
8	6.66	6.68	5.97	5.97	5.74	6.52	6.52
9	2.88	2.85	2.58	2.86	2.30	2.81	2.78
10	5.71	5.70	5.18	5.19	4.02	5.49	5.48
11						5.28	5.28
12						5.58	5.58
14						4.01	3.96
15						4.53	4.51
P1						5.86	5.86
P2						4.61	4.61

Note: Monitoring Wells MW-11 to MW-15 and Piezometers P1 and P2 were installed after the 5/18/92 measurements.

Well	Hydraulic Conductivity
MW-4	1.4×10^{-3}cm/sec (29.4 gal/day/ft^2)
MW-7	4.0×10^{-4}cm/sec (8.5 gal/day/ft^2)
MW-9	1.1×10^{-4}cm/sec (2.3 gal/day/ft^2)

Hydraulic conductivities were calculated using AQTESOLV, a computer software modeling package. AQTESOLV offers several slug test solutions and, in the instance of the TW site, the Bouwer-Rice method for unconfined aquifers was determined to be the most appropriate method of interpretation. Data input for AQTESOLV is the conventional data required in the Theis method of calculating hydraulic conductivity.

The overall increase in hydraulic conductivities from MW-9 at the northwest portion of the site to MW-7 at the southwest portion of the site is consistent with a corresponding coarsening of aquifer materials in a direction towards the river. This can be seen through inspection of the geologic cross sections presented in Figures 4-2 and 4-3. Lower hydraulic conductivities at the northwest portion of the site, near MW-9, MW-14 and MW-15 appear to coincide with the downgradient limits of the ground water mound as defined in Figure 4-1. This conductivity contrast may contribute to restricting development of the ground water mounding influence to areas south and west of MW-9. Aquifer characteristics at the TW site may be summarized as follows:

Aquifer Thickness: 25 feet
Hydraulic Gradient: 0.005 to 0.025
Hydraulic Conductivity: 2.3 to 29.4 gal/day/ft^2
Transmissivity: 57.7 gal/day to 735 gal/day
Effective Porosity: Estimated at 0.33 (33%)

4.3.2 Water Table Elevations

Synoptic water table measurements were acquired on five separate dates during the three stages of the E.I. On June 16, 1991 and June 15, 1992, two separate sets of measurements were acquired through a complete tidal cycle to evaluate influences of the contiguous Delaware River on hydraulic gradient and ground water flow. Water level measurements were obtained with an electronic sounding device, and all measuring points were established by a licensed surveyor. Tabulated water level measurements are presented in Table 4-20.

The June 15, 1992 round served as the basis for the preparation of the Water Table Elevation Map shown in Figure 4-1.

Successive rounds of synoptic water level measurements show consistent trends, seasonal variation being represented by an approximate decrease of 0.5 feet between high and low water periods in Spring and Fall, respectively. Ground water elevations across the 14.2 acre site show a significant range, from a high of 6.52 feet above MSL in MW-8 to a low of 2.81 feet above MSL in MW-9. For the most part, ground water elevations indicate a water table slope towards the Delaware River, varying slightly from south to a southeasterly component. Anomalous hydraulic gradients exist at the northwest and west portion of the TW site, both in terms of magnitude and direction. These have been attributed to ground water mounding and are discussed in section 4.3.3.

The vertical hydraulic gradient at the TW site was determined from monitoring wells MW-9 and MW-14. These two wells, located approximately 25 feet apart, are screened from 9 to 19 feet and 25 to 35 feet, respectively, and may therefore be considered a well couplet. A head loss of 1.2 feet over a vertical distance of 17.6 feet between MW-14 and MW-9 is probably attributable to the silty nature of aquifer materials at this location. This negative hydraulic gradient of 0.068 measured on June 15, 1992 indicates an upward component of ground water flow in the aquifer. This flow pattern is consistent with anticipated ground water discharge to the contiguous Delaware River and is further supported by the observation of a seep at low tide, along the banks of the Delaware River, near the Pennsylvania Fish Commission property. The lack of contaminants in upgradient wells (MW-6 and MW-7) preclude the presence of site related contaminants at the seep.

Only monitoring well MW-6 is significantly influenced by tidal encroachment; water table elevations in this well increase as much as 0.4 feet at high tide, lessening the hydraulic gradient measured from the middle of the TW site to the location of MW-6. The June 16, 1992 synoptic rounds indicated no significant water level fluctuations through the tidal cycle in MW-7, the only other site monitoring well located near to the river, however, this data was not consistent with the June 16, 1991 measurements. The fact that water table trends do not correlate properly with tidal cycles in MW-6 during the

June 16, 1991 round suggests the possibility of either a measurement or transcription error.

4.3.3 Ground Water Mounding

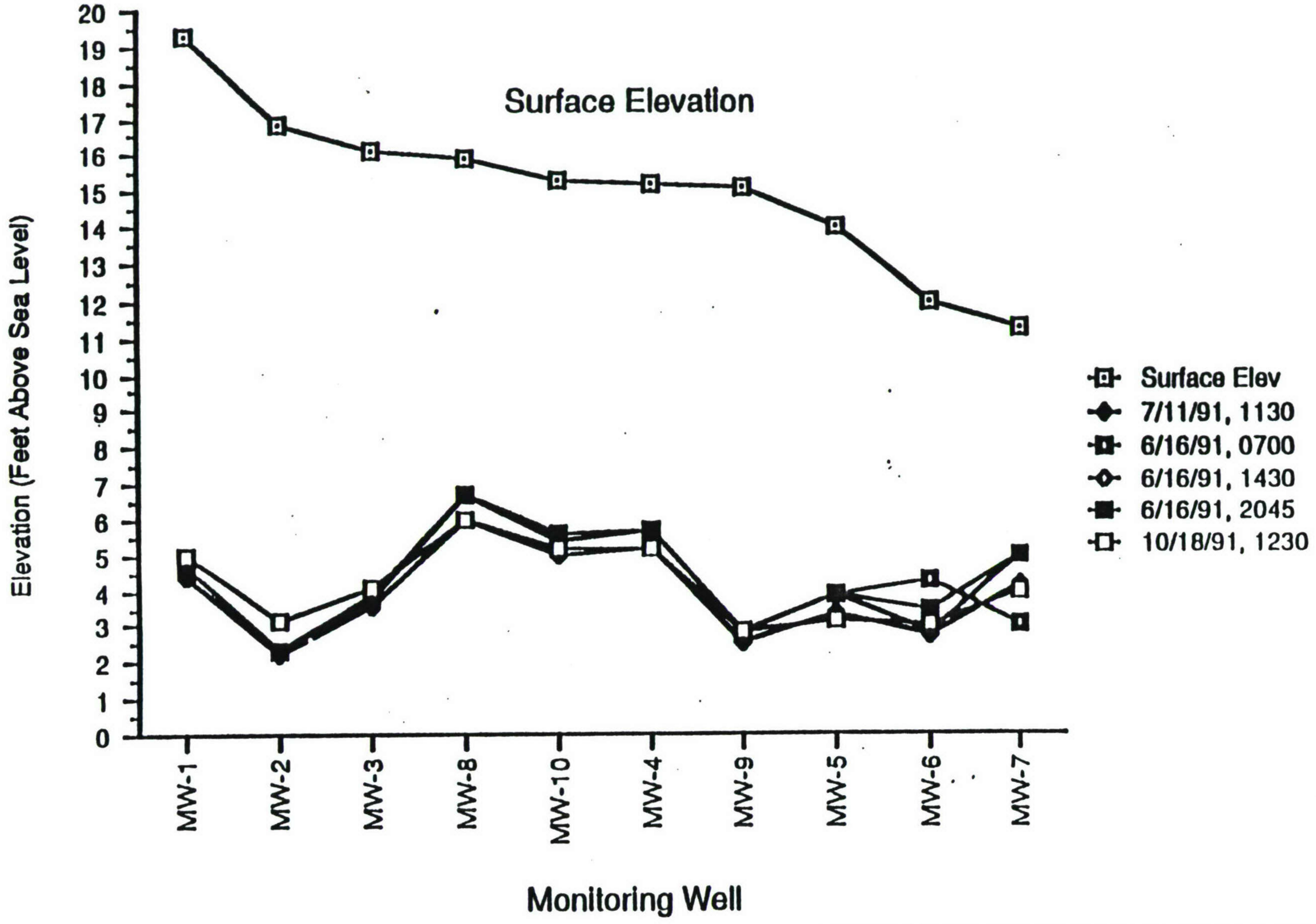
One of the objectives of the confirmatory site investigation conducted in June 1992 was to confirm the presence of a ground water mound in the northwest portion of the TW site. This was accomplished through the following tasks:

- The redevelopment of well MW-9;
- The installation of additional monitoring wells (MW-11, MW-12, and MW-14) and piezometers (P-1 and P-2); and
- The evaluation of potential leakage from the storm water collection well near monitoring well MW-8.

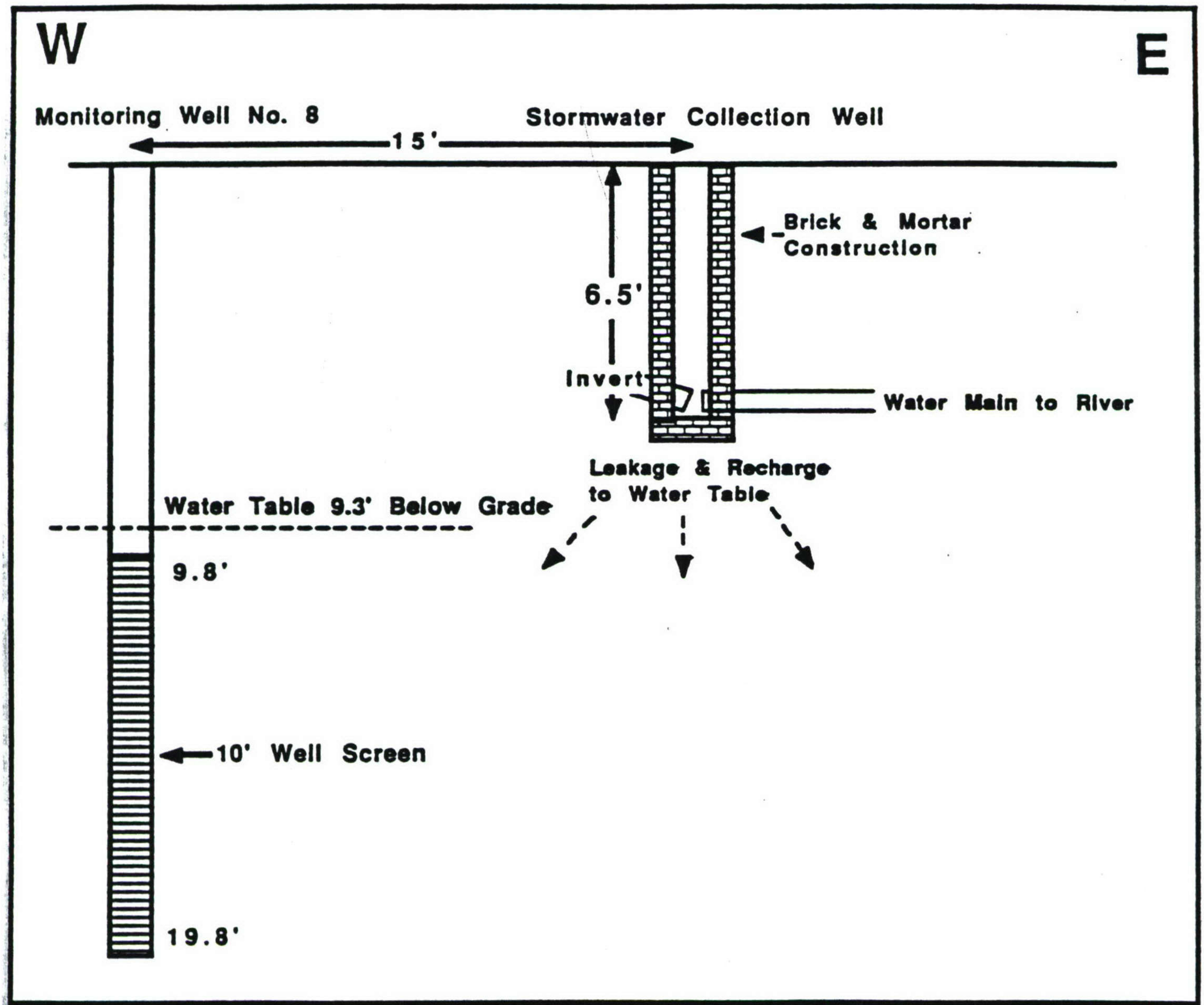
Ground water mounding in the northwest and west portion of the TW site is evident from both the water table elevation map (Figure 4-1) and the water table profile (Figure 4-4). The causative factor for ground water mounding is interpreted to be leakage from the site storm water collection system, centering around the storm water collection sump located adjacent to monitoring well MW-8. Figure 4-5 shows the relationship between the leakage from the base of the storm water collection sump and the anomalously high water table elevations recorded in MW-8.

As a qualitative check on this interpretation, potable water from the TW facility was pumped into the storm water collection sump, while observing water levels fluctuations in monitoring well MW-8, located 15 feet to the west. This brief exercise was undertaken following acquisition of all requisite ground water samples and prior to slug testing of monitoring wells MW-4, MW-7 and MW-9. Potable water was discharged into the storm water collection sump from a garden hose at an estimated rate of 5 gallons per minute. Over a period of about two hours, the water level in MW-8 was observed to rise several tenths of an inch.

Piezometric data acquired on five separate occasions, and the qualitative data described above, all point to the storm water collection system as the source of the ground water mound. It is believed the cracks and joints in the brick and mortar construction of the storm water collection sump allows for a



Tacony Warehouse Philadelphia, Pennsylvania	Water Level Measurements In feet above Sea Level	Figure 4 - 4 Water Level Elevation Plot
Versar Inc. Langhorne, Pennsylvania		



Versar Inc. | **Tacony Warehouse, Pennsylvania**

Figure 4-5 Schematic Indicating Relationship Between Stormwater Collection & Monitoring Wells

Scale: 1" = 4' Prepared by: D. Morganelli July 20, 1992 significant amount of leakage and recharge to the water table following each major rainfall event. Dissipation of the resultant ground water mound is not complete between successive rainfalls. Therefore, the mound continuously exerts a local influence on ground water flow and contaminant transport.

4.3.4 Ground Water Flow

The TW site is divided into west and east sections for the purpose of ground water flow interpretation and discussion:

Southeast Portion of the TW Site: Ground water flow on the eastern half of the TW site is in an east-southeasterly direction towards a nearby inlet of the Delaware River. Due to the low hydraulic gradient in this area, ground water velocities are slow, probably less than 0.1 feet/day, depending on actual hydraulic conductivities. Slug tests were not performed on this part of the TW site. Data in this area was obtained by comparison with MW-7, where aquifer fabric is most comparable. Velocity calculations were made using the Darcy equation.

Tidal flushing of the aquifer at the southeastern most portion of the site modifies the hydraulic gradient, flattening it somewhat during high tide with a corresponding slowing of ground water velocity. In the vicinity of monitoring wells MW-11 and MW-7, the direction of flow is southerly towards the Delaware River. This is the expected regional flowpattern and discharge to the river is verified by the presence of a seep which is visible at low tide, immediately to the south of MW-7, along the river's bank. Ground water velocity in this area is under 0.1 feet/day.

Northwest Portion of the TW Site: Ground water flowpaths on the northwestern half of the TW site are more complex. South-southwesterly flowpaths characterize the area including monitoring wells MW-4, MW-10 and MW-12, with a corresponding velocity here of slightly over 0.1 feet day, based on slug test hydraulic conductivities.

The northwest portion of the TW site has the most complicated ground water flow patterns. In the vicinity of monitoring wells MW-3, MW-8 and P-1, (near the apex of the ground water mound), there is a steep northwest slope to the hydraulic gradient. Northwesterly ground water flowpaths may attain velocities as high as 0.3 feet/day here. Monitoring wells MW-1 and MW-15 are located in an area of south-southwesterly ground water flow with much slower velocities of less than 0.1 feet/day. Note that between these two groups of wells, there is not only a reversal in hydraulic gradient, but there is also an order of magnitude difference in hydraulic conductivity (i.e. 29.4 gal/day/ft^2 versus 2.3 gal/day/ft^2).

Ground water flowpaths in the immediate area of MW-9 are one of the most important concerns in the TW environmental investigation. Water samples from this well have recorded significant concentrations of PCE and vinyl chloride, this contamination being probably attributable to an abandoned UST located immediately to the north of MW-9. MW-9 lies along the convergence of southerly and northerly flowpaths. This well also lies close to, if not at, the hydraulic conductivity change that occurs between the southwest and northwest portions of the TW site. The well was redeveloped to ensure that interpreted gradients and flowpaths are accurate and piezometric data did not change as a result of that effort.

The direction of ground water flow in the immediate area of MW-9 is interpreted to be to the west-southwest, towards the site boundary and adjacent cement plant. Ground water velocity at MW-9 is indicated to be slow, probably less than 0.1 feet/day. However, an order of magnitude conductivity increase and steeper hydraulic gradients to the south-southeast of MW-9 may affect an accelerated ground water velocity to as much as 0.3 feet/day, if these parameters also influence areas to the west-southwest of MW-9.

Based on interpreted ground water flowpaths, MW-14 lies downgradient of MW-9. It should be pointed out, however, that the former well is screened in the basal portion of the aquifer at a depth of 25 to 35 feet below grade. The head relationships between these two wells suggest a significant upward component of flow. Therefore, any dissolved contaminants originating in the vicinity of MW-9 and traveling with advective (bulk) ground water flow would likely travel at shallow aquifer depths and not reach and be detected in the screened interval in MW-14. Monitoring well MW-14 was sited to complement MW-9 as a well couplet (MW-14 was intended to monitor the lower section of the aquifer for any free product which might be associated with the detection of chlorinated solvents in MW-9's shallow well screen and a nearby UST, the probable source).

4.3.5. General Site Water Quality Conditions

The TW site is located in a highly industrialized area. Therefore, general water quality conditions should be assessed before conducting risk assessments which assume water usage for potable supply purposes. Although total dissolved solids (TDS) were not measured during field sampling activities, ground water conductivities, which are generally proportional to TDS, range from 195 to 740 micromhos at the site. It is notable that well development for MW-1 lasted the longest with more volume removed than any other site well. Therefore, the high conductivity at that location appears to be associated more with general background water quality than with incomplete well development.

In addition to an observed trend of high ground water conductivities at the site, suspended metals and high water hardness also characterize general water quality conditions. Unfiltered ground water samples in all wells consistently show high levels of metals which are subsequently not identified in the filtered samples (see Tables 4-17 and 4-19). Iron and manganese concentrations are also high in filtered samples at most sample locations, ranging from 0.4 to 170 ppm and 0.6 to 4.3 ppm, respectively.

Iron in water, at concentrations as low as 0.3 ppm, imparts a metallic or astringent taste and causes rust colored stains on plumbing fixtures, tableware, and laundry. Iron-bearing water favors the growth of iron bacteria, slime-forming organisms that cause clogging of pipes and a foul taste and odor. Manganese, seldom found alone in a water supply, is usually accompanied by iron. Concentrations as low as 0.2 ppm will produce dark brown or black staining. Fabrics washed in manganese bearing waters are almost invariably stained. Deposits collect in plumbing, and tap water frequently contains a black sediment and turbidity. Manganese bacteria often causes clogging of pipes.

Calcium concentrations in ground water samples from wells at the TW sites range from 18 ppm to 82 ppm, most with an average concentration of 45 ppm.

Water hardness at the site may be characterized as slightly hard (8.5 to 60 ppm) to moderately hard (60 to 180 ppm). Hard water is responsible for the formation of lime scaling in pipes, water heaters, boilers, and air conditioners. It is generally recommended that hardness not exceed 60 ppm for household applications.

Ground water quality at the southeastern portion of the TW site is subject to the influence of the adjacent Delaware River, which is observed to cause water levels in this area to fluctuate with tidal changes associated with the river and the Delaware Bay estuary. Ground water at this part of the site may, therefore, assume some of the physical characteristics of the river itself.

For the reasons discussed above, ground water classification based on potential usages would probably preclude potable consumption in the immediate vicinity of the subject property.

SECTION 5.0

QUALITY ASSURANCE

The purpose of the quality assurance program at the TW site was to maintain an established level of precision, completeness, accuracy, and conformance with EPA and USATHAMA standards. The EI was conducted within the guidelines established in the Quality Assurance Project Plan (QAPP) prepared for the TW EI and approved by USATHAMA.

5.1 FIELD OPERATIONS

The field work at the TW site was performed in accordance with Standard Operating Procedures (SOP), as described in the TW Sampling Design Plan and QAPP. The SOP's include procedures for sampling, sample custody, documentation, document control, decontamination, field analysis, and instrument calibration.

Field quality control samples were collected during the investigation and submitted to the CLASS laboratory for analysis. These samples consisted of field blanks, trip blanks, duplicates, and rinsates. Data validation for this project was provided by A.D. Little and USATHAMA personnel in accordance with the QAPP, EPA data validation guidelines, and industry practice.

Water samples from a bottled, deionized water source, used for blanks and a final rinse during decontamination, and the onsite water supply (Philadelphia City), used for steam cleaning and initial decontamination, were analyzed for TCL parameters and TPHC by the CLASS laboratory. Low levels of chloromethane (5.95 ppb) and chloroform (0.905 ppb) were detected in the bottled water source. Levels of bromodichloromethane (13.3 ppb) and chloroform (65.4 ppb) were detected in the onsite water source. No inorganics were detected in the deionized water. For the onsite water source, no metals were detected above the levels expected in a public water supply.

5.2 LABORATORY OPERATIONS

To control the quality of the analytical data, only USATHAMA approved procedures and equipment were used for sample preparation and analysis. SOP's for analytical methods utilized for samples collected from TW are presented in the QAPP prepared for the TW EI. Precision, accuracy, representativeness, comparability, and completeness of the analytical process were assessed through the use of calibration checks, method blanks, replicate analyses, and other QC methods as required by specific methods. Laboratory QC data were provided with data packages to USATHAMA for evaluation. Under the CLASS program, USATHAMA evaluates the performance of laboratories in analyzing for commonly encountered analytes at project sites. The evaluation process further assures that data quality objectives are met.

5.3 DELIVERABLE DOCUMENTS

Deliverable documents for the Tacony Warehouse EI, including this EI Phase I Report, were subjected to a quality assurance review prior to submittal to USATHAMA. The QA review process included critical evaluations by the Versar QA officer and Project Manager, as well as technical specialists. The documents were then submitted for internal review by USATHAMA project personnel.

SECTION 6.0

SITE ASSESSMENT

This EI generated new information on the physical setting and conditions at the TW site, and created a data base of chemical data on the quality of soils, sediment, surface water, and ground water at the site. Additional analytical data was collected on the presence of asbestos and PCB containing electrical equipment at the facility. The data used in the assessment were supplemented with historical data, where appropriate. Completion of the EI documented the presence of organic and inorganic constituents in site soils, sediments, surface water, and ground water. Asbestos containing materials and PCB containing equipment were also identified at the site. A Risk Assessment prepared as part of the EI (presented in Section 8 of this report) addresses the potential effects of the constituents on the health of potential receptors or the environment.

6.1 BUILDING INVESTIGATION

Asbestos containing materials (ACM) were identified throughout the TW facility. Damaged, friable ACM presents an imminent risk of fiber releases and subsequent exposure to onsite workers or trespassers. Other ACM found at the site has a high potential to be damaged and also presents a concern for fiber releases. Nonfriable ACM will not release fibers unless physically disturbed through abrasive activity. Therefore, nonfriable ACM presents a minimal exposure concern based on the current use scenario.

Damaged, friable ACM with a high potential for exposure was identified in building 467, building 462, and around the aboveground storage tanks. The ACM included tank insulation, pipe insulation, and boiler, boiler stack, and ash flue insulation. Mobility of and exposure to asbestos fibers would generally be limited to the immediate vicinity of the ACM. Wind aided dispersal of asbestos fibers from the aboveground tank insulation is likely to occur. However, the concentrations expected in air downwind of the ACM would be well below the EPA's air standard of 0.02 fibers per cubic centimeter of air.

A number of remedial alternatives and management strategies are available for addressing the various ACM identified at the site, and thus minimizing potential exposures. A detailed discussion of these is presented in the Phase II Report for the site.

Analysis of dielectric fluid samples from six transformers at the TW site revealed that four of the units are PCB-contaminated, and the remaining two are PCB-containing, as defined in TSCA regulations. The risks associated with these PCBs is limited while the fluid remains contained within the transformers. Exposure scenarios would be limited to electrical maintenance activities and catastrophic events, such as a fire. The lack of proper labeling and records for the transformers presents an added concern for these potential exposure pathways. The findings of the EI indicate that the TW facility has not met regulatory requirements for the transformers, and the facility is in violation of TSCA.

Wipe samples were collected from building materials in areas of suspected or observed spills. Wipe samples exhibiting contaminant concentrations were all collected from within onsite structures. Therefore, migration potential for these compounds is extremely limited outside of the pore space of the materials on which these compounds were detected. Low levels of PCBs, below the EPA action level of 10 ug/100 cm^2, were detected on the walls of the two existing transformer substations, within the former pesticide storage building, and in the area of a hydraulic fluid spill in building 461. Low levels of 2,4-D and endosulfan sulfate were detected in the former pesticide storage building. These constituents are not deemed to present a significant risk to human health or the environment under the current use scenario due to the lack of migration potential and the suspected adherence to building materials.

6.2 SURFACE AND SUBSURFACE SOILS

6.2.1 Surface Soils

Surface soil samples collected during the EI confirmed the presence of low levels of pesticides/herbicides and PCBs, and concentrations of TPHC in the surface soil along the railroad tracks in the western section of the subject property. Elevated levels of inorganic constituents were also detected, although no discernable pattern could be established for these constituents. Metals identified in excess of 2 times background or detection limit include arsenic, beryllium, calcium, cadmium, chromium, copper, lead, maganese, nickel, silver, and zinc. Detection of these constituents verifies historical data which indicates that waste oils and herbicides were applied as weed control along the railroad tracks, in that these metals are common constituents of the materials applied.

The potential for transport of constituents detected in surface soils is low. The areal extent of potentially contaminated surface soils is small, because the majority of the site is paved (approximately 96%), and most of the exposed areas are overgrown with vegetation. These factors limit the transport of airborne soils, and thus offsite contamination and exposure. Organic and inorganic constituents present in the soils have limited mobility and tend to be attenuated in soils.

No suitable standards exist for chemical constituents in soils. The risk assessment takes a detailed look at exposure pathways and risks associated with various constituents identified in surface soils. The results of the risk assessment suggest an unacceptable risk associated with arsenic concentrations in surface soils via a number of onsite exposure scenarios.

6.2.2 Subsurface Soils

Subsurface soil samples were collected to allow characterization of subsurface soil conditions in the area of potential contaminant sources. These sources included underground and aboveground storage tanks and associated appurtenances, the former spray pond, and an oil/water separator. Analytical results revealed the presence of a variety of contaminants in subsurface soils. Polycyclic Aromatic Hydrocarbons (PAHs) were detected at the highest concentrations in the area west of the former spray pond and three, 10,000 gallon USTs. Total PAH concentrations were consistently higher in samples obtained from the 4-foot depth than in those obtained from a depth of 10 feet or more. This factor appears to support a conclusion of near surface deposition, with the former spray pond being the expected source of the observed contamination in its immediate area. Cooling water pumped to the pond is likely to have been contaminated with quench oils containing PAHs as a constituent. The low levels of PAHs identified at the lower depths were likely transported by the associated quench oil and cooling water during the time of deposition to the pond. In addition, surface spillage associated with the three USTs now located in the spray pond is expected to have contributed to the TPHC concentrations detected in subsurface soils in this area.

PAHs have varying volatilities, soil binding characteristics, and water solubilities (see Table 6-1). PAHs that have high water solubility and low tendency to adsorb to soils (e.g., low molecular weight compounds such as naphthalene, acenaphthylene, and fluorene) tend to be more mobile in the environment than PAHs that are of higher molecular weight, with a greater number of ring structures (e.g., chrysene and benzo[A]pyrene). Therefore, naphthalene and fluorene are more likely constituents of ground water, while chrysene and benzo[A]pyrene are more likely to be detected in soils.

The PAHs exhibiting the highest concentrations and identified most frequently in subsurface soils at the TW site were pyrene, phenanthrene, benzo[A]anthracene, benzo[A]pyrene, chrysene, and fluoranthene. In general, the higher molecular weight compounds were detected at higher concentrations in the subsurface soil samples. This is consistent with the expected environmental fate of PAHs. No PAHs were detected in ground water samples collected at the site. This indicates that no migration of PAHs to ground water has occurred, because monitoring wells were sited in proximity to the elevated PAH soil concentrations. Several factors are most likely responsible for this lack of migration. Low molecular weight PAHs are highly susceptible to biodegradation, and thus may be oxidized prior to transport. Another factor limiting potential transport to ground water is the fact that the majority of the site is paved, thus limiting infiltration of precipitation. Additionally, the initial transport mechanism for the PAH's (i.e., quench oils) no longer exists. The PAH's identified in the soil column are unlikely to be dissolved from soil particles by the limited infiltration of precipitation through the exposed soil of the former spray pond. The above described factors support a conclusion that the PAHs present in site

TABLE 6-1
CHEMICAL AND PHYSICAL PROPERTIES OF POLYCYCLIC AROMATIC HYDROCARBONS (PAHS)

Compounds	Molecular Weight	Number of Carbon Rings	Water Solubility (mg/l)	Henry's Law Constant (unitless)	Vapor Pressure (mm @20-25 deg C)	Log Koc	Log Kow
Naphthalene	128.18	2	30	1.92E-02	5.40E-02	2.74	3.36
2-Methylnaphthalene	142.20	2	24.6	NA (b)	NA	3.93	4.11
Acenaphthylene	152.20	3	3.93	1.17E-02	2.90E-02	3.68	4.07
Acenaphthene	154.21	3	3.47	3.30E-03	1.55E-03	1.25	3.92
Fluorene	166.22	3	1.69	8.75E-03	7.00E-04	3.7	4.12
Phenanthrene	178.24	3	0.816	1.63E-03	2.10E-04	3.72	4.568
Anthracene	178.24	3	0.045	7.38E-04	1.95E-04	-0.43	-0.24
Fluoranthene	202.26	4	0.166	7.04E-01	1.00E-02	4.62	5.22
Pyrene	202.26	4	0.16	4.54E-04	6.85E-07	4.66	4.88
zo(a)anthracene	228.30	4	0.01	2.75E-05	5.00E-09	6.14	5.61
Chrysene	228.30	4	0.0022	3.03E-18	6.30E-07	5.39	5.6
Benzo(b)fluoranthene	252.32	5	0.0012	5.00E-04	5.00E-07	5.74	6.57
Benzo(k)fluoranthene	252.32	5	0.00055	4.33E-02	9.59E-11	6.64	6.85
Benzo(a)pyrene	252.32	5	0.003	1.00E-04	5.49E-09	5.6	5.99
Indeno(1,2,3-cd)pyrene	276.34	6	0.062	1.23E-18	1.00E-09	7.49	7.7
Dibenzo(a,h)anthracene	278.36	5	0.0005	3.05E-07	1.00E-09	6.22	6.36
Benzo(g,h,i)perylene	276.34	6	0.00026	5.83E-06	1.01E-10	6.89	7.1
Dibenzofuran	278.36	3	0.0005	3.05E-07	NA	6.22	6.36

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a/ Values are obtained from Montgomery and Welkom (1989).

b/ NA = not available.

subsurface soils will remain in the soil column and not migrate to ground water. Therefore, the risks to human health and the environment presented by the PAHs is very limited.

Volatile organic compounds (VOCs) were detected at several soil boring locations, all of which were designed to monitor USTs. All three samples initially collected from the area of the abandoned UST (SB-19, SB-20, and SB-21) exhibited detectable levels of VOCs. SB-27, located downgradient of these abandoned UST borings, also revealed detectable levels of VOCs. The compounds detected include tetrachloroethene, trichloroethene, and dichloroethylene. The history of the abandoned UST is limited, and the potential exists for past use of the tank for waste storage that may have included used solvents. Therefore, the abandoned UST is the most likely source of the VOCs. VOCs in general show a high mobility in soils and would be expected to impact ground water at the site. A review of ground water data for sample GW-9, which is located downgradient of the UST, revealed substantial concentrations of tetrachloroethylene and potential breakdown products including vinyl chloride. The VOC ground water contamination is discussed in Section 6.4 of this report.

Benzene and 2-hexanone were detected at low levels in a sample (SB-17) collected from adjacent to the 300-gallon aboveground storage tank. The compounds were only detected in the sample obtained from the 4-foot level and were not detected in any ground water samples. The most likely source of these compounds is limited surface spillage from the aboveground tank. The tank reportedly contained gasoline for use in facility vehicles, although it was empty at the time of the EI. The tank is equipped with a hand-controlled pump. It is common for dispensers of this type to retain residual product in lines. Through improper handling of the hose, gasoline may have been spilled on the ground and resulted in the VOCs detected in the soil. Based on the absence of the two compounds, as well as any other associated compounds, in the deeper sample or ground water samples, this contamination is believed limited to near surface soils in the area of the aboveground tank. The fact that the subject tank is out of service and empty eliminates the potential for further spillage and migration of the contamination.

VOCs were detected at one other location. Tetrachloroethane was detected in a subsurface soil sample (SB-5) obtained from adjacent to the 1,400 gallon fuel oil UST on the east side of the TW site. A monitoring well installed at this location exhibited a concentration of only trichloroethylene. No correlation between the UST and the VOC concentrations observed could be drawn. Historical information indicates that the tank was used strictly for No. 2 fuel oil, and petroleum hydrocarbons that would indicate a potential leak from the tank were not observed. A more likely source of the contaminants observed is surface deposition of a used solvent in limited quantities. Although such disposal is not documented, it was not an uncommon occurrence at industrial facilities in the past. Confirmation of any involvement of the UST in the observed contamination should be obtained when the subject tank is removed.

Subsurface soil metals concentrations in excess of background levels were detected throughout the TW site. No consistent pattern of elevated concentrations could be established, although most metals were detected at greater than 2 times background at some location on the site. Metals concentrations were generally higher in the western portion of the site. Boring SB-28 consistently exhibited the highest metals concentrations. No specific source of the higher concentrations in this boring was determined and the concentration may represent variation in fill material. The lack of a discernable pattern of elevated metals concentrations makes it impossible to correlate elevated metals with certain activities at the site (i.e., the spray pond). However, it is likely that metals levels observed represent the natural variety in subsurface materials at the site, impacted on some level by the various activities performed at the site over its time of operation. Metals in subsurface soils would not be expected to be highly mobile due to the tendency to attenuate to soils and the lack of infiltration of water from the surface of the site.

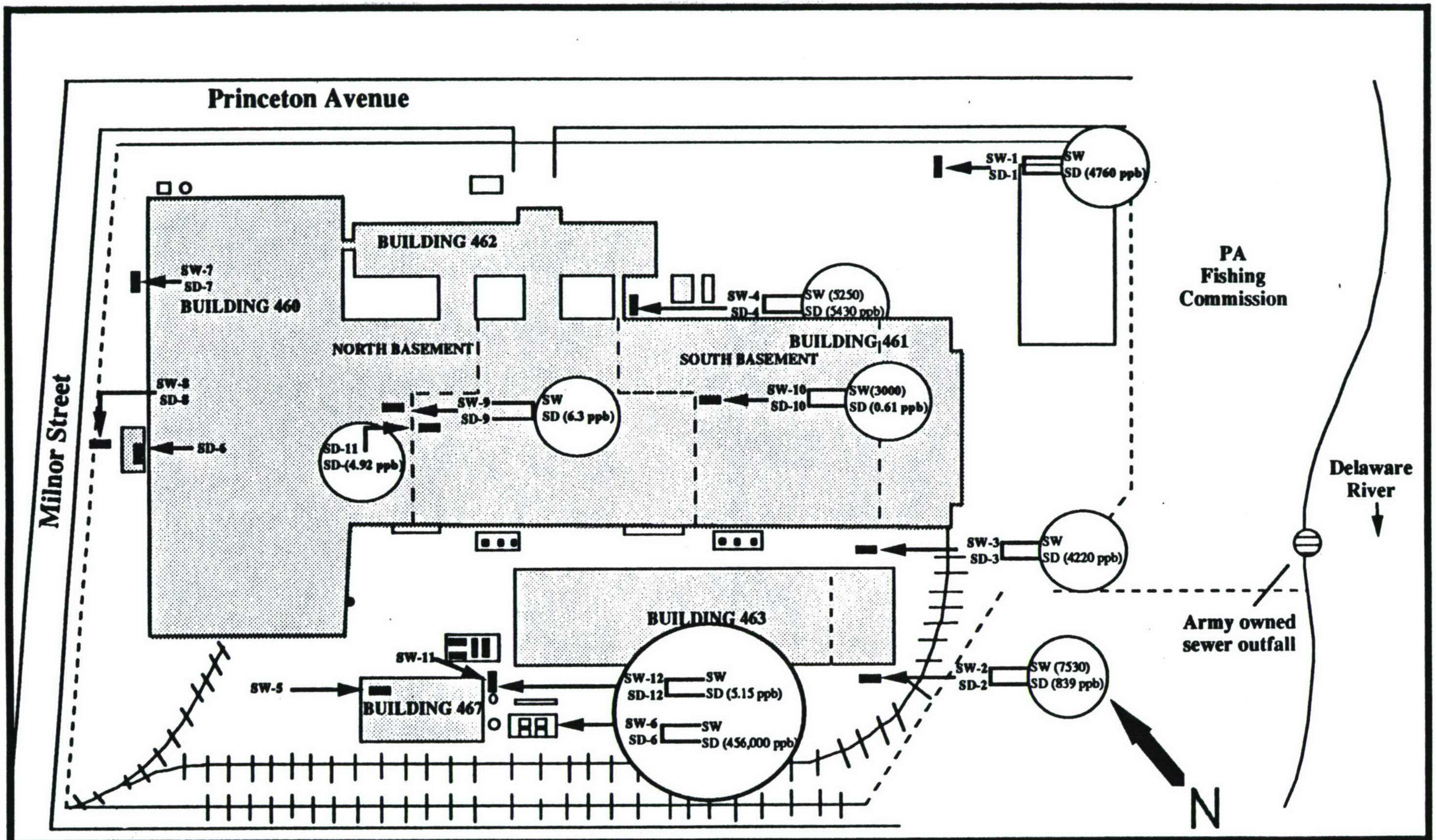
6.3 SURFACE WATER AND SEDIMENTS

Surface water and sediment samples were obtained from storm water drains in paved areas at the north, west, and east portions of the TW site. Additional samples were taken at interior building locations from drains and sumps in the basements of buildings 460 and 461, from the underground utility tunnel in building 467, from the containment berm for the ASTs west of building 463, and also from the inlet and outlet of the oil/water separator south of building 467.

As might be expected, the most prevalent contaminant noted in these samples was petroleum hydrocarbons. TPHC concentrations ranging from 3,000 ppb to 7,530 ppb in surface water samples and from 0.61 ppb to 456,000 ppb in sediments appear to occur primarily in areas adjacent to AST containment areas, UST locations, and contiguous storm drains (Figure 6-1). TPHC concentrations are consistent with either minor leakage or spills at fill ports and the associated runoff in paved areas. It is notable that storm drain surface water and sediments acquired from the north side of the TW site, where no tanks are located, showed no evidence of TPHC contamination. TPHC contamination was also observed in site ground water samples during initial site sampling, but was unconfirmed during confirmatory sampling. A possible relationship between surface water and ground water petroleum contaminants is discussed in Section 6.4 of this report.

Low levels of tetrachloroethylene (PCE) were detected sporadically in surface water samples at storm water drains on the north, east, and west sections of the site (Figure 6-2). No discernible pattern appears to exist in the distribution of this compound in surface water. Ground water PCE concentrations, although generally higher, are less widespread at the site and seem to correlate to more definable point sources. The latter will also be discussed in Section 6.4.

Metal concentrations in surface water samples and sediments are, for the most part, randomly distributed at the various sampling locations. One exception to this is SW-3, a storm drain surface water sample acquired at the southwestern corner of building 461. This sample shows metal concentrations which are consistently elevated one to two orders of magnitude above all other site surface water samples. The storm drain from which SW-3 was obtained lies along the same stormwater discharge pipeline as ground water monitoring well MW-3, which is located approximately 300 feet to the northwest. A ground water sample (GW-3) from this well also showed anomalously high metal



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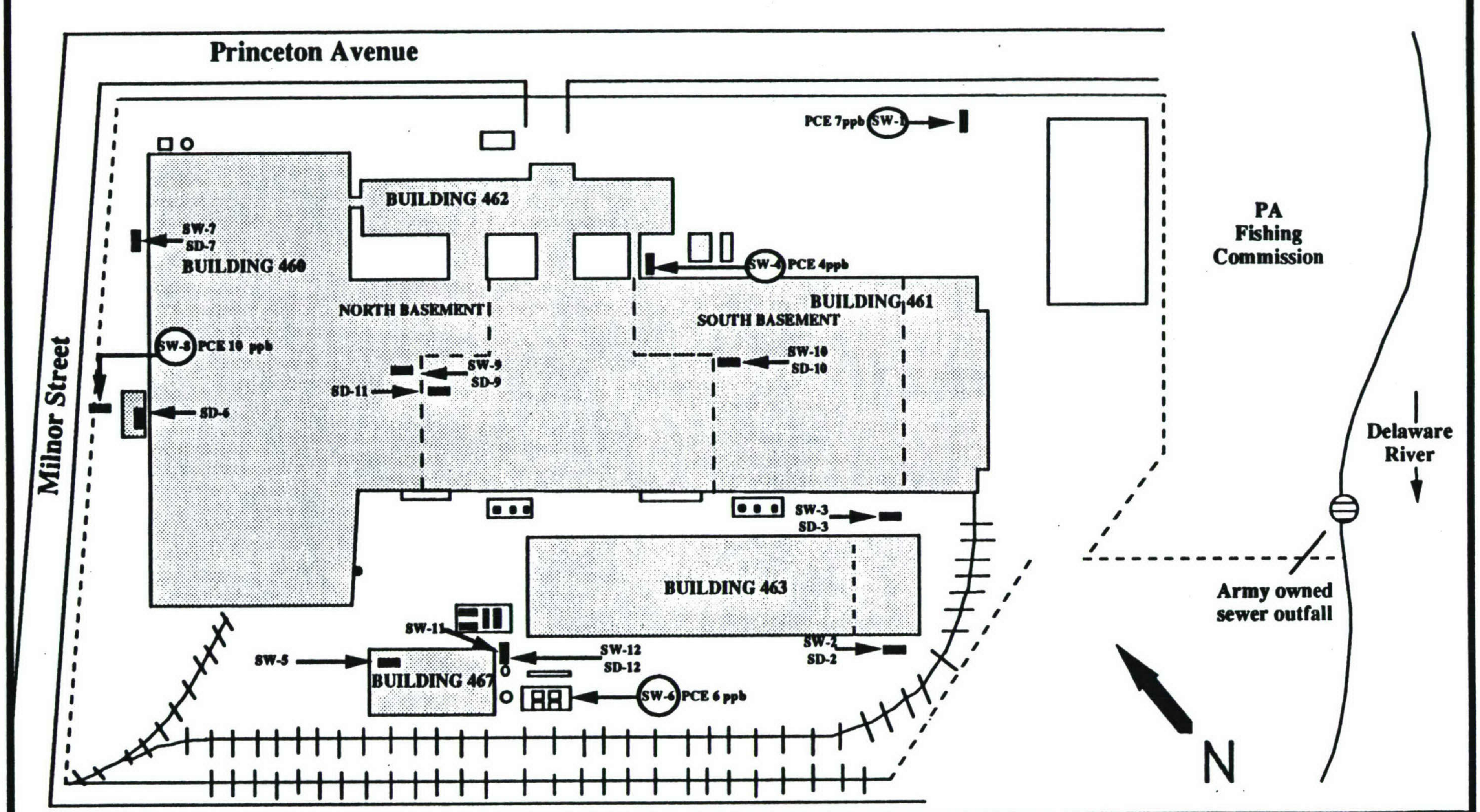
LANGHORNE, PA

SCALE: 1-INCH EQUALS APPROX. 150 FEET

○ SURFACE WATER AND SEDIMENT SAMPLE LOCATION

[SURFACE WATER CONCENTRATION (SW)
SEDIMENT CONCENTRATION (SD)

FIGURE 6-1
TRPH CONCENTRATIONS IN SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP



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○ SURFACE WATER SAMPLE LOCATION

FIGURE 6-2
TETRACHLOROETHYLENE (PCE) CONCENTRATIONS IN SURFACE WATER AND SEDIMENT SAMPLE LOCATION MAP

concentrations with respect to other site ground water samples. It is not understood what, if any, relationship exists between metal concentrations in surface water and ground water along the western side of building 461.

Compounds identified in surface water and sediment samples may be available for transport to ground water and surface water via the drainage system. The integrity of the system is best described as questionable and evidence of leakage impacting a monitoring well at the site is discussed in Section 6.4. Movement of sediment in significant quantities through the system is unlikely based on the trap-like structure of the storm drains that are expected to retain the majority of solids entering the system. Compounds detected in storm drain sediments represent an accumulation over time and would only be transported to the Delaware River via dissolution in storm water runoff. Compounds reaching the Delaware River, if any, are believed to represent no discernable threat to the quality of the river due to the low volume of storm water anticipated to be discharged and the volume of water in the river moving past the site at any one time.

6.4 GROUND WATER

In general, contaminants observed in ground water samples from the fourteen site monitoring wells are consistent with those potentially anticipated with respect to site solid waste management units (SMUS) and past site activities. Ground water impacts at the TW site are basically limited to certain volatile organic compounds and sporadic occurrences of petroleum hydrocarbons. VOCs observed in multiple rounds of ground water sampling include tetrachloroethene, trichloroethylene, 1,1-dichloroethylene, 1,2-dichloroethylene, and vinyl chloride. Metal concentrations in site ground water samples occur as suspended particles as demonstrated by high water turbidity and conductivity. Filtered metal concentrations were consistently below the certified reporting limit in contrast to the initial unfiltered concentrations, the only exception to this being iron.

Ground water samples from the fourteen site monitoring wells are believed to accurately reflect water quality conditions in the aquifer underlying the TW site with one possible exception. MW-8, located at the northwestern portion of the site, is situated at the apex of a prominent ground water mound

(Figure 4-1). Water quality in this well may be impacted to a large extent by leakage of storm water associated with a nearby collection sump. The same ground water mound causes an anomaly in ground water flowpaths, which modifies the originally intended monitoring objective for this sampling location.

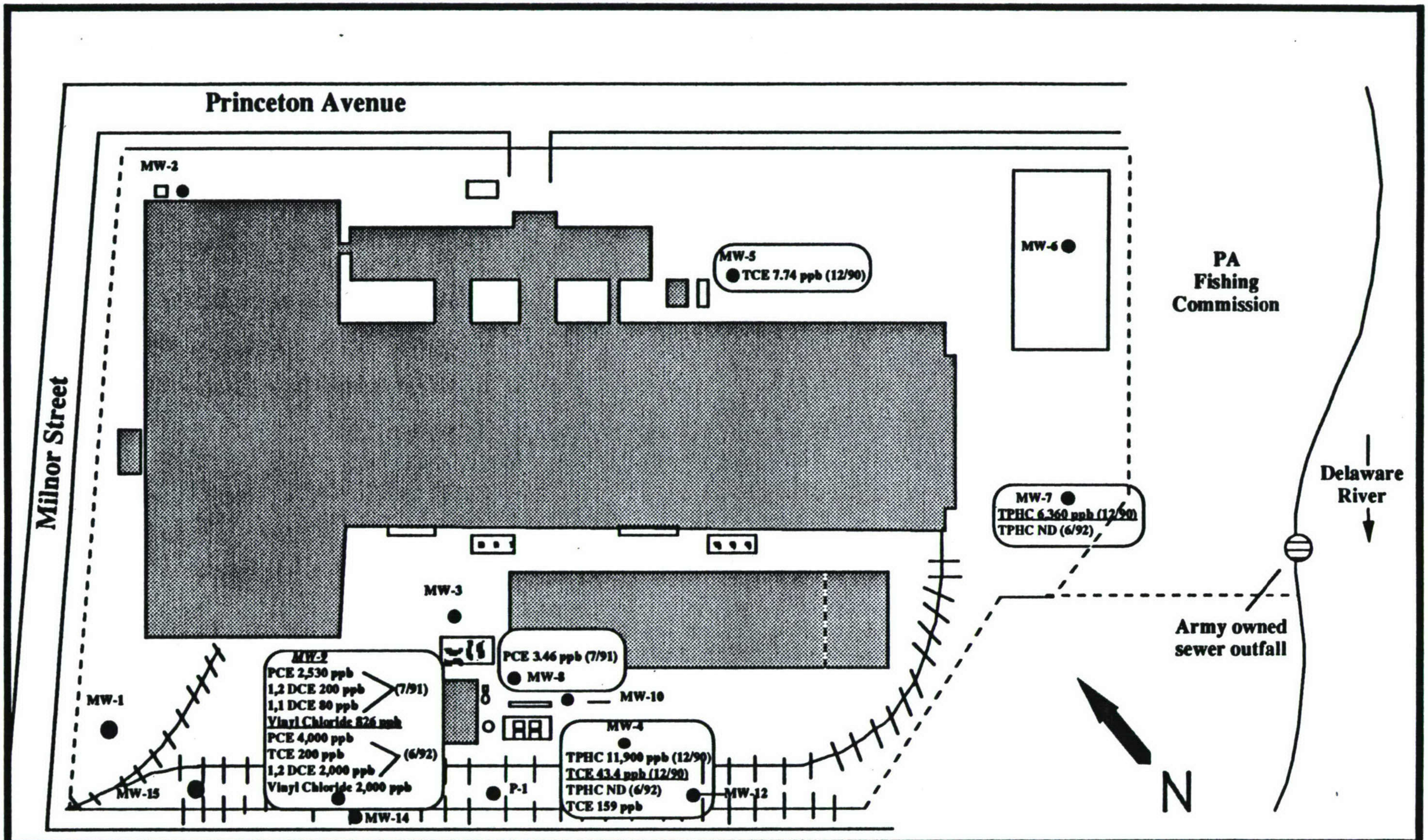
Total petroleum hydrocarbons (TPHC) of 11.9 ppm and 6.4 ppm were recorded in ground water samples GW-4 and GW-7, respectively. These two samples were obtained from ground water monitoring wells MW-4 (sampled in December, 1990) and MW-7 (sampled in June, 1991) located at the west-southwest part of the TW site (Figure 6-3). MW-4 lies downgradient of two 10,000 gallon above ground storage tanks (ASTS), and MW-7 is situated further downgradient from the area of these ASTS, proximal to the Delaware River.

Following the December 1990 and July 1991 ground water sampling rounds, it was thought that TPHC concentrations in MW-4 and MW-7 might be related and associated with a petroleum hydrocarbon plume migrating in a southerly direction towards the river. However, no physically measurable free product was ever detected in these wells and TPHC levels decreased to below the certified reporting limit by the June 1992 round of ground water sampling. The absence of TPHC contamination in all wells sampled during the June 1992 round suggests an occurrence of petroleum hydrocarbons in the aquifer which is periodic in nature.

Review of the spatial and temporal distribution of TPHC contamination as recorded during the three consecutive rounds of ground water sampling events indicates that there is no single, definable contaminant plume associated with either the tanks which stored petroleum products, or leaking storm water drains with associated TPHC soil contamination.

Volatile organic compounds were detected in three of the TW site monitoring wells (Figure 6-3). The following VOC concentrations were recorded in December 1990, July 1991 and June 1992:

Well	Date Sampled	Parameter	Concentration
MW-9	July 1991	Tetrachloroethene	2,530 ppb
		1,1-dichloroethylene	80 ppb
		1,2-dichloroethylene	200 ppb
		Trichloroethylene	189 ppb
		Vinyl Chloride	826 ppb



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● MONITORING WELL AND PIEZOMETER LOCATION
 -TPHC
 -PCE, 1,2 DCE, 1,1 DCE, TCE, VINYL CHLORIDE (SAMPLING DATE)

FIGURE 6-3
TPHC AND VOC CONCENTRATIONS IN GROUND WATER LOCATION MAP

MW-9	June 1992	Tetrachloroethene	3,960 ppb
		1,1-dichloroethylene	67 ppb
		Trichloroethylene	234 ppb
		Vinyl Chloride	1,600 ppb
MW-4	Dec. 1990	Trichloroethylene	43.4 ppb
	June 1992	Trichloroethylene	159 ppb
MW-5	Dec. 1990	Trichloroethylene	7.74 ppb
MW-8	July 1991	Trichloroethylene	3.46 ppb

PCE and its associated degradation compounds, including TCE, were detected in MW-9 during both the July 1990 and June 1992 rounds of ground water sampling. Monitoring well MW-9 was sited downgradient from an underground storage tank (UST) located adjacent to Building 467. Soil samples from borings located immediately east and west of MW-9 also showed PCE contamination, suggesting that the tank may be the source of these VOCs. This UST may have been used as a waste oil disposal tank, although no documentation exists to verify its use for that purpose.

TCE was detected both in monitoring wells MW-4 and MW-9 during consecutive rounds of ground water sampling. Figure 4-1 (Appendix M) shows that ground water flowpaths towards MW-4 and MW-9 originate from a ground water mound centering just to the south of Building 467. However, from the analytical data shown above, it is apparent that VOC contamination in these two wells has a slightly different profile. This difference in water quality "signatures" suggests separate sources for the chlorinated solvents detected in MW-4 and MW-9.

It is also possible that leakage from the abandoned UST in the vicinity of MW-9 may have resulted in ground water impacts to MW-4, which was located downgradient of the UST, prior to the existence of the presently observed ground water mound. However, in addition to the different plume signatures discussed above, no information exists relative to the time of occurrence of the postulated release or when development of the current ground water mound commenced.

Low levels of TCE were detected in MW-5 during the December 1990 round of ground water sampling. This well was sited to monitor a UST on the east side of Building 461. However, due to the comparatively low TCE concentration in this well, it is believed that this is a relatively minor occurrence of TCE in the aquifer and probably originates from some extraneous source and not the tank itself. The same reasoning applies to a TCE concentration of 3.46 ppb detected in GW-8 during the July 1991 sampling round.

One of the primary objectives of the confirmatory investigation conducted in June 1992 was to determine the potential for VOCs detected in the area of monitoring well MW-9 to migrate beyond the western site boundary. Constraints to this investigation included a limited distance within which additional wells could be placed downgradient of MW-9 and still be located on-site, and the presence of overhead power lines which effected positioning of the drilling rig.

There was sufficient space to install only a single monitoring well approximately 25 feet downgradient (southwest) of MW-9. It was decided that the well screen in MW-14 should be installed to bedrock, in the basal portion of the aquifer at a depth of 25-35 feet below grade. MW-14 would then complement MW-9 as the deeper component of a two well couplet, rather than producing redundant data as a well screened at water table depth. An upward component of ground water flow was anticipated at this location, where the aquifer discharges to the Delaware River approximately 900 feet to the south. The "deep" well screen in MW-14 was positioned to evaluate the possible occurrence of dense non-aqueous phase liquids (DNAPLS), as a separate phase of the chlorinated hydrocarbons detected in MW-9. However, neither DNAPLS, nor dissolved chlorinated solvents were detected in MW-14.

The presence of a negative vertical gradient indicative of head loss in an upward direction in the aquifer was confirmed following the installation of MW-14, and the acquisition of water level measurements in this well and in MW-9. It is also notable that both wells penetrated silts and clays in the uppermost portion of the aquifer, providing evidence of significant aquifer anistropy. Ground water flowpaths are therefore expected to be shallow. VOC contamination originating in the vicinity of MW-9 and travelling with advective (bulk) ground water flow would most likely follow a westerly path and track above the well screen in MW-14.

Despite the difficulties in predicting the likelihood of off-site VOC migration discussed above, soil samples taken at the soil-water interface in MW-14 seem to corroborate a projected path towards the western site boundary for the PCE and TCE concentrations observed in MW-9. Table 4-10 shows some degree of correlation between PCE and TCE concentrations detected in soil samples taken at water table depths in wells MW-9 and MW-14. Ground water flowpaths from Figure 4-1 also indicate that a west-southwesterly direction of transport is the most probable interpretation.

Ground water velocities in the immediate vicinity of MW-9 are probably less than 0.1 feet per day, according to slug test data. However, there is more than an order of magnitude increase in measured hydraulic conductivity within a distance of less than 250 feet to the south, where MW-4 is located. Ground water velocities of up to 0.3 feet per day could have an accelerating effect on VOC transport, if any of the detected compounds enter this area of higher aquifer hydraulic conductivity. The presence of vinyl chloride (the last compound in the chain of PCE degradation products), at significant concentrations in MW-9 ground water samples suggests that the release may have occurred early enough to have moved appreciable distance in a southwesterly direction towards the site boundary in that area. Existing water quality data does not permit a complete assessment of the off-site extent of contamination, if any exists.

Metal concentrations in site ground water samples appear to be limited to suspended matter as indicated by the detection of most metal cations only in unfiltered samples. With few exceptions, iron and manganese are the only metals which were detected in filtered samples, and these metal concentrations are common to this highly industrialized section of the greater Philadelphia metropolitan area. Suspended metals are not a significant concern in ground water risk assessments, since they do not migrate appreciable distances in the aquifer and can be filtered out or treated for process water usages, such as might occur in an industrial zoned area.

The potential for future use of groundwater at the site for drinking purposes is severely limited by the poor overall quality of the aquifer (i.e., high suspended metals, etc.) in the area of the site. Any use of ground water would require softening and filtration, at a minimum, and wells would likely produce below a level necessary to provide adequate drinking water volumes. Also, with a readily available public supply, the need to tap a questionable ground water source is remote.

SECTION 7.0

REMEDIAL ALTERNATIVES

Information collected during the Environmental Investigation has revealed a number of areas of concern where remedial action is recommended to eliminate potential threats to human health and the environment. The primary concerns are presented by the presence of VOCs in groundwater in the area of the abandoned UST, elevated metals concentrations in surface soils, organic and inorganic compounds in stormdrain sediments, and asbestos materials in facility buildings. PCB transformers at the site also warrant a response in order to bring the units into compliance with TSCA requirements.

The Phase II Report for the Tacony Warehouse presents a thorough evaluation of the remedial alternatives applicable for the areas of concern identified in the Phase I Report. Potential remedial actions that may be considered are various pump and treat scenarios for ground water, retrofilling of transformers, asbestos removal and disposal, excavation and disposal of contaminated surface soils, and sediment removal and engineering study of the facility's storm sewer system. These alternatives represent a few of the possible remedial measures that are evaluated for feasibility in the Phase II Report.

SECTION 8.0

BASELINE RISK ASSESSMENT

This chapter presents the baseline evaluations of risks to humans and the environment posed by site-related chemicals on and potentially migrating from the Tacony Warehouse site. The objectives of a risk assessment are to describe current or future potential risks to public health and/or the environment as a consequence of an uncontrolled releases of chemicals from the site. The primary purpose of this risk assessment is to aid in the development of remedial alternatives by identifying all site-related risks that need to be eliminated or reduced.

The risks associated with exposures to chemicals of potential concern identified at the Tacony Warehouse site were evaluated using the available monitoring data presented in Section 4 of this report. The potential adverse human health and environmental effects (current and future) were determined based on existing site conditions.

8.1 SCOPE OF RISK ASSESSMENT

As indicated in RAGS (EPA 1989a), there are four steps involved in conducting an EPA Superfund baseline human health risk assessment: data collection and evaluation, exposure assessment, toxicity assessment, and risk characterization. Each step is briefly described below.

Data collection and evaluation involve gathering and evaluating site data relevant to human health and identifying those substances present at the site that should be the focus of the risk assessment process (i.e., chemicals of potential concern).

An exposure assessment is conducted to estimate the magnitudes of actual and/or potential human exposures, the frequencies and durations of these exposures, and the pathways by which humans may be exposed. In the exposure assessment, reasonable maximum estimates of exposure are developed for both current and, if applicable, future land-use assumptions. Current exposure estimates are used to determine whether one or more threats exist based on existing exposure conditions at the site. Future exposure estimates are used to provide decision-makers with an understanding of potential future exposures and qualitative estimates of the likelihood of such exposures occurring. Conducting an exposure assessment involves analyzing chemical releases; identifying exposed populations; estimating exposure point concentrations for specific pathways, based both on environmental monitoring data and predictive chemical modeling results; and estimating chemical intakes for specific pathways. The results of an exposure assessment are pathway-specific intakes for current and future exposures to individual substances.

A toxicity assessment considers: (1) the types of adverse health effects associated with chemical exposures; (2) the relationships between magnitudes of exposures and potential adverse effects; and (3) related uncertainties such as the weight of evidence of a particular chemical's carcinogenicity in humans. Toxicity assessments for chemicals found at Superfund sites are generally accomplished in two steps. The first step, hazard identification, is the process of determining whether exposure to an agent can cause an increase in the incidence of an adverse health effect (e.g., cancer, birth defects). Hazard identification also involves characterizing the nature and strength of the evidence of causation. The second step, dose-response evaluation, is the process of quantitatively evaluating the toxicity information and characterizing the relationships between the doses of the chemicals administered or received and the incidence of adverse health effects in the exposed population. From those quantitative dose-response relationships, toxicity values are derived that can be used to estimate the incidence of adverse effects occurring in humans at different exposure levels. Typically, Superfund site risk assessments rely heavily on existing toxicity values (e.g., RfDs) developed for specific chemicals by EPA.

Risk characterization summarizes and combines outputs of the exposure and toxicity assessments to characterize baseline risks, both in quantitative expressions and qualitative statements. During risk characterization, chemical-specific toxicity information is compared against both measured chemical exposure levels, if applicable, and those levels predicted through fate and transport modeling to determine whether current or future levels at or near the site may be of potential concern.

Possible receptors for site contaminants and potential exposure pathways were identified using local demographic and land use data, as well as site observations. Exposure point concentrations were obtained from site data or estimated through computer modeling of pathways where human receptors were identified. Potential risks to receptors were estimated and quantified by comparing the estimated exposure levels to reference levels and slope factors. The Risk Assessment Guidance for Superfund (RAGS [EPA, 1989a]), the Exposure Factors Handbook (EPA, 1989b), and the Superfund Exposure Assessment Manual (SEAM, [EPA, 1988]) were used as guidance in formulating this risk assessment.

8.2 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

8.2.1 Data Collection

Data for the baseline risk assessment were collected in three phases during the environmental investigation. The field investigations were designed to characterize the sources of chemicals of potential concern at the site with respect to known or suspected releases to the environment. The identified source of chemicals of potential concern were underground storage tanks (USTs), aboveground storage tanks (ASTs), the former spray pond, oil/water separators, stormwater drains, transformer substations, railroad beds, a former fill area, and the warehouse buildings. Specific media of concern were the site surface and subsurface soils, ground water aquifers beneath the site, and site runoff that may discharge to nearby surface water bodies.

Risks from asbestos in the site buildings, transformers on the property, or localized spills on building surfaces were not evaluated in the risk assessment. These areas are discussed in the alternatives analysis section of this report. Current plans are to remediate these areas and eliminate any further potential risk to current or future on-site personnel.

8.2.2 Data Evaluation

Sample analyses for the Environmental Investigation were performed by A.D. Little and Versar, Inc., in accordance with the USAEC (formerly USATHAMA) Quality Assurance (QA) Program protocols. The analytical results are presented in Appendices E through K of the EI and are summarized in this chapter where appropriate. Averages, frequencies of detection, and maxima and minima values were determined. Duplicate analyses were averaged to avoid weighing one site location more than another. The 95% UCLs of the arithmetic means were calculated using the following formula:

$$95\%\ \text{UCL} = \overline{X} + t_{\substack{\alpha = 0.05 \\ df = n - 1}} \times \frac{\text{st dev}}{\sqrt{n}}$$

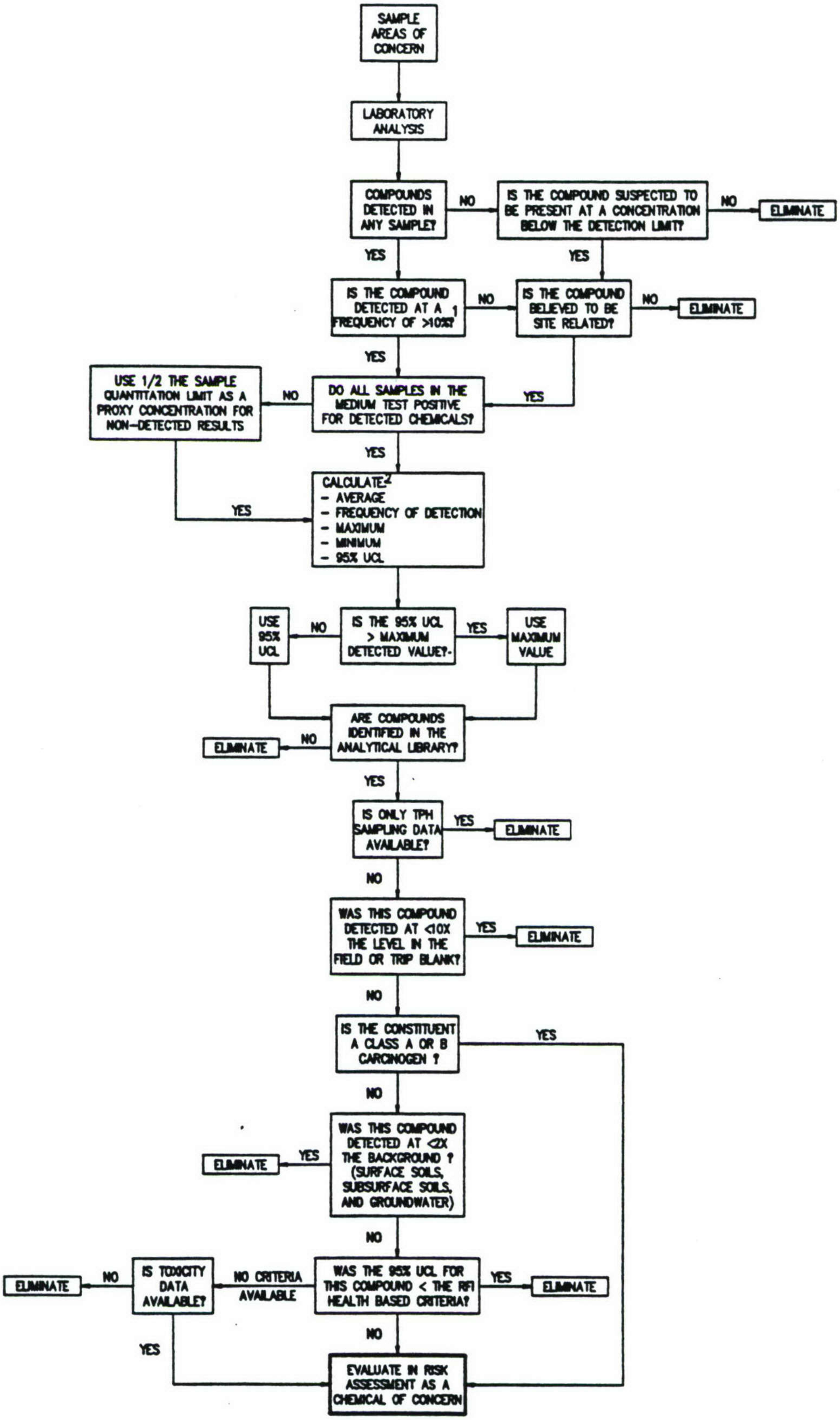
If the 95% UCL of a chemical was greater than that chemical's maximum detected value, the maximum detected value was used as representing the reasonable maximum exposure estimate for that chemical.

The limitations and uncertainties associated with the analytical results were evaluated as part of the data reporting requirements of the laboratory. Only data that have undergone the validation protocols according to the guidelines established within the USAEC QA Program were used in the risk assessment. Background samples for soil and ground water were examined to identify naturally occurring levels of chemicals and representative ambient concentrations resulting from off-site sources. Qualifiers attached to data by the laboratories as well as the results of all field and laboratory blank samples were considered.

This risk assessment focused on the chemicals that pose the most significant threats to human health. Chemicals of potential concern (COPC) were chosen based on their intrinsic toxicities and their concentrations found in site media. The methods for evaluating COPC used in the selection process are found in RAGS Volume 1: Human Health Evaluation Manual (HHEM). Figure 8-0 presents a flowchart that shows the process by which COPC were selected.

The following criteria were used to develop a data set for use in the quantitative risk assessments:

- If a chemical was not detected in any sample in a medium, that chemical was eliminated from the data set for that medium, unless it was believed that the chemical may have been present at concentrations below its analytical detection limit.
- If a chemical was detected at least once in a given medium, it was identified as a chemical of potential concern; however, if the chemical was not detected at a frequency greater than 10 percent, it



[1] THIS CRITERIA WAS NOT APPLIED TO SURFACE SOILS WHERE ONLY FOUR SAMPLES WERE COLLECTED.
[2] DUPLICATE ANALYSES WERE AVERAGED TO AVOID WEIGHTED RESULTS.

FIG. 8-0 CHEMICAL OF CONCERN SELECTION FLOWCHART (FOR HUMAN HEALTH EXPOSURE PATHWAYS) was eliminated from consideration as a COPC. The criteria were applied to chemicals detected infrequently in any one medium and not detected in other media at high concentrations if the chemicals were not believed to be site-related (RAGS, 1989). This criterion was not applied to surface soils where only four samples were collected.

- If at least one sample in a medium tested positive for a given chemical, then one-half of the sample quantitation limit was used as a proxy concentration for the non-detected results for calculating average and 95 percent UCL concentrations. This was done to account for the possibility that the same chemicals may have been present in the sample at levels below their detection limits.

- Compounds that could not be identified in the analytical library were not retained as chemicals of concern because a toxicological assessment cannot be conducted on unknown chemicals.

- Total petroleum hydrocarbons (TPH) were not retained for evaluation in the risk assessment. Individual components normally associated with hydrocarbons (e.g., PAHs) were retained, as appropriate.

- Common laboratory chemicals (e.g., acetone, bis(2-ethylhexyl) phthalate, methylene chloride) were eliminated from considerations as COPC if detected at less than ten times the levels detected in their method, field, or trip blanks (EPA, 1989a).

- The intent of the risk assessment was to characterize the risks associated with the most important chemicals; therefore, it was appropriate to eliminate those chemicals that did not expect to contribute a significant portion of the risk. To determine the chemicals that did not contribute significant risk, 95% UCL concentrations were compared to published health-based criteria. Since GPA class A and B carcinogens were anticipated to contribute to site risk even below health-based criteria, all were retained.

- Site activities were not well defined; therefore, it was not possible to select chemicals of potential concern based on expected substances at the site. To determine what was site related for surface soil, subsurface soil, and groundwater, chemical concentrations were compared with background sample results to establish whether a chemical was naturally occurring or the result of releases of substances at that site. Background samples were unavailable for surface water and sediment samples. The differences between site-related and background concentrations were evaluated by comparing observed levels of chemicals of potential concern at the site with background concentrations of the same environmental media. If the results of site monitoring were less than two orders of magnitude above background, statistical analysis of the data would determine whether site chemical results were significantly different from the mean concentration of the chemical at background locations (EPA, 1992d). Only one background sample was available for both surface and subsurface soils, and two background samples were available for groundwater. Because of the few available background samples, an alternative method was used to compare site concentrations with background results. The final rule for the EPA's Hazard Ranking System (Federal Register Vol. 55, No. 24, December 14, 1990) established criteria for an observed release. A released sample was assumed when a sample measurement equaled or exceeded the sample quantitation limit (SQL) and was at least three times above the background level, and available information attributed some portion of the release of the substance to the site. To be more conservative, concentrations for individual chemicals greater than two times the mean background levels in a medium were retained for further review. This criterion was applied only when a chemical was detected in background samples.

- EPA weight of evidence class C carcinogens and non-carcinogens detected below health-based criteria were eliminated as chemicals of potential concern. Health-based criteria were obtained from the RCRA Facility Investigation (RFI) Guidance (EPA, 1989c). Chemicals without RFI health-based criteria were evaluated in the risk assessment if toxicity data were available.

The chemicals selected as COPC for quantitative risk evaluation based on data collection/evaluation, levels, and frequency of occurrence, and toxicity characteristics are discussed in the following subsections for each environmental medium of concern.

8.2.2.1 Surface Soils

Surface soil samples were collected from four locations along the railroad tracks at the site. One background surface soil sample was collected on site. Chemicals subjected to analyses included metals, polychlorinated biphenyls (PCBs), pesticides, and total petroleum hydrocarbons (TPH). A summary of surface soil sampling results can be found in Table 4-8 and sampling locations are shown in Figure 3-3. Analytical results for all detected chemicals in surface soils are found in Appendix O.

Aluminum, potassium, manganese, mercury, iron, sodium, thallium, and vanadium were eliminated from consideration because they were detected at levels below two times their background mean concentrations. Barium, nickel, silver, and beta-endosulfan were below health-based criteria as listed in the RFI Guidance (EPA, 1989c) and therefore were eliminated.

The chemicals of potential concern identified in the surface soils along the railroad tracks are listed in Table 8-1, along with their frequencies of detection and ranges of concentrations. Sixteen chemicals were retained after eliminating those chemicals that were found at concentrations below two times background concentrations or below health-based criteria. All of these sixteen chemicals were considered chemicals of potential concern.

8.2.2.2 Subsurface Soils

Twenty-seven borings were installed in conjunction with ground water monitoring well installations. One soil boring sample (SB-2) was collected during installation of the background wells and was used as background for subsurface soils. Borings were analyzed for volatile organic compounds, semivolatile organic compounds, target analyte list (chemicals) metals, pesticides, PCBs and TPHs. A summary of subsurface soil sampling results is found in Section 4 of the Environmental Investigation (EI). Boring locations are shown on Figure 3-4 of the EI. Analytical results are found in Appendix O.

Subsurface soil sampling results were evaluated according to the following criteria. Benzene, 1,4-dichlorobenzene, trans-1,2-dichloroethene, carbon disulfide, methyl isobutyl ketone, acenaphthylene, dibenz[a,h]anthracene, fluorene, naphthalene, and butyl benzyl phthalate were eliminated from consideration because they were detected at frequencies of less than 10 percent, and were not detected in other media. In addition, based on the history of the site, these chemicals were not believed to be site-related. Chemicals found at 95% UCL concentrations to be less than two times representative background concentrations were also eliminated. Iron and potassium were eliminated because on-site concentrations were below two times their background levels. Silver, beta-endosulfan, endrin ketone, bis-2-ethylhexyl phthalate, trans-1,2-dichloroethene, and methylene chloride were eliminated because they were detected at levels below health-based criteria published in the RFI Guidance (EPA, 1989c). Several polycyclic aromatic hydrocarbon (PAH) compounds (acenaphthene, anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, benzo(g,h,i)pyrene, benzo(k)fluoranthene, chrysene, dibenzofuran, fluoranthene, fluorene,

Table 8-1
Chemicals of Potential Concern in the Railroad Track Surface Soils

Chemical	Frequency of Detection[a]	Average Concentration (mg/kg)	Range of Detected Concentrations (mg/kg)	95% UCL (mg/kg)
METALS				
Arsenic	4/4	104.55	75.9-135	139
Barium	4/4	156	74-240	250
Beryllium	4/4	0.67	0.303-1.18	1.17
Cadmium	1/4	0.752	0.424	2.24
Calcium	4/4	9,280	2,200-28,000	26,500
Copper	4/4	167.5	79.0-280	282
Chromium	4/4	49.2	16.5-110	107
Lead	4/4	345	103-574	679
Magnesium	4/4	4,430	1,700-11,000	10,500
Zinc	2/4	188	120-190	400
PESTICIDES/PCB COMPOUNDS				
Aldrin	1/4	0.00865	0.0225	0.0214
beta-BHC	1/4	0.0147	0.0543	0.0511
Endrin aldehyde	4/4	0.0486	0.0450-0.0522	0.0526
gamma-chlordane	1/4	0.0042	0.0111	0.0105
PCB 1260	4/4	0.311	0.232-0.466	0.458
DDT	4/4	0.0249	0.0169-0.0299	0.0328

[a] Number of samples in which the chemical was positively detected over the number of samples analyzed.

indeno(1,2,3-c,d) pyrene, phenanthrene, and pyrene) and 2-methyl naphthalene were detected exclusively in the soil borings downgradient of the former spray pond and were evaluated for that area only. Samples evaluated for the spray pond area include SB-17, SB-16, SB-10, SB-11, SB-12, SB-13, SB-14 and SB-22. Chemicals of potential concern selected for the subsurface soils over the entire site and the spray pond area are listed in Tables 8-2 and 8-3, respectively.

8.2.2.3 Ground water

Ground water samples from 14 wells screened in the upper aquifer were collected and analyzed. Two of the 14 on-site wells, MW-1 and MW-2, were used as sources of background samples because they were located upgradient of the area of concern. Chemical analyses of ground water samples included total and dissolved metals, volatile organic compounds, semivolatile organic compounds (SVOCs), pesticides, and TPH. A summary of ground water sampling results can be found in Section 4 of the EI, and well locations are shown on Figure 3-7 of the EI.

The ground water sampling results were evaluated according to the aforementioned criteria. Dissolved metals were not considered because total metal values were presumed to be higher. Also, it could not be assumed that any ground water treatment, including filtering, prior to residential use. Data evaluation tables are found in Appendix O. The chemicals of potential concern identified in the ground water, their frequencies, and ranges of detected concentrations are found in Table 8-4. Cyanide, cadmium, and chloroform were eliminated because they were detected at frequencies of less than 10 percent and were not selected as chemicals of potential concern in other media. Several metals (calcium, magnesium, nickel, and vanadium) were eliminated as chemicals of potential concern because they were detected at levels consistent with background concentrations. Acetone was below health-based criteria and was eliminated. Caprolactam was detected in on-site and upgradient wells at approximately the same concentrations (i.e., differ by less than a factor of 2); therefore, caprolactam was not retained for further consideration.

Table 8-2
Non-PAH Chemicals of Potential Concern in the Subsurface Soil (Entire Site)

Chemical	Frequency of Detection[a]	Average Concentration (mg/kg)	Range of Detected Concentrations (mg/kg)	95% UCL (mg/kg)
METALS				
Aluminum	26/26	14,700	3,600-59,400	19,200
Arsenic	25/26	5.42	1.33-13.0	6.57
Beryllium	18/26	0.186	0.078-0.39	0.23
Calcium	25/26	3,280	104-26,000	5,540
Chromium	22/26	17.1	5.77-52.3	21.8
Copper	23/26	10.1	3.35-21.5	12.3
Lead	23/26	0.304	2.14-337	57
Magnesium	25/26	2,870	630-9,300	3,640
Manganese	25/26	227	73-540	277
Mercury	11/26	0.0448	0.00359-0.179	0.0627
Sodium	16/26	81.4	64.9-260	103
Thallium	18/26	113	33.7-290	152
Vanadium	25/26	21.5	4.3-63.8	27.1
Zinc	16/26	37.6	12.6-190	52
VOLATILES				
Acetone	6/26	1.05	0.0126-5	1.89
cis-1,2-Dichloroethene	3/3	0.194	0.00334-0.361	0.702
Tetrachloroethene	5/26	0.015	0.0279-0.172	0.0321
Trichloroethene	4/26	0.00258	0.00379-0.0107	0.00341
PESTICIDES				
DDT	5/5	0.126	0.0233-0.283	0.294

[a] Number of samples in which the chemical was positively detected over the number of samples analyzed.

Table 8-3
PAH Chemicals of Potential Concern in the Subsurface Soils (Spray Pond Area)

Chemical	Frequency of Detection[a]	Average (mg/kg)	Range of Detected Concentrations (mg/kg)	95% UCL (mg/kg)
2-Methyl Naphthalene	5/11	2.16	0.33-8.34	3.98
Acenaphthene	3/11	1.90	0.765-17.1	4.08
Anthracene	3/11	4.99	1.12-37.1	12.1
Benzo(a)anthracene	7/11	5.8	0.542-32.3	12
Benzo(b)fluoranthene	6/11	4.21	0.353-26.1	9.14
Benzo[a]pyrene	6/11	7.88	0.461-56.2	18.5
Benzo(g,h,i)pyrene	5/11	3.13	0.391-22.3	7.32
Benzo(k)fluoranthene	5/11	7.19	2.16-48.4	16.3
Chrysene	6/11	6.42	1.34-34.8	13
Dibenzofuran	2/11	1.27	1.32-7.79	2.71
Fluoranthene	6/11	14.5	1.92-92.4	31.9
Fluorene	2/11	1.99	4.68-13.3	4.54
Indeno(1,2,3-cd)pyrene	5/11	2.04	0.239-13.4	4.54
Phenananthrene	7/11	21.9	1.33-172	54.3
Pyrene	7/11	16	1.13-89.9	33.3

Table 8-4
Chemicals of Potential Concern in the Ground Water (Entire Site)

Chemical	Frequency of Detection(a)	Site Mean (µg/L)	Range of Detected Concentrations (µg/L)	95% UCL (µg/L)
TOTAL METALS				
Aluminum	16/16	15,200	160-56,000	25,600
Arsenic	11/16	9.55	3.79-29	15.0
Barium	16/16	219	25.2-670	325
Beryllium	5/16	0.901	0.553-3.21	1.48
Chromium	13/16	31.5	4.91-107	48.3
Copper	13/16	33	5.11-130	54.7
Iron	16/16	42,200	1,200-170,000	70,100
Lead	11/16	33.4	2.17-240	67.4
Manganese	16/16	2,130	105-5,300	2,980
Potassium	16/16	16,200	1,970-140,000	36,800
Silver	2/16	0.190	0.33-0.369	0.237
Sodium	12/16	18,600	9,300-11,000	33,200
Thallium	4/16	390	199-946	534
Zinc	12/16	100	51.9-370	165
VOLATILE ORGANIC COMPOUNDS				
1,1-Dichloroethene	3/16	4.93	1.38-1.88	7.11
1,1-Dichloroethane	2/16	3.86	0.7-80	9.75
trans-1,2-Dichloroethene	2/16	3.17	60.4-67.3	7.83
cis-1,2-Dichloroethene	4/10	141	10-2,000	418
Methylene Chloride	10/16	5.07	5.88-7.25	6.10
Trichloroethene	5/16	26.7	7.74-220	55.1
Tetrachloroethene	4/16	231	0.65-4,900	640
Vinyl Chloride	3/16	119	826-2,000	327
PESTICIDES				
alpha-BHC	4/8	0.133	0.0133-0.0645	0.0231
DDT	8/8	0.216	0.13-0.265	0.261

[a] Number of samples in which the chemical was positively detected over the numbr of samples available.

Concentrations of volatile organic chemicals were several orders of magnitude higher at MW-9 than in the other wells and, as a result, this well was evaluated separately as a "hot spot" (Table 8-5). Because MW-9 was sampled twice, the maximum detected values of all chemicals found in these samples were used to represent a reasonable maximum exposure.

8.2.2.4 Surface Water

Twelve water samples from storm drains, AST retention basins, basement sumps, and oil/water separators potentially discharging to the site surface water drainage network were collected and analyzed for volatile organic chemicals, semi-volatile organic chemicals, pesticides, and total metals. A summary of these water sampling results is found in Section 4 of the EI, and sampling locations are shown on Figure 3-6 of the EI. Analytical results are found in Appendix O.

The water sampling results were evaluated according to previously identified selection criteria. Since background surface water samples were not collected, no background comparisons could be made. Additionally, because of the relative inaccessibility of the underground surface water drainage network, primary receptors would be ecological rather than human. Therefore, human health criteria were not used to eliminate chemicals found in surface waters. The chemicals of concern identified in the surface waters are found in Table 8-6 along with their frequencies of detection and ranges of detected concentrations. Methylene chloride, acetone, and butyl benzyl phthalate are common laboratory contaminants, and were detected in samples at concentrations less than 10 times the levels detected in the blanks. Consequently, these chemicals were not retained for further evaluation. Chloromethane was found in a blank sample at a concentration five times greater than the concentrations found in monitored samples and was, therefore, eliminated as a chemical of potential concern. 2-Butoxyethanol was tentatively identified in only one sample as were 1,1,2,2-tetrachloroethane and methyl ethyl ketone. These chemicals were also eliminated as potential chemicals of concern. Chloroform and di-n-butyl phthalate were detected at frequencies less than ten percent and were not detected in other media. They were also eliminated from further consideration. Data evaluation tables are found in Appendix O.

Table 8-5
VOC Chemicals of Potential Concern in Ground Water (MW-9 Only)

Chemical	Frequency of Detection[a]	Range of Detected Concentrations (µg/L)	Maximum
1,1-Dichloroethane	2/3	0.7-80	80
1,1-Dichloroethene	3/3	1.4-1.88	1.88
1,2-Dichloroethene	2/3	60-67	67
cis-1,2-Dichloroethene	3/3	200-2,000	2,000
Trichloroethene	3/3	189-200	200
Tetrachloroethene	3/3	2,000-4,000	4,000
Vinyl Chloride	3/3	826-2,000	2,000

[a] Number of samples in which the chemical was positively detected over the number of samples available.

Table 8-6
Chemicals of Potential Concern Detected in the Storm Sewer Surface Water

Chemical	Frequency of Detection (a)	Average Concentration (µg/L)	95% UCL (µg/L)	Range of Detected Concentrations (µg/L)
METALS				
Aluminum	11/12	21,600	65,400	129-250,000
Arsenic	6/12	29.3	83.7	3.69-313
Barium	12/12	386	1,000	27.2-3,600
Beryllium	4/12	2.91	8.49	0.427-32.7
Cadmium	3/12	63.7	193	2.67-740
Calcium	12/12	91,300	191,000	13,000-600,000
Chromium	12/12	196	561	6.68-2,100
Copper	12/12	2,200	6,560	6.34-25,000
Iron	12/12	3,330,000	4,830,000	1,200-5,000,000
Lead	11/12	2,360	6,720	28.1-25,100
Magnesium	12/12	36,100	94,400	2,500-340,000
Manganese	12/12	1,330	3,080	14.4-10,000
Mercury	2/12	0.544	0.978	0.566-2.72
Nickel	9/12	239	710	11.4-2,700
Potassium	12/12	10,100	16,600	1,320-41,000
Silver	3/12	2.08	6.07	0.32-23
Sodium	6/12	5,700	10,500	2,450-23,000
Thallium	2/12	368	988	244-3,600
Vanadium	9/12	129	372	6.73-1,400
Zinc	12/12	6,440	19,000	44.3-72,000

[a] Number of samples in which the chemical was positively detected over the number of samples available.

8.2.2.5 Sediments

Sediment samples were also collected at the surface water sample locations and analyzed for volatile organic chemicals, semi-volatile organic chemicals, pesticides, PCBs, and metals. Sediment sampling results are summarized Section 4 of the EI, and sampling locations are shown on Figure 3-6 of the EI. Analytical results are found in Appendix O.

Analytical results of sediments were evaluated in accordance with previously identified criteria. The chemicals of potential concern for the storm sewer surface sediments are found in Table 8-7, along with the frequencies ranges of detected concentrations. Background locations were unavailable for sediment sampling. Additionally, because of the inaccessibility of the underground surface water drainage network, humans are not expected to be exposed to sediments at this site. Several volatile and semivolatile organic compounds (benzene, carbon disulfide, chlorobenzene, ethylbenzene, methyl ethyl ketone, toluene, 1,2-dichlorobenzene, 1,3-dichlorobenzene 1,2-dimethylbenzene, 1,3-dimethylbenzene, benzyl alcohol, heptachlor epoxide, dieldrin, chrysene, and delta-BHC) as well as selenium were each detected at frequencies of 10 percent or less (i.e., detected in one sample). These compounds were not considered to be site-related since they were not detected in other site media. Consequently, these were not retained for further evaluation in this risk assessment. Hexadecanoic acid was eliminated because it was tentatively identified in only two samples and was detected in the laboratory method blank. Barium, calcium, iron, and magnesium were eliminated from consideration because of the levels detected in the laboratory method blanks. Dimethylnaphthalenes, trimethylnapthalenes, 2-butoxyphenol, and octane were also eliminated because these compounds were only tentatively identified.

8.2.3 Summary of Chemicals of Potential Concern

Chemicals found in the surface soils along the railroad tracks consisted of pesticides and metals. Metals were evenly distributed among the four samples, with the exception of cadmium and thallium, which were detected in only one sample. Endrin aldehyde, PCB-1260, and DDT were detected in all four

Table 8-7
Chemicals of Potential Concern Detected in the Storm Sewer Surface Sediments

Chemical	Frequency of Detection (a)	Site Mean (mg/kg)	95% UCL (mg/kg)	Range of Detected Concentrations (mg/kg)
METALS				
Arsenic	10/10	32.1	41.8	4.21-91.7
Aluminum	10/10	11,100	13,300	3,900-19,000
Beryllium	6/10	1.16	1.56	0.961-3.8
Cadmium	2/10	5.11	7.63	10.3-10.8
Chromium	9/10	351	480	18.7-1,100
Copper	10/10	686	848	55.0-1,700
Lead	9/10	1,850	2,490	717-5,150
Manganese	10/10	463	593	120-1,100
Mercury	7/10	0.708	1.03	0.160-1.35(b)
Nickel	7/10	63.2	79.3	6.43-110
Potassium	10/10	2,130	2,440	830-3,300
Silver	9/10	1.18	1.53	0.335-2.88
Sodium	4/10	505	787	143-801
Thallium	7/10	277	409	31.7-1,000
Vanadium	9/10	97	125	23.8-290
Zinc	6/10	1,320	1,720	270-3,300
VOLATILE ORGANIC COMPOUNDS				
Acetone	4/10	3.07	3.99	0.0197-0.576
1,4-Dichlorobenzene	2/10	0.00282	0.00519	0.0036-0.0209
SEMI-VOLATILE ORGANIC COMPOUNDS				
Bis (2-ethylhexyl)phthalate	9/10	35.6	59.4	6.04-217
Butylbenzyl phthalate	3/10	12.7	21	14.6-65.2
Benzo(a)anthracene	2/10	1.37	1.94	4.16-4.42
Benzo(g,h,i)perylene	2/10	0.983	1.36	2.79-2.96
Di-n-butyl phthalate	3/10	20.1	37.9	4.13-153
Fluoranthene	2/10	3.06	4.62	8.83-12.9
Phenanthrene	4/10	3.61	5.09	4.99-11.3
Pyrene	6/10	7.99	10.6	6.38-19.0
gamma-Chlordane	1/1	0.391	NA	0.391
Isodrin	1/1	0.292	NA	0.292(c)
PCB 1260	1/2	22.2	243	44.4

[a] Number of samples in which the chemical was positively detected over the number of samples available.
[b] Two samples (SD-2 and SD-11) contained mercury at concentrations reported to be greater than 0.5 mg/kg.
[c] The reported concentration was greater than 0.100 mg/kg.
NA = Not applicable.

soil samples, and beta-BHC, aldrin, beta-endosulfan, and gamma-chlordane were detected in one sample. Subsurface soils were evaluated for the entire site and for the former spray pond. For the entire site, COPCs consisted of metals, pesticides, and VOCs. For the former spray pond, PAHs were the COPCs.

The concentrations of total metals detected in ground water samples collected from the twelve on-site monitoring wells were elevated when compared to background concentrations as represented by two upgradient wells. Except for monitoring well No. 3, which had elevated levels, the metals concentrations were evenly distributed in the monitoring wells. Several volatile organic chemicals were detected in monitoring wells 4, 5, 8, 9, 10, 11, 12, 14, and 15. The highest volatile organic chemical concentrations were detected in monitoring well 9, which was located directly downgradient from an underground storage tank. This well was evaluated as a separate source area for volatile organic chemicals.

Elevated concentrations of total metals were detected in the surface water samples from the underground surface water drainage network on the site. The metal concentrations were evenly distributed with the exception of surface water location No. 3, which exhibited the highest levels of all the metals. One volatile organic chemical (chloromethane) was detected in 7 of 12 locations, but was also detected in the field blank at comparable concentrations.

Elevated concentrations of total metals were detected in the sediment samples. The metals concentrations were evenly distributed with the exception of location SD-2. Location SD-2 contained the highest levels of cadmium, lead, mercury, and zinc. Mercury levels were reported by the USAEC contract lab to exceed 0.5 mg/kg in samples SD-2 and SD-11. Volatile organic chemicals were detected in samples SD-1 and SD-2. Semivolatile organic chemicals were detected in all samples except SD-9 and SD-10. Sample SD-5 was analyzed solely for pesticides and PCBs. Heptachlor in this sample was reported at a concentration greater than 0.1 mg/kg by the USAEC contract laboratory.

8.3 EXPOSURE AND RISK ASSESSMENT

8.3.1 Human Exposure Assessment

Exposure bridges the gap between a potential hazard (i.e., presence of a toxic chemical) and a risk. Exposures to chemicals may occur via inhalation, ingestion, or by dermal absorption routes. The objectives of an exposure assessment are to: (1) identify populations that may potentially be exposed to chemicals of concern; (2) identify the pathways by which such exposures may occur; and (3) quantify chemical intakes, or potential dose, based on the magnitudes, frequencies, and durations of these potential exposures. The exposure assessment thus provides pathway-specific intakes for current and future exposures to site-related chemicals of concern.

The following subsections address in detail the identification of potentially exposed populations (Section 8.3.1.1), the identification of pathways of exposure (Section 8.3.1.2), exposure point concentrations (Section 8.3.1.3), and the estimation of uptake for individuals pathways (Section 8.3.1.4).

8.3.1.1 Potentially Exposed Populations

The current and future receptors at this site were identified. Potential receptors were either eliminated or confirmed based on the presence or absence of a complete exposure pathway. A complete exposure pathway is one that consists of a source of a chemical, a complete migration pathway, and an exposure scenario. Of the potential receptor scenarios initially identified at the site, several consisted of incomplete exposure pathways and were, therefore, considered unlikely to occur.

The site consists of three buildings and is extensively paved. Over 96 percent of the site surface is paved. Site access is controlled by a 24-hour guard gate. Additionally, the site is encircled with cyclone fencing topped with barbed wire. However, some vandalism has occurred on the site as evidenced by graffiti on the building structures; therefore, trespassers are a potentially exposed population at the present time. Because of the difficulty accessing the site, it is assumed that all trespassers are adults. Another potentially exposed population at the present time comprises site workers.

There are warehouse workers who periodically load goods into and out of the warehouse, as well as the site guards. There are no drinking water wells on site, nor are there any located downgradient of the site. The public water supply is obtained from the Delaware River from an intake approximately 2 miles upgradient of the site and there are no plans for moving this intake closer to the site; therefore, residential ingestion of site ground water will not be evaluated for the present. Additionally, the ground water at the site is both tidally influenced and of poor drinking water quality. However, bare soil can be found by the railroad tracks and soil exposures can occur.

Land use within the immediate vicinity of the site comprises industrial warehouses, with residential dwellings located approximately ¼ mile to the east. A boat launch operated by the Pennsylvania Department of Environmental Protection is located immediately south of the site, separating the site from the Delaware River. The boat launch is heavily used on weekends, and recreational fishing activities have been observed there.

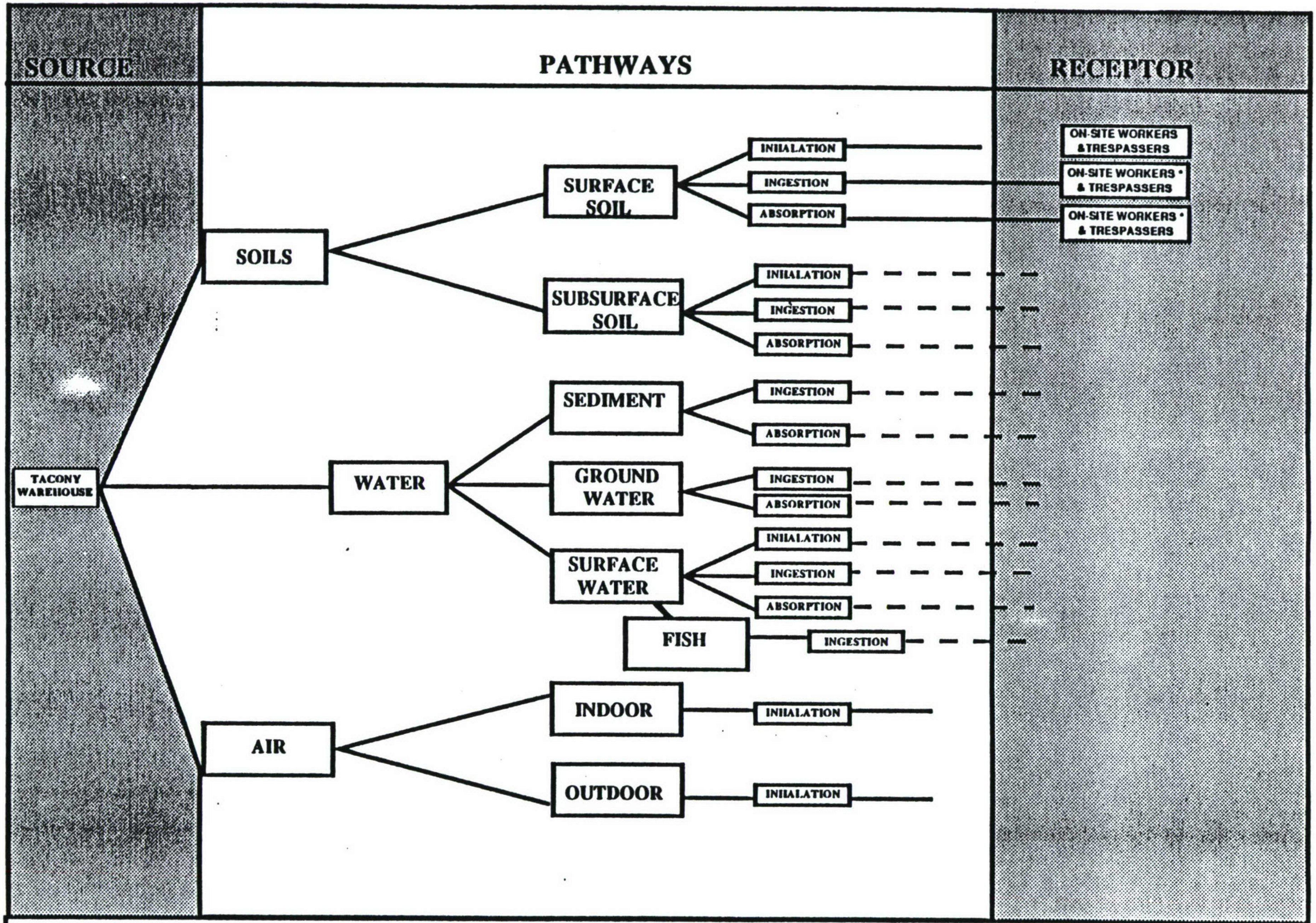
Current Potentially Exposed Populations

Current potentially exposed populations for this site include on-site workers and occasional trespassers (Figure 8-1). On-site workers consist of full-time adult employees whose activities are limited to guard duty or workers who periodically load goods into and out of an on-site warehouse.

Occasional trespassers are assumed to be young adults because of the restricted access to the site. Since there are no current residential or recreational facilities at this site, current exposure scenarios were not considered for these populations.

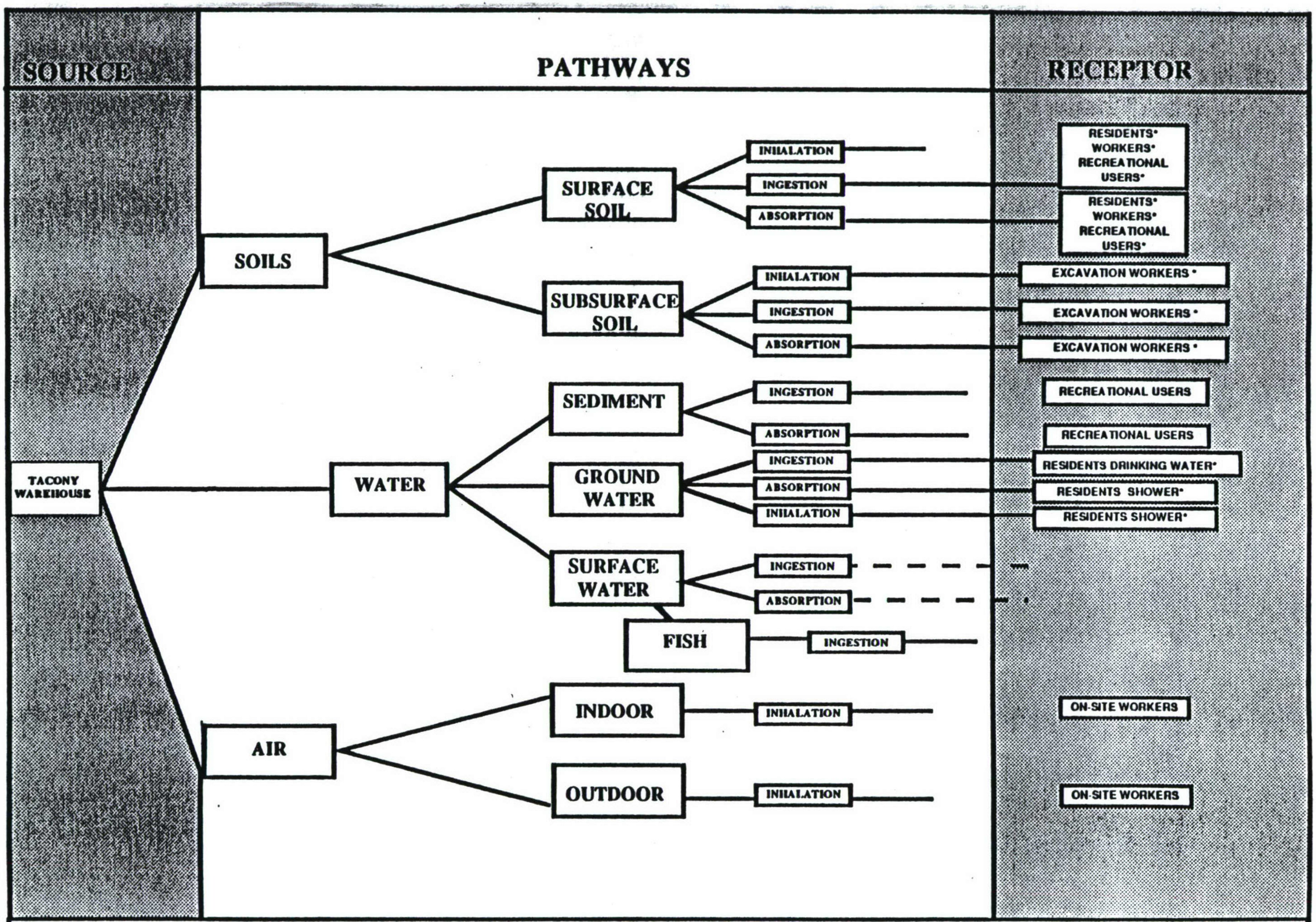
Future Potentially Exposed Populations

Once the site is decommissioned, the property may be used for either residential, commercial/industrial, or recreational purposes. Both adults and children could be exposed as future residents on the property, or as visitors to a park or recreational area that may be sited there. If the site is used as commercial/industrial property, only adults would be expected to be exposed as workers. Additionally, construction activities at the site may expose short-term construction workers to risks from subsurface soils at the site. Future potentially exposed populations are identified in Figure 8-2.



NOTES: INCOMPLETE EXPOSURE ROUTES ARE SHOWN BY DASHED LINES FOR INCOMPLETE PATHWAY.
ASTERISK (*) DENOTES EXPOSURE ROUTES THAT WERE EVALUATED FOR RISK.

FIGURE 8-1 EXPOSURE ROUTES (PRESENT) AT TACONY WAREHOUSE, PHILADELPHIA, PENNSYLVANIA



NOTES: INCOMPLETE EXPOSURE ROUTES ARE SHOWN BY DASHED LINES FOR INCOMPLETE PATHWAY.
INCOMPLETE LINES DENOTE UNASSESSABLE EXPOSURE ROUTES SINCE INSUFFIECIENT DATA IS AVAILABLE.
ASTERISK (*) DENOTES EXPOSURE ROUTES THAT WERE EVALUATED FOR RISK.

FIGURE 8-2 FUTURE EXPOSURE ROUTES AT TACONY WAREHOUSE, PHILADELPHIA, PENNSYLVANIA

8.3.1.2 Pathways of Exposures

Potential human exposure pathways for the Tacony Warehouse Site have been evaluated for current and potential future users of the site based on a no-action remediation option. A complete exposure pathway includes a chemical source/release, a retention or transport medium, an exposure point, and route of exposure. Figures 8-1 and 8-2 illustrate the current and future potential exposure routes at the Tacony Warehouse site, respectively. In these figures, complete and incomplete exposure routes are shown with solid and broken lines, respectively. Exposure routes that have been selected for evaluation for the risk assessment are marked with an asterisk. Appropriate receptors for this site include: current on-site workers and trespassers and future on-site workers, trespassers, recreational users, and residents.

Surface Soils (Current)

Potential direct contact with site-related chemicals in surface soils is currently limited to on-site workers or trespassers and is further restricted to the railroad tracks because most of the site (96% of the surface area) is paved. Potential exposure routes are via incidental ingestion and dermal absorption. Particulate inhalation is not considered a probable route of exposure because of the moistness of the surface soils and the extent of pavement. Off-site (residential) exposures are unlikely because the nearest residential areas are located ¼ mile east of the site, and access to the site is restricted. Site access to workers is limited to adults.

Surface Soils (Future)

After the Tacony Warehouse property is decommissioned, the site may be used as a residential, commercial/industrial park, or as a recreational area. Residential exposure to soil could occur via inadvertent ingestion and dermal absorption. Inhalation of soil particles and inhalation of chemicals that volatilize from the soil are not expected to be realistic concerns for two reasons. First, volatile organic chemical residues are not a concern in surface soils. Second, if residences are constructed on site, it is assumed that most of the residential surfaces will be either paved or covered with vegetation, so that fugitive dust will not be a concern. Both adults and children may be subject to the residential exposure scenarios. Commercial/industrial activities will potentially expose workers through inadvertent ingestion and dermal absorption of soils. Only adults are assumed to be exposed in an industrial/commercial setting. Recreational use of the site as an extension of the boat launch area could result in inadvertent soil ingestion and dermal absorption of chemicals from soils; both adults and children may be exposed under this scenario.

Subsurface Soils (Current)

Potential exposures to subsurface soils at the site are assumed to be extremely unlikely because there are no current or planned activities involving the excavation of subsurface soils.

Subsurface Soils (Future)

If future construction activities involving excavation occur on site, potential exposures to subsurface soils could occur. Construction workers would be expected to be exposed to subsurface soils via ingestion, inhalation, and dermal absorption. Construction workers are the only receptors considered for exposure to subsurface soils because it is highly unlikely that residential structures will be placed at soil levels 4 to 10 feet below current site elevations. Additionally, any exposures to trespassers would be less than the occupational exposure of construction workers.

Surface Water (Current)

Because there are no surface water bodies on site, the only potential exposures to surface water are to current recreational users of the Delaware River through inadvertent ingestion and dermal absorption of chemicals present in the Delaware River as a result of discharges from the onsite surface water drainage network.

A worst-case site discharge of surface water runoff would occur during a 100-year storm where 7.3 inches of rainfall would drain the site over a 24-hour period of time (Soil Conservation Service, 1992). Approximately 96 percent of the site is paved or covered with building structures. Assuming that all the rainfall drains off the site through the two culverts flowing into the Delaware River as surface runoff, the total volume of surface water from the site over a 24-hour period would be calculated by:

$$Q = P_t \times SA \times CF$$

Where:

Q = total flow (gallons/day)

P_t = total precipitation (feet/day): 0.61 (or 7.3 inches)

SA = surface area of the site (acres^2): 13 acres

CF = conversion factor 3.26E+05 gal/day per 1 acre-foot

Approximately 4 percent of the site is unpaved and available for soil erosion. Thus the maximum contaminated surface flow from the unpaved portion of the site during this storm event would be 1.03E + 05 gallons. This flow would be diluted approximately twenty-five fold by the runoff from the paved areas. The average daily flow in the Delaware River as reported by the USGS gauging station in Philadelphia is approximately 8.7 billion gallons per day (USGS, 1991). Thus the overall dilution factor would be at least one-hundred thousand fold. This dilution factor is conservative because the flow in the Delaware River would be greatly increased during a 100-year storm; therefore, it is not likely that the waters of the Delaware River would be impacted by site runoff.

Additionally, it is not likely that drinking water in the area can be impacted by any chemicals released from the site via surface water because the Delaware River downstream of the site is not used as a source of drinking water. The Baxter Water Treatment Plant and intake is located approximately 2 miles upstream; therefore, surface water exposure pathways will not be evaluated quantitatively for the site.

Surface Water (Future)

There were no future surface water scenarios considered for this risk assessment for the same reasons given for the current surface water scenarios.

Sediments (Current)

Due to the location of site sediments and their inaccessibility, it is highly unlikely that exposures would occur at the present time. The trap-like structure of the drains makes sediment movement to the Delaware River an unlikely occurrence.

Sediments (Future)

If the sediments remain in place, it is unlikely that, due to their inaccessibility, there will be any exposures to future site receptors. It is not likely that removal of the sediments for future remediations would involve dermal contact because the sediments would be removed by vacuuming. Even if contact were to occur, exposure times would be brief because vacuuming operations would take less than 1 hour at each site; therefore, future exposure scenarios for sediments were not considered quantitatively in this risk assessment.

Ground water (Current)

Human exposures to site ground water as a potable water supply is not a concern because there are no known current human receptors to this medium located within the vicinity of the Tacony Warehouse (R.F. Weston, 1989). The hydrogeological conditions of the site (i.e., situated adjacent to the Delaware River in a tidal zone) virtually eliminate the possibility of ground water receptors downgradient, thus precluding any potential exposure. Therefore, current exposure scenarios for residential populations from potable ground water at the site were not included in this risk assessment.

Although there is a potential release of on-site ground water to the Delaware River, it is expected to be negligible relative to the flow of the Delaware River. The United States Geological Survey (USGS) records flow data from various gauging stations on the Delaware River and data from the Tacony Bridge indicate that average daily flow in the Delaware River is approximately 8.7 billion gallons/day (USGS, 1991). Also, movement of ground water to the river is not a point source discharge. Therefore, ground water contribution from the site is expected to remain minimal, and risks to recreational users of the Delaware River from groundwater will not be evaluated quantitatively.

Ground water (Future)

Although highly unlikely, future residents, if any, on the former Tacony Warehouse site may install wells into the aquifer beneath the site. At the current time, there is no moratorium on private wells in the city of Philadelphia. If a potable water well was installed, this water would be used as the principal drinking water supply. In addition to assessing exposure via ingestion of water, inhalation of volatiles emitted during showering and dermal absorption during showering were assessed as exposure pathways. Both adult and child residents are assumed to be exposed in a residential scenario. Although it is unlikely that residents would use site ground water prior to it being filtered for removal of suspended solids and dissolved metals, use of unfiltered water was assumed in accordance with the guidance in RAGS.

Indoor Air (Current and Future)

The potentially exposed human population for indoor air quality concerns are limited to on-site workers in Buildings 462 and 467, where friable asbestos has been identified. Areas that contained nonfriable asbestos-containing materials do not pose any significant risk in their current condition. Risks from friable asbestos will not be included in the risk assessment. The alternatives analysis will contain provisions for removal of the asbestos, thus eliminating the risk.

Outdoor Air (Current and Future)

Outdoor air quality will not be addressed due to the absence of volatiles in the surface soils and the lack of an exposed residential setting at the present time.

Summary of Exposure Pathways for Quantitative Evaluation

The following ten potential exposure routes were chosen for evaluation based on the analytical data available and the potential exposure pathways for site contaminants.

1) Ingestion of chemicals from surface soils by current onsite personnel and trespassers;

2) Dermal absorption of contaminated surface soils by current onsite personnel and trespassers;

3) Ingestion of chemicals from surface soils by future residents, recreational, and commercial users;

4) Dermal absorption of contaminated surface soils by future residents, recreational, and commercial users;

5) Ingestion of contaminated subsurface soils by construction workers;

6) Inhalation of fugitive dusts generated from contaminated subsurface soils by construction workers;

7) Dermal absorption of chemicals from subsurface soils by construction workers;

8) Ingestion of ground water by future residents on the site;

9) Dermal contact with ground water by future residents on the site;

10) Inhalation of volatiles from the ground water while showering by future residents on the site.

8.3.1.3 Exposure Point Concentrations

The goal of the exposure assessment is the identification of the reasonable maximum exposure (RME) for each pathway, in order to estimate a conservative exposure scenario that is still within the range of possible exposures. Monitoring data were available for site surface soils, sediments, and surface water. Exposure point concentrations of the chemicals of potential concern have been quantitatively estimated for these media.

Reasonable maximum exposures for the site were estimated using the 95% UCL on the arithmetic mean of the concentrations detected in each media, in accordance with EPA (1989a). Constant concentration over time was assumed, with no consideration of source depletion. This is considered to be a very conservative assumption in that most of the organic chemicals associated with the site degrade over time. It was also assumed that no ground water treatment of any kind would take place, including filtering. Variables used for human intake calculations are presented in Table 8-8.

8.3.1.4 Estimation of Uptake for Individual Pathways

Chemical-specific intakes, or doses, were calculated for the exposure pathways identified for quantitative evaluation in Section 8.3.1.2. The equations used to determine these exposures and the assumptions employed in those equations are presented below.

Ingestion of Ground water (Future)

Ingestion of COPC will occur when an individual consumes tap water and beverages made from water withdrawn from a residential ground water well. The ingestion rate used was based on the assumption that 100 percent of the fluid

Table 8-8
Variables Used For Human Intake Calculations

Contaminant Source and Exposed Population	Exposure Route	GW mg/L	CA mg/m^3	CS mg/kg	SA cm^2	PC cm/hr	IR[1]	ABS	AF mg/cm^2	ET hr/day	EF days/yr	ED yrs	CF[2]	BW kg	AT[3] years
Groundwater	Adult Ingestion Children Ingestion	RI Data RI Data	-- --	-- --	-- --	-- --	2 0.8	-- --	-- --	-- --	350 350	30 6	-- --	70 15	30 6
	Adult Inhalation Children Inhalation	-- --	Mod.[4] Mod.[4]	-- --	-- --	-- --	15 15	-- --	-- --	-- --	350 350	30 6	-- --	70 15	30 6
	Adult Dermal Children Dermal	RI Data RI Data	-- --	-- --	22,800 9,180	[5] [5]	-- --	1 1	-- --	0.2 0.2	350 350	30 6	0.001 0.001	70 15	30 6
Surface Soil Current	Worker Ingestion Trespasser Ingestion	-- --	-- --	RI Data RI Data	-- --	-- --	50 100	-- --	-- --	-- --	250 24	25 30	1.0E-6 1.0E-6	70 70	70(30) 70(30)
	Worker Dermal Trespasser Dermal	-- --	-- --	RI Data RI Data	3,120 3,120	-- --	-- --	● ●	1 1	-- --	250 24	25 30	1.0E-6 1.0E-6	70 70	70(30) 70(30)
Future Residents	Adult Ingestion Children Ingestion	-- --	-- --	RI Data RI Data	-- --	-- --	100 200	-- --	-- --	-- --	350 350	30 6	1.0E-6 1.0E-6	70 15	70(30) 70(6)
	Adult Dermal Children Dermal	-- --	-- --	RI Data RI Data	8,620 4,970	-- --	-- --	● ●	1 1	-- --	350 350	30 6	1.0E-6 1.0E-6	70 15	70(30) 70(6)
Future Recreational	Adult Ingestion Children Ingestion	-- --	-- --	RI Data RI Data	-- --	-- --	100 200	-- --	-- --	-- --	52 52	30 6	1.0E-6 1.0E-6	70 15	70(30) 70(6)
	Adult Ingestion Children Dermal	-- --	-- --	RI Data RI Data	8,620 4,970	-- --	-- --	● ●	1 1	-- --	52 52	30 6	1.0E-6 1.0E-6	70 15	70(30) 70(6)
Future Commercial	Adult Ingestion	--	--	RI Data	--	--	50	--	--	--	250	25	1.0E-6	70	70(30)
	Adult Dermal	--	--	RI Data	3,120	--	--	●	1	--	250	25	1.0E-6	70	70(30)
Subsurface Soils	Worker Ingestion	--	--	RI Data	--	--	480	--	--	--	20[6]	3[7]	1.0E-6	70	90[8]
Future Excavation	Worker Inhalation	--	Mod.[4]	--	--	--	20	--	--	8	20[6]	3[7]	--	70	90[8]
	Worker Dermal	--		RI Data	5,200	--	--	●	1	--	20[5]	3[7]	1.0E-6	70	90[8]

[1] Ingestion or inhalation; units for groundwater are of L/day, for groundwater inhalation are m^3/day, and for soil ingestion are mg/day.
[2] Conversion Factor.
[3] 70 years for carcinogens, 30 years for noncarcinogens for adults, 6 years for noncarcinogens for children (multiply by 365).
[4] This value was modeled from RI Data.
[5] This value is chemical-specific.
[6] Exposure frequency is in days per month.
[7] Exposure duration is in months.
[8] Averaging time is in days.
● Absorption factors obtained from Dermal Assessment: Principles and Applications (EPA, 1992).

intake for the resident was from the contaminated ground water source. Ground water exposure was evaluated for the site as a whole, and for MW-9. Volatiles at MW-9 were present at the highest site concentrations and were evaluated separately.

Chronic exposure from ingestion of contaminated ground water was calculated as follows (EPA, 1989a):

$$CDI = \frac{CW \times IR \times EF \times ED}{BW \times AT}$$

Where:

CDI= Chronic Daily Intake (mg/kg-day)
CW = Chemical Concentration in Water (mg/liter)
IR = Ingestion Rate (liters/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (days)

Variables:

CW = Measured value
IR = 2 liters/day (adult) (EPA, 1989b)
0.8 liters/day (child) (EPA, 1989b)
EF = 350 days/year
ED = 30 years (adult)
6 years (child)
BW = 70 kg (adult) (EPA, 1989b)
15 kg (child) (EPA, 1989b)
AT = 70 years x 365 days/year (carcinogens)
30 years x 365 days/year (noncarcinogens for adults)
6 years x 365 days/year (noncarcinogens for children)

Tables 8-9 and 8-11 present summaries of the exposures via ground water calculated for adults and children ingesting ground water from the site. Tables 8-10 and 8-12 summarize the exposures from MW-9 only. Tables in Appendix O present the ground water exposure calculations.

Inhalation of Chemicals Volatilizing During Showering (Future)

In order to evaluate the exposures from inhalation of vapors during showering, a volatile emissions model was used. Only VOCs are evaluated for this scenario, because of their superior vaporization capacity.

VOCs can be emitted when heated household water is sprayed out of a shower head. Because potential receptors may use ground water contaminated by site activities, they may be exposed to the VOCs identified in the

Table 8-9
Carcinogenic Chronic Daily Intakes
Ground Water (Entire Site)

COMPOUND:	Ground Water GW Ingestion		Ground Water Inhalation		Ground Water Dermal Absorption	
	Adult	Child	Adult	Child	Adult	Child
Silver	2.78E-06	1.04E-06	NA	NA	3.81E-09	1.43E-09
Arsenic	1.76E-04	6.58E-05	NA	NA	4.02E-07	1.51E-07
Lead	7.91E-04	2.95E-04	NA	NA	7.22E-09	2.71E-09
Aluminum	3.01E-01	1.12E-01	NA	NA	6.85E-04	2.58E-04
Barium	3.82E-03	1.42E-03	NA	NA	8.70E-06	3.27E-06
Beryllium	1.74E-05	6.49E-06	NA	NA	3.96E-08	1.49E-08
Chromium	4.30E-04	1.60E-04	NA	NA	9.80E-07	3.68E-07
Copper	6.42E-04	2.40E-04	NA	NA	1.46E-06	5.50E-07
Iron	8.23E-01	3.07E-01	NA	NA	1.88E-03	7.05E-04
Potassium	4.32E-01	1.61E-01	NA	NA	9.85E-04	3.70E-04
Manganese	3.50E+01	1.31E+01	NA	NA	7.98E-02	3.00E-02
Sodium	3.90E-01	1.46E-01	NA	NA	8.89E-04	3.34E-04
Thallium	6.27E-03	2.34E-03	NA	NA	1.43E-05	5.37E-06
Zinc	1.94E-03	7.23E-04	NA	NA	4.42E-06	1.66E-06
1,1-Dichloroethene	2.21E-05	8.24E-06	NA	NA	3.02E-08	1.13E-08
1,1-Dichloroethane	1.14E-04	4.27E-05	1.14E-08	1.06E-08	4.18E-06	1.57E-06
trans-1,2-Dichloroethene	9.19E-05	3.43E-05	3.07E-09	2.87E-09	1.87E-06	7.01E-07
cis-1,2-Dichloroethene	4.91E-03	1.83E-03	2.75E-07	2.57E-07	1.12E-04	4.21E-05
Methylene Chloride	7.16E-05	2.67E-05	1.75E-09	1.63E-09	1.63E-06	6.14E-07
Vinyl Chloride	3.84E-03	1.43E-03	5.04E-08	4.70E-08	3.94E-05	1.48E-05
Tetrachloroethene	7.51E-03	2.81E-03	7.47E-07	6.97E-07	1.25E-04	4.70E-05
Trichloroethene	6.47E-04	2.42E-04	6.43E-08	6.00E-08	7.08E-05	2.66E-05
alpha-BHC	2.71E-07	1.01E-07	1.62E-11	1.51E-11	9.89E-09	3.72E-09
DDT	3.06E-06	1.14E-06	2.01E-13	1.88E-13	1.12E-07	4.20E-08

Table 8-10
Carcinogenic Chronic Daily Intakes
Ground Water - MW-9 Only

COMPOUND:	Ground Water GW Ingestion Adult	Child	Ground Water Inhalation Adult	Child	Ground Water Dermal Absorption Adult	Child
1,1-Dichloroethene	2.21E-05	8.24E-06	2.19E-06	2.05E-06	8.05E-07	3.0E-07
1,1-Dichloroethane	9.39E-04	3.51E-04	3.14E-05	2.93E-05	1.91E-05	7.2E-06
1,2-Dichloroethene	7.87E-04	2.94E-04	4.41E-05	4.12E-05	1.79E-05	6.7E-06
cis-1,2-Dichloroethene	2.35E-02	8.77E-03	5.74E-04	5.36E-04	5.35E-04	2.0E-04
Methylene Chloride	7.05E-05	2.63E-05	3.08E-04	2.88E-04	2.41E-04	9.1E-05
Vinyl Chloride	2.35E-02	8.77E-03	7.00E-06	6.53E-06	1.17E-06	4.4E-07
Tetrachloroethene	4.70E-02	1.75E-02	4.67E-03	4.36E-03	5.14E-03	1.9E-03
Trichloroethene	2.35E-03	8.77E-04	1.40E-04	1.31E-04	8.57E-05	3.2E-05

(a) N/A = Not Applicable.

Table 8-11
Noncarcinogenic Chronic Daily Intakes
Ground Water (Entire Site)

COMPOUND:	Ground Water GW Ingestion Adult	Child	Ground Water Inhalation Adult	Child	Ground Water Dermal Absorption Adult	Child
Silver	6.49E-06	1.21E-05	NA	NA	8.88E-09	1.67E-08
Arsenic	4.11E-04	7.67E-04	NA	NA	9.37E-07	1.76E-06
Lead	1.85E-03	3.45E-03	NA	NA	1.68E-08	3.16E-08
Aluminum	7.01E-01	1.31E+00	NA	NA	1.60E-03	3.00E-03
Barium	8.90E-03	1.66E-02	NA	NA	2.03E-05	3.81E-05
Beryllium	4.05E-05	7.57E-05	NA	NA	9.24E-08	1.74E-07
Chromium	1.00E-03	1.87E-03	NA	NA	2.29E-06	4.30E-06
Copper	1.50E-03	2.80E-03	NA	NA	3.42E-06	6.42E-06
Iron	1.92E+00	3.59E+00	NA	NA	4.38E-03	8.23E-03
Potassium	1.01E+00	1.88E+00	NA	NA	2.30E-03	4.32E-03
Manganese	8.16E+01	1.52E+02	NA	NA	1.86E-01	3.50E-01
Sodium	9.10E-01	1.70E+00	NA	NA	2.07E-03	3.90E-03
Thallium	1.46E-02	2.73E-02	NA	NA	3.34E-05	6.27E-05
Zinc	4.52E-03	8.44E-03	NA	NA	1.03E-05	1.94E-05
1,1-Dichloroethene	5.15E-05	9.61E-05	NA	NA	7.05E-08	1.32E-07
1,1-Dichloroethane	2.67E-04	4.99E-04	2.65E-08	1.24E-07	9.74E-06	1.83E-05
trans-1,2-Dichloroethene	2.15E-04	4.00E-04	7.16E-09	3.34E-08	4.35E-06	8.18E-06
cis-1,2-Dichloroethene	1.15E-02	2.14E-02	6.42E-07	3.00E-06	2.61E-04	4.91E-04
Methylene Chloride	1.67E-04	3.12E-04	4.09E-09	1.91E-08	3.81E-06	7.16E-06
Vinyl Chloride	8.96E-03	1.67E-02	1.18E-07	5.48E-07	9.19E-05	1.73E-04
Tetrachloroethene	1.75E-02	3.27E-02	1.74E-06	8.13E-06	2.92E-04	5.48E-04
Trichloroethene	1.51E-03	2.82E-03	1.50E-07	7.00E-07	1.65E-04	3.10E-04
alpha-BHC	6.33E-07	1.18E-06	3.77E-11	1.76E-10	2.31E-08	4.34E-08
DDT	7.15E-06	1.33E-05	4.69E-13	2.19E-12	2.61E-07	4.90E-07

(a) NA = Not Applicable.

Table 8-12
Noncarcinogenic Chronic Daily Intakes
Ground Water - MW-9 Only

COMPOUND:	Ground Water GW Ingestion Adult	Child	Ground Water Inhalation Adult	Child	Ground Water Dermal Absorption Adult	Child
1,1-Dichloroethene	5.15E-05	9.61E-05	5.12E-06	2.39E-05	1.88E-06	3.53E-06
1,1-Dichloroethane	2.19E-03	4.09E-03	7.32E-05	3.42E-04	4.45E-05	8.36E-05
1,2-Dichloroethene	1.84E-03	3.43E-03	1.03E-04	4.80E-04	4.19E-05	7.86E-05
cis-1,2-Dichloroethene	5.48E-02	1.02E-01	1.34E-03	6.25E-03	1.25E-03	2.35E-03
Methylene Chloride	1.64E-04	3.07E-04	7.19E-04	3.35E-03	5.62E-04	1.06E-03
Vinyl Chloride	5.48E-02	1.02E-01	1.63E-05	7.62E-05	2.74E-06	5.14E-06
Tetrachloroethene	1.10E-01	2.05E-01	1.09E-02	5.08E-02	1.20E-02	2.25E-02
Trichloroethene	5.48E-03	1.02E-02	3.27E-04	1.52E-03	2.00E-04	3.76E-04

(a) NA = Not Applicable.

ground water. To evaluate the risks associated with the emission of VOCs from shower water, equations are used that estimate the release efficiency of contaminants of concern by comparing them to the release efficiency of trichloroethene (TCE), which has been determined experimentally. Scaling to other chemicals is accomplished by assuming that the rate of volatilization between shower water and the air is proportional to the Henry's Law constant. The ratio of a contaminant's Henry's Law constant and TCE's Henry's Law constant can provide the efficiency of release for the contaminant in question. Henry's Law constants are based on standard temperature and pressure. Accordingly, as the temperature of water increases, the partial pressure of the gas is increased, as is the rate of volatilization. The method is derived from work by Andelman (1984, 1985a, and 1985b) and is outlined in the Gas Research Institute's (GRI) risk assessment manuals, (1988). This exposure scenario will be evaluated for residents, both adult and children, who may potentially use ground water for showering.

In order to estimate the emission rate for VOCs from shower water, the release efficiency, E, of the contaminant in question was first determined using the following relationship:

$$E = (E_{TCE})\ (H)\ /\ (H_{TCE})$$

Where:

E_{TCE} = efficiency of release of trichloroethene from water to air based on controlled experiments; 0.6 is a typical value (GRI, 1988) (unitless),

H = Henry's Law constant for an organic compound m^3-atm/mol, values from the Superfund Chemical Data Matrix (EPA, 1991),

H_{TCE} = Henry's Law constant for trichloroethene, 1.0E-02 m^3-atm/mol (EPA, 1991).

As the contaminants are emitted into the shower area over a long period (approaching infinity), the concentration asymptotically approaches a maximum value, C_{inf}. The time required to reach C_{inf} is much longer than typical showering times of 5-15 minutes (GRI, 1988). C_{inf} is determined with the following relationship:

$$C_{inf} = [(E)(F_w)(C_t)]/F_a$$

Where:

C_{inf} =concentration of contaminant in air (mg/m^3)

E -release efficiency of the contaminant in question (unitless)

F_w -flow rate of water in shower, typical value is 8 l/min (GRI, 1988)

C_t -concentration of contaminant in shower water from onsite monitoring well data (mg/L)

F_a -flow rate of air in the shower, typical value is 2.4 m^3/min

The rate constant, k, for the exponential function describing the contaminant air concentration over time is defined as the ratio between the air flow rate and the volume of the bathroom. A typical bathroom volume of 12 m^3 was used.

With these parameters describing the concentration as it asymptotically approaches C_{inf}, one can calculate the average concentration of a contaminant in the shower air over a duration of t_s minutes:

$$C_a = C_{inf} [1 + (1/(kt_s)) (\exp (- kt_s) - 1)]$$

Ambient concentrations for contaminants released during showering are presented in Tables 8-13 and 8-14 for the entire site and for MW-9 only, respectively.

This scenario involves exposure of potential future residents, both adults and children, to chemicals in ground water through inhalation of volatiles during showering.

$$\text{Daily Intake (mg/kg-day)} = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT}$$

Where:

CA = Contaminant Concentration in Air (mg/m^3)
IR = Inhalation Rate (m^3/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
BW = Body Weight (kg)
AT = Averaging Time (days)

Variables:

CA = Modeled from ground water data
IR = 0.6 m^3/hour (In IR of 15m^3/day) (EPA, 1989b)
ET = 0.167 hours/day (GRI, 1988)
EF = 350 days/yr
ED = 30 years (adult)

Table 8-13

AMBIENT AIR CONCENTRATION DURING SHOWERING (Entire Site)

	WATER CONCENTRATION 95% UCL (mg/L)	SHOWER TIME (min) ts	FLOW RATES		BATHROO VOLUME (m3) Vb	HENRY'S LAW (m3-atm/mol) H	ASYMPTOTIC AIR CONC (mg/m3) C_inf(mean)	RATE CONST (1/min) k	RELEASE EFFICIENCY		HENRY'S LAW (TCE) (m3-atm/mol) H_TCE	95% UCL AIR CONC (mg/m3) Cs(mean)
COMPOUND	(a)	(b)	WATER (L/min) Fw (c)	AIR (m3/min) Fa (d)	(e)	(f)	(g)	(h)	COMPOU E (i)	TCE E_TCE (j)	(k)	(l)
Silver	2.37E-04	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Arsenic	1.50E-02	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Lead	6.74E-02	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Aluminum	2.56E+01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Barium	3.25E-01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Beryllium	1.48E-03	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Chromium	3.66E-02	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Copper	5.47E-02	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Iron	7.01E+01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Potassium	3.68E+01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Manganese	2.98E+03	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Sodium	3.32E+01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Thallium	5.34E-01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
Zinc	1.65E-01	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
1,1-Dichloroethene	1.88E-03	12	8	2.4	12	NA	NA	0.2	NA	0.6	1.00E-02	NA
1,1-Dichloroethane	9.75E-03	12	8	2.4	12	2.60E-02	3.25E-05	0.2	1.000	0.6	1.00E-02	2.02E-05
trans-1,2-Dichloroethene	7.83E-03	12	8	2.4	12	5.60E-03	8.77E-06	0.2	0.336	0.6	1.00E-02	5.45E-06
cis-1,2-Dichloroethene	4.18E-01	12	8	2.4	12	9.40E-03	7.86E-04	0.2	0.564	0.6	1.00E-02	4.88E-04
Methylene Chloride	6.10E-03	12	8	2.4	12	4.10E-03	5.00E-06	0.2	0.246	0.6	1.00E-02	3.11E-06
Vinyl Chloride	3.27E-01	12	8	2.4	12	2.20E-03	1.44E-04	0.2	0.132	0.6	1.00E-02	8.94E-05
Tetrachloroethene	6.40E-01	12	8	2.4	12	2.70E-02	2.13E-03	0.2	1.000	0.6	1.00E-02	1.33E-03
Trichloroethene	5.51E-02	12	8	2.4	12	1.80E-02	1.84E-04	0.2	1.000	0.6	1.00E-02	1.14E-04
alpha-BHC	2.31E-05	12	8	2.4	12	1.00E-02	4.62E-08	0.2	0.600	0.6	1.00E-02	2.87E-08
DDT	2.61E-04	12	8	2.4	12	1.10E-05	5.74E-10	0.2	0.001	0.6	1.00E-02	3.57E-10

NOTES:

a - Concentrations of contaminants found in ground water from onsite monitoring wells.
b - Time that shower is used, average of 12 minutes used (U.S.EPA RAGS).
c - Estimated flow rate of water in shower, typical value from GRI, 1988.
d - Estimated flow rate of air in shower, typical value from GRI, 1988.
e - Volume of bathroom, typical value from GRI, 1988.
f - Henry's Law Constants for compound, from Superfund Chemical Data Matrix (EPA, 1991)
g - Asymptotic air concentration if shower ran for a long time (much longer than 5 minutes), calculated as described in text.
h - Rate constant for exponential function, calculated as described in text.
i - Efficiency of release of compounds from water to air, calculated as described in text.
j - Efficiency of release for trichloroethene, as determined through research (GRI, 1988).
k - Henry's Law Constant for trichloroethene (EPA, 1991)
l - Air concentration in shower, calculated as described in text.

Table 8-14

AMBIENT AIR CONCENTRATION DURING SHOWERING (MW-9 Only)

	WATER CONCENTRATION	SHOWER	FLOW RATES		BATHROO	HENRY'S	ASYMPTOTIC	RATE	RELEASE EFFICIENCY		HENRY'S	95% UCL AIR
COMPOUND	95% UCL (ug/L) (a)	TIME (min) ts (b)	WATER (L/min) Fw (c)	AIR (m3/min) Fa (d)	VOLUME (m3) Vb (e)	LAW (m3-atm/mol) H (f)	AIR CONC (mg/m3) C_inf(mean) (g)	CONST (1/min) k (h)	COMPOU E (i)	TCE E_TCE (j)	LAW (TCE) (m3-atm/mol) H_TCE (k)	CONC (mg/m3) Cs(mean) (l)
1,1-Dichloroethene	1.88E-03	12	8	2.4	12	2.60E-02	6.27E-06	0.2	1.000	0.6	1.00E-02	3.89E-03
1,1-Dichloroethane	8.00E-02	12	8	2.4	12	5.60E-03	8.96E-05	0.2	0.336	0.6	1.00E-02	5.57E-02
trans-1,2-Dichloroethene	6.70E-02	12	8	2.4	12	9.40E-03	1.26E-04	0.2	0.564	0.6	1.00E-02	7.82E-02
cis-1,2-Dichloroethene	2.00E+00	12	8	2.4	12	4.10E-03	1.64E-03	0.2	0.246	0.6	1.00E-02	1.02E+00
Methylene Chloride	2.00E+00	12	8	2.4	12	2.20E-03	8.80E-04	0.2	0.132	0.6	1.00E-02	5.47E-01
Vinyl Chloride	6.00E-03	12	8	2.4	12	2.70E-02	2.00E-05	0.2	1.000	0.6	1.00E-02	1.24E-02
Tetrachloroethene	4.00E+00	12	8	2.4	12	1.80E-02	1.33E-02	0.2	1.000	0.6	1.00E-02	8.28E+00
Trichloroethene	2.00E-01	12	8	2.4	12	1.00E-02	4.00E-04	0.2	0.600	0.6	1.00E-02	2.48E-01

NOTES:

a - Concentrations of contaminants found in ground water from onsite monitoring wells.
b - Time that shower is used, average of 12 minutes used (U.S.EPA RAGS).
c - Estimated flow rate of water in shower, typical value from GRI, 1988.
d - Estimated flow rate of air in shower, typical value from GRI, 1988.
e - Volume of bathroom, typical value from GRI, 1988.
f - Henry's Law Constants for compound, from Superfund Chemical Data Matrix (EPA, 1991)
g - Asymptotic air concentration if shower ran for a long time (much longer than 5 minutes), calculated as described in text.
h - Rate constant for exponential function, calculated as described in text.
i - Efficiency of release of compounds from water to air, calculated as described in text.
j - Efficiency of release for trichloroethene, as determined through research (GRI, 1988).
k - Henry's Law Constant for trichloroethene (EPA, 1991).
l - Air concentration in shower, calculated as described in text.

6 years (child)
BW = 70 kg (adult) (EPA, 1989b)
15 kg (child) (EPA, 1989b)
AT = 70 years x 365 days/year (carcinogens)
30 years x 365 days/year (noncarcinogens for adults)
6 years x 365 days/year (noncarcinogens for children)

Tables in Appendix O present exposures for vapors inhaled during showering for adults and children. Tables 8-9 through 8-12 summarize exposures from ground water.

Dermal Exposure to Shower Water (Future)

This scenario involves the exposure of potential future residents, both adults and children, to contaminants in ground water through dermal contact. All values were obtained from the Exposure Factors Handbook (EPA, 1989b) unless otherwise noted.

$$\text{Daily Intake (mg/kg-day)} = \frac{CW \times SA \times PC \times ET \times EF \times ED \times CF}{BW \times AT}$$

Where:

CW = Chemical Concentration in Water (mg/liter)
SA = Skin Surface Area Available for Contact (cm^2)
PC = Chemical-specific Permeability Constant (cm/hour)
ET = Exposure Time (hours/day)
EF = Exposure Frequency (days/year)
ED = Exposure Duration (years)
CF = Volumetric Conversion Factor for Water (1 liter/1,000 cm^3)
BW = Body Weight (kg)
AT = Averaging Time (days)

Variables:

CW = Measured value
SA = 22,800cm^2 (adult) (EPA, 1992)
9,180cm^2 (child) (EPA, 1992)
PC = Chemical-specific, from EPA (1992)
ET = 0.167 hours/day
EF = 350 days/year
ED = 30 years (adult)
6 years (child)
CF = 1 liter/1000 cm^3
BW = 70 kg (adult)
15 kg (child)
AT = 70 years x 365 days/year (carcinogens)
30 years x 365 days/year (noncarcinogens for adults)
6 years x 365 days/year (noncarcinogens for children)

Estimated exposures from dermal contact with contaminated ground water during showering are calculated in Appendix O and summarized in Tables 8-9 through 8-12.

Ingestion of Surface Soils (Current)

The exposure scenario for soil ingestion assumes contact by onsite workers and adult trespassers. The RME estimate is based on the 95% upper bound surface soil concentration at the railroad tracks at the site. Standard default factors for a commercial/ industrial land use scenario were obtained from the EPA (1991a), and include: a daily intake rate of 50 mg, an exposure frequency of 250 days/year, and an exposure duration of 25 years. Standard default factors for trespassers on the site were obtained from the EPA (1989a) and include: an adult ingestion rate of 100 mg/day, and an exposure duration of 30 years. The fraction of soil ingested from the site was assumed to be one (i.e., 100 percent), as a conservative estimate. A conversion factor of 10^{-6} kg/mg was also included to account for units. The estimate of exposure frequency of 2 days per month, or 24 days per year, was developed for the trespasser based on the site-specific factors (e.g., cyclone fencing topped with barbed wire and a 24 hour guard) that preclude access by casual visitors. Access by children is unlikely based on the physical site restrictions; therefore, ingestion by children is not included in the risk assessment. The intake was calculated as follows:

$$\text{Intake (mg/kg-day)} = \frac{(CS)(IR)(CF)(FI)(EF)(ED)}{(BW)(AT)}$$

Where:

- CS - chemical specific concentration in the surface soils (mg/kg)
- IR - soil ingestion rate (mg/day)
- CF - conversion factor (10^{-6} kg/mg)
- FI - fraction ingested from chemical source (unitless)
- EF - exposure frequency (days/year)
- ED - exposure duration (years)
- BW - body weight (kg)
- AT - averaging time (days)

Tables in Appendix O present the dose calculations. The calculated daily intakes are summarized in Tables 8-15 and 8-16.

Table 8-15
Carcinogenic Chronic Daily Intakes
Surface Soils Present

COMPOUND:	Surface Soil Present Ingestion Workers	Surface Soil Present Ingestion Trespassers	Surface Soil Present Dermal Workers	Surface Soil Present Dermal Trespassers
LEAD	1.00E-04	2.31E-05	NA	NA
ARSENIC	2.36E-05	5.43E-06	NA	NA
BERYLLIUM	2.04E-07	4.71E-08	NA	NA
CADMIUM	7.41E-08	1.71E-08	NA	NA
CALCIUM	4.63E-03	1.07E-03	NA	NA
CHROMIUM	1.87E-05	4.31E-06	NA	NA
COPPER	4.89E-05	1.13E-05	NA	NA
MAGNESIUM	1.83E-03	4.23E-04	NA	NA
ZINC	3.32E-05	7.65E-06	NA	NA
ALDRIN	3.74E-09	8.62E-10	NA	NA
beta-BHC	8.93E-09	2.06E-09	NA	NA
ENDRIN ALDEHYDE	9.12E-09	2.10E-09	NA	NA
gamma-CHLORDANE	1.83E-09	4.23E-10	NA	NA
PCB 1260	8.00E-08	1.84E-08	3.00E-07	3.45E-08
DDT	5.22E-09	1.20E-09	NA	NA

(a) N/A = Not Applicable.

Table 8-16
Non-Carcinogenic Chronic Daily Intakes
Surface Soils Present

	Surface Soil Present Ingestion		Surface Soil Present Dermal	
COMPOUND:	Workers	Trespassers	Workers	Trespassers
LEAD	2.81E-04	5.39E-05	NA	NA
ARSENIC	6.60E-05	1.27E-05	NA	NA
BERYLLIUM	5.72E-07	1.10E-07	NA	NA
CADMIUM	2.07E-07	3.98E-08	NA	NA
CALCIUM	1.30E-02	2.49E-03	NA	NA
CHROMIUM	5.23E-05	1.01E-05	NA	NA
COPPER	1.37E-04	2.63E-05	NA	NA
MAGNESIUM	5.14E-03	9.86E-04	NA	NA
ZINC	9.30E-05	1.78E-05	NA	NA
ALDRIN	1.05E-08	2.01E-09	NA	NA
beta-BHC	2.50E-08	4.80E-09	NA	NA
ENDRIN ALDEHYDE	2.55E-08	4.90E-09	NA	NA
gamma-CHLORDANE	5.14E-09	9.86E-10	NA	NA
PCB 1260	2.24E-07	4.30E-08	8.39E-07	8.05E-08
DDT	1.46E-08	2.81E-09	NA	NA

(a) N/A = Not Applicable.

Dermal Absorption of Chemicals from Surface Soils (Current)

According to the Dermal Exposure Assessment Guidance (EPA, 1992c), absorption factors are available for three compounds. However, EPA has not recommended an absorption factor for two of these compounds, DDT and benzo[a]pyrene. EPA has recommended a percutaneous absorption factor of 0.6 percent to 6 percent for PCBs. Subsequently, dermal exposures could only be quantitatively assessed for PCBs.

Exposures via skin absorption of site-related chemicals from surface soils were calculated separately for on-site workers and trespassers using the same hypothetical exposure scenarios as the soil ingestion scenario. The 95 percent upper bound surface soil concentrations were used. The exposure factors used in the scenario are based on conservative estimates of soil to skin adherence and skin absorption, as well as projected frequency and duration of exposure. Skin surface areas used were the 50th percentile values for the body parts, representing an RME for the head, hands, and forearms of adults. Exposure frequency and duration are assumed to be the same as the soil ingestion scenario. Default factors obtained from the EPA (1989a) include: body weight of 70 kg and a skin surface area available for contact of 0.312 m^2. An absorption factor of 0.06 for PCBs was selected based on recommendation from the Dermal Exposure Assessment. An adherence of 1.00 mg/cm^2 was used as given in Dermal Exposure Assessment (EPA, 1992) as the typical soil adherence. The exposure is estimated using the following equation:

$$\text{Absorbed Dose (mg/kg-day)} = \frac{(CS)(CF)(SA)(AF)(ABS)(EF)(ED)}{(BW)(AT)}$$

Where:

- CS - Chemical Specific Concentration in the Surface Soils (mg/kg)
- CF - Conversion Factor (10^{-6} kg/mg)
- SA - Skin Surface Area (cm^2/event)
- AF - Soil to Skin Adherence Factor (mg/cm^2)
- ABS- Adult Skin Absorption factor (unitless)
- EF - Frequency Exposure (days/year)
- ED - Exposure Duration (years)
- BW - Adult Body Weight (kg)
- AT - Averaging Time (days)

Tables in Appendix O present the carcinogenic and non-carcinogenic intakes for this pathway. A complete list of the carcinogenic and non-carcinogenic intakes calculated for the chemicals of concern is presented in Tables 8-15 and 8-16.

Ingestion of Surface Soils (Future)

Exposures from ingestion of site-related chemicals from surface soils were calculated separately for adults and children, for an unlimited future use scenario (i.e., the property is considered equally likely to be used for residential, commercial, or recreational purposes). All three scenarios were evaluated and dose results are presented in Appendix O. Exposures to children were not evaluated for the commercial scenario because of the unlikelihood of occurrence. Summaries of results are presented in Tables 8-17 through 8-22.

Dermal Absorption of Chemicals from Surface Soils (Future)

Exposures from dermal absorption of site-related chemicals from surface soils were calculated separately for both adults and children, where applicable in all three future scenarios (residential, commercial, and recreational). Results are summarized in Tables 8-17 through 8-22 and calculations are presented in Appendix O.

Ingestion of Subsurface Soils (Future)

Subsurface soils were evaluated for the site as a whole as well as for the former spray pond area where PAHs were detected.

If excavation activity were to occur in conjunction with future construction activities, subsurface soils would become a viable media of exposure. Construction workers would be exposed to the greatest concentrations due to the intrusive nature of their work. Exposure time would be limited to 8-hour workdays for a duration of no more than 3 months, the maximum time expected for subsurface excavations. A soil ingestion rate of 480 mg/day and a body weight of 70 kg was used (EPA, 1989b and 1991a). Tables 8-23 through 8-26 summarize the results. Tables in Appendix O detail the calculations.

Inhalation of Fugitive Dusts from Subsurface Soils (Future)

In order to calculate air concentrations of dust generated from construction activities, modelling was necessary. The Gas Research Institute (GRI) Model Handbook describes a 1980 EPA model for estimating fugitive dust

Table 8-17
Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Residential

	Surface Soil Ingestion		Surface Soil Dermal	
COMPOUND:	Adult	Child	Adult	Child
LEAD	3.37E-04	6.29E-04	NA	NA
ARSENIC	7.93E-05	1.48E-04	NA	NA
BERYLLIUM	6.87E-07	1.28E-06	NA	NA
CADMIUM	2.49E-07	4.65E-07	NA	NA
CALCIUM	1.56E-02	2.90E-02	NA	NA
CHROMIUM	6.28E-05	1.17E-04	NA	NA
COPPER	1.64E-04	3.07E-04	NA	NA
MAGNESIUM	6.16E-03	1.15E-02	NA	NA
ZINC	1.12E-04	2.08E-04	NA	NA
ALDRIN	1.26E-08	2.35E-08	NA	NA
beta-BHC	3.00E-08	5.60E-08	NA	NA
ENDRIN ALDEHYDE	3.06E-08	5.72E-08	NA	NA
gamma-CHLORDANE	6.16E-09	1.15E-08	NA	NA
PCB 1260	2.69E-07	5.02E-07	1.39E-06	7.48E-07
DDT	1.76E-08	3.28E-08	NA	NA

(a) N/A = Not Applicable.

Table 8-18
Non-Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Residential

	Surface Soil Ingestion		Surface Soil Dermal	
COMPOUND:	Adult	Child	Adult	Child
LEAD	7.86E-04	7.34E-03	NA	NA
ARSENIC	1.85E-04	1.73E-03	NA	NA
BERYLLIUM	1.60E-06	1.50E-05	NA	NA
CADMIUM	5.81E-07	5.42E-06	NA	NA
CALCIUM	3.63E-02	3.39E-01	NA	NA
CHROMIUM	1.47E-04	1.37E-03	NA	NA
COPPER	3.84E-04	3.58E-03	NA	NA
MAGNESIUM	1.44E-02	1.34E-01	NA	NA
ZINC	2.60E-04	2.43E-03	NA	NA
ALDRIN	2.93E-08	2.74E-07	NA	NA
beta-BHC	7.00E-08	6.53E-07	NA	NA
ENDRIN ALDEHYDE	7.15E-08	6.67E-07	NA	NA
gamma-CHLORDANE	1.44E-08	1.34E-07	NA	NA
PCB 1260	6.27E-07	5.86E-06	3.24E-06	8.73E-06
DDT	4.10E-08	3.82E-07	NA	NA

(a) N/A = Not Applicable.

Table 8-19
Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Commercial

COMPOUND:	Surface Soil Ingestion Adult	Surface Soil Dermal Adult
LEAD	1.00E-04	NA
ARSENIC	2.36E-05	NA
BERYLLIUM	2.04E-07	NA
CADMIUM	7.41E-08	NA
CALCIUM	4.63E-03	NA
CHROMIUM	1.87E-05	NA
COPPER	4.89E-05	NA
MAGNESIUM	1.83E-03	NA
ZINC	3.32E-05	NA
ALDRIN	3.74E-09	NA
beta-BHC	8.93E-09	NA
ENDRIN ALDEHYDE	9.12E-09	NA
gamma-CHLORDANE	1.83E-09	NA
PCB 1260	8.00E-08	3.00E-07
DDT	5.22E-09	NA

(a) N/A = Not Applicable.

Table 8-20
Non-Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Commercial

COMPOUND:	Surface Soil Ingestion Adult	Surface Soil Dermal Adult
LEAD	2.81E-04	NA
ARSENIC	6.60E-05	NA
BERYLLIUM	5.72E-07	NA
CADMIUM	2.07E-07	NA
CALCIUM	1.30E-02	NA
CHROMIUM	5.23E-05	NA
COPPER	1.37E-04	NA
MAGNESIUM	5.14E-03	NA
ZINC	9.30E-05	NA
ALDRIN	1.05E-08	NA
beta-BHC	2.50E-08	NA
ENDRIN ALDEHYDE	2.55E-08	NA
gamma-CHLORDANE	5.14E-09	NA
PCB 1260	2.24E-07	8.39E-07
DDT	1.46E-08	NA

(a) N/A = Not Applicable.

Table 8-21
Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Recreational

COMPOUND:	Surface Soil Ingestion Adult	Child	Surface Soil Dermal Adult	Child
LEAD	5.01E-05	9.35E-05	NA	NA
ARSENIC	1.18E-05	2.20E-05	NA	NA
BERYLLIUM	1.02E-07	1.90E-07	NA	NA
CADMIUM	3.70E-08	6.90E-08	NA	NA
CALCIUM	2.31E-03	4.31E-03	NA	NA
CHROMIUM	9.33E-06	1.74E-05	NA	NA
COPPER	2.44E-05	4.56E-05	NA	NA
MAGNESIUM	9.16E-04	1.71E-03	NA	NA
ZINC	1.66E-05	3.09E-05	NA	NA
ALDRIN	1.87E-09	3.48E-09	NA	NA
beta-BHC	4.46E-09	8.32E-09	NA	NA
ENDRIN ALDEHYDE	4.55E-09	8.50E-09	NA	NA
gamma-CHLORDANE	9.16E-10	1.71E-09	NA	NA
PCB 1260	3.99E-08	7.46E-08	2.07E-07	1.11E-07
DDT	2.61E-09	4.87E-09	NA	NA

(a) N/A = Not Applicable.

Table 8-22
Non-Carcinogenic Chronic Daily Intakes
Surface Soils - Future: Recreational

COMPOUND:	Surface Soil Ingestion Adult	Child	Surface Soil Dermal Adult	Child
LEAD	1.17E-04	1.09E-03	NA	NA
ARSENIC	2.75E-05	2.56E-04	NA	NA
BERYLLIUM	2.38E-07	2.22E-06	NA	NA
CADMIUM	8.63E-08	8.05E-07	NA	NA
CALCIUM	5.39E-03	5.03E-02	NA	NA
CHROMIUM	2.18E-05	2.03E-04	NA	NA
COPPER	5.70E-05	5.32E-04	NA	NA
MAGNESIUM	2.14E-03	1.99E-02	NA	NA
ZINC	3.87E-05	3.61E-04	NA	NA
ALDRIN	4.36E-09	4.07E-08	NA	NA
beta-BHC	1.04E-08	9.71E-08	NA	NA
ENDRIN ALDEHYDE	1.06E-08	9.92E-08	NA	NA
gamma-CHLORDANE	2.14E-09	1.99E-08	NA	NA
PCB 1260	9.32E-08	8.70E-07	4.82E-07	1.30E-06
DDT	6.09E-09	5.68E-08	NA	NA

Table 8-23
Carcinogenic Subchronic Daily Intakes
Subsurface Soils - Future: Construction (Entire Site)

COMPOUND:	Subsurface Soil Ingestion Adult	Subsurface Soil Inhalation Adult	Subsurface Soil Dermal Adult
MERCURY	1.01E-09	5.07E-10	NA
LEAD	9.18E-07	4.61E-07	NA
ARSENIC	1.06E-07	5.31E-08	NA
ALUMINUM	3.09E-04	1.55E-04	NA
BERYLLIUM	3.70E-09	1.86E-09	NA
CALCIUM	8.92E-05	4.48E-05	NA
CHROMIUM	3.51E-07	1.76E-07	NA
COPPER	1.98E-07	9.94E-08	NA
MAGNESIUM	5.86E-05	2.94E-05	NA
MANGANESE	4.46E-06	2.24E-06	NA
SODIUM	1.66E-06	8.33E-07	NA
THALLIUM	2.45E-06	1.23E-06	NA
VANADIUM	4.36E-07	2.19E-07	NA
ZINC	8.37E-07	4.20E-07	NA
DDT	4.01E-09	2.01E-09	NA
ACETONE	3.04E-08	1.53E-08	NA
METHYLENE CHLORIDE	7.17E-10	3.60E-10	NA
TETRACHLOROETHENE	5.17E-10	2.59E-10	NA
TRICHLOROETHENE	5.49E-11	2.76E-11	NA

(a) N/A = Not Applicable.

Table 8-24
Carcinogenic Subchronic Daily Intakes
Subsurface Soils - Future: Construction (Spray Pond)

COMPOUND:	Subsurface Soil Ingestion Adult	Subsurface Soil Inhalation Adult	Subsurface Soil Dermal Adult
2-Methyl Naphthalene	6.41E-08	3.22E-08	NA
Acenaphthene	6.57E-08	3.30E-08	NA
Acenaphthylene	1.45E-08	7.27E-09	NA
Anthracene	1.95E-07	9.78E-08	NA
Benzo[a]anthracene	1.93E-07	9.70E-08	NA
Benzo[a]pyrene	2.98E-07	1.50E-07	NA
Benzo[b]fluoranthene	1.47E-07	7.39E-08	NA
Benzo[g,h,i]pyrene	1.18E-07	5.92E-08	NA
Benzo[k]fluoranthene	2.62E-07	1.32E-07	NA
Chrysene	2.09E-07	1.05E-07	NA
Diben[a,h]anthracene	2.77E-08	1.39E-08	NA
Dibenzofuran	4.36E-08	2.19E-08	NA
Fluoranthene	5.14E-07	2.58E-07	NA
Fluorene	7.31E-08	3.67E-08	NA
Ideno[1,2,3-c,d]pyrene	7.31E-08	3.67E-08	NA
Naphthalene	4.65E-08	2.34E-08	NA
Phenanthrene	8.74E-07	4.39E-07	NA
Pyrene	5.36E-07	2.69E-07	NA

Table 8-25
Non-Carcinogenic Subchronic Daily Intakes
Subsurface Soils - Future: Construction (Entire Site)

COMPOUND:	Subsurface Soil Ingestion Adult	Subsurface Soil Inhalation Adult	Subsurface Soil Dermal Adult
MERCURY	2.87E-07	1.44E-07	NA
LEAD	2.61E-04	1.31E-04	NA
ARSENIC	3.00E-05	1.51E-05	NA
ALUMINUM	8.78E-02	4.41E-02	NA
BERYLLIUM	1.05E-06	5.28E-07	NA
CALCIUM	2.53E-02	1.27E-02	NA
CHROMIUM	9.97E-05	5.00E-05	NA
COPPER	5.62E-05	2.82E-05	NA
MAGNESIUM	1.66E-02	8.35E-03	NA
MANGANESE	1.27E-03	6.36E-04	NA
SODIUM	4.71E-04	2.36E-04	NA
THALLIUM	6.95E-04	3.49E-04	NA
VANADIUM	1.24E-04	6.22E-05	NA
ZINC	2.38E-04	1.19E-04	NA
DDT	1.14E-06	5.71E-07	NA
ACETONE	8.64E-06	4.34E-06	NA
METHYLENE CHLORIDE	2.03E-07	1.02E-07	NA
TETRACHLOROETHENE	1.47E-07	7.37E-08	NA
TRICHLOROETHENE	1.56E-08	7.82E-09	NA

(a) N/A = Not Applicable.

Table 8-26
Non-Carcinogenic Subchronic Daily Intakes
Subsurface Soils - Future: Construction (Spray Pond)

COMPOUND:	Subsurface Soil Ingestion Adult	Subsurface Soil Inhalation Adult	Subsurface Soil Dermal Adult
2-Methyl Naphthalene	1.82E-05	9.13E-06	NA
Acenaphthene	1.87E-05	9.36E-06	NA
Acenaphthylene	4.11E-06	2.06E-06	NA
Anthracene	5.53E-05	2.78E-05	NA
Benzo[a]anthracene	5.49E-05	2.75E-05	NA
Benzo[a]pyrene	8.46E-05	4.24E-05	NA
Benzo[b]fluoranthene	4.18E-05	2.10E-05	NA
Benzo[g,h,i]pyrene	3.35E-05	1.68E-05	NA
Benzo[k]fluoranthene	7.45E-05	3.74E-05	NA
Chrysene	5.94E-05	2.98E-05	NA
Diben[a,h]anthracene	7.86E-06	3.95E-06	NA
Dibenzofuran	1.24E-05	6.22E-06	NA
Fluoranthene	1.46E-04	7.32E-05	NA
Fluorene	2.08E-05	1.04E-05	NA
Ideno[1,2,3-c,d]pyrene	2.08E-05	1.04E-05	NA
Naphthalene	1.32E-05	6.63E-06	NA
Phenanthrene	2.48E-04	1.25E-04	NA
Pyrene	1.52E-04	7.64E-05	NA

N/A = Not Applicable.

emissions from bulldozer activity, based on surface mining observations. This model would certainly provide an overestimate of the dust exposures expected at the Tacony site during construction activities. The model is described by the following equation:

$$E_{10} = \frac{78.4 \ x \ s^{1.2}}{\phi^{1.3}}$$

Where:

E_{10} - emission rate for particles 10 microns and below (16/hr-bulldozer);

S - material silt content (%); and

Φ - soil moisture content (%).

Silt content was estimated as 8 percent, as the typical value in an industrial setting (Cowherd, et al., 1984). Soil moisture content was taken from laboratory results of the subsurface soil samples where soil moisture ranged from 4.3 to 47.2 percent. The average value, 14.6 percent, was used. It was assumed that each worker would be exposed to the emissions from one bulldozer throughout the work day.

The emissions rate (E_{10}) of particles 10 microns or smaller is then compared to the sampled concentration to determine the contaminant emissions (E) in the air. This calculation is as follows:

$$E - E_{10} * C_s$$

Where:

E - Emission rate of sampled contaminants (mg/hr),

E_{10} - Emission rate of particles 10 microns or below (kg/hr from previous model), and

C_s - Sampled concentration (mg/kg).

The Near Field Box Model (Pasquill and Horst, 1979) was used to model the dispersion of fugitive dust emissions. This model is designed for cases where the receptors are either on site or very close to it and is accurate at short downwind distances. The model is described by the following equation:

$$C_a = \frac{E}{H_b \ W_b \ \mu_m}$$

Where:

C_a - concentration of contaminant in ambient air (mg/m^3),

E - emission rate of sampled contaminants (mg/hr, as obtained by the previous model,

H_b - downwind height of box (obtained from Table 8-27),

W_b - width of box (m),

μ_m - average wind speed through the box (m/s).

The downwind distance, X, was assumed to be 10 meters, the smallest receptor distance available, giving H_b a value of 1.4 meters, as illustrated in Table 8-27. The width of the box is the length dimension of the contaminated area, measured to be approximately 200 feet.

The average wind speed is calculated by the following formula:

$$\mu_m = 0.22(\mu_{10}) \ln (2.5H_b)$$

Where:

μ_{10} - wind speed at 10 m height.

The parameter μ_{10} was estimated using the average wind speed for Philadelphia (4.3 m/sec). Tables 8-28 and 8-29 present the results of both the Bulldozer Emission model and the Near Field Box Model. These air concentrations are then used to estimate subchronic inhalation daily doses due to construction activities. Tables 8-23 through 26 summarize the results. Appendix O presents the dose calculation tables.

Dermal Absorption of Chemicals from Subsurface Site Soils (Future)

Exposure frequency and duration are assumed to be the same as the ingestion and inhalation scenarios. Tables in Appendix O present calculations of doses to construction workers and Tables 8-23 through 26 summarize the results.

8.3.1.5 Toxicity Assessment

Toxicity profiles that characterize the health effects of the chemicals of potential concern, as well as their environmental fate and behavior in biological systems, are presented in Appendix P. These toxicity profiles include chemical properties, pharmaco-toxicity, and dose-response assessments for each chemical evaluated for human health exposure.

Table 8-27
Plume Heights Used in the Near-Field Box Model

Length of Side of Box, x (m)	Box Height, Hb (m)
10	1.4
20	2.1
30	2.7
40	3.3
50	3.8
60	4.3
70	4.8
80	5.3
90	5.8
100	6.2

Reference: Derived from work by Pasquill and Horst, 1979, as used in GRI, 1988.

Table 8-28
Estimated Chemical Concentration in the Air from Entire Site Calculated Using the Box Model

	Subsurface Soil Concentration (mg/Kg)	s (%)	p (%)	E (mg/hr)	H (m)	W (m)	u (m/hr)	Ca (mg/m3)
Mercury	6.27E-02	8	14.6	8.28E-01	1.4	6.10E+01	4.27E+03	2.28E-06
Lead	5.70E+01	8	14.6	7.53E+02	1.4	6.10E+01	4.27E+03	2.07E-03
Arsenic	6.57E+00	8	14.6	8.68E+01	1.4	6.10E+01	4.27E+03	2.38E-04
Aluminum	1.92E+04	8	14.6	2.54E+05	1.4	6.10E+01	4.27E+03	6.97E-01
Beryllium	2.30E-01	8	14.6	3.04E+00	1.4	6.10E+01	4.27E+03	8.35E-06
Calcium	5.54E+03	8	14.6	7.32E+04	1.4	6.10E+01	4.27E+03	2.01E-01
Chromium	2.18E+01	8	14.6	2.88E+02	1.4	6.10E+01	4.27E+03	7.91E-04
Copper	1.23E+01	8	14.6	1.63E+02	1.4	6.10E+01	4.27E+03	4.46E-04
Magnesium	3.64E+03	8	14.6	4.81E+04	1.4	6.10E+01	4.27E+03	1.32E-01
Manganese	2.77E+02	8	14.6	3.66E+03	1.4	6.10E+01	4.27E+03	1.01E-02
Sodium	1.03E+02	8	14.6	1.36E+03	1.4	6.10E+01	4.27E+03	3.74E-03
Thallium	1.52E+02	8	14.6	2.01E+03	1.4	6.10E+01	4.27E+03	5.52E-03
Vanadium	2.71E+01	8	14.6	3.58E+02	1.4	6.10E+01	4.27E+03	9.83E-04
Zinc	5.20E+01	8	14.6	6.87E+02	1.4	6.10E+01	4.27E+03	1.89E-03
DDT	2.49E-01	8	14.6	3.29E+00	1.4	6.10E+01	4.27E+03	9.03E-06
Acetone	1.89E+00	8	14.6	2.50E+01	1.4	6.10E+01	4.27E+03	6.86E-05
Methylene Chloride	4.45E-02	8	14.6	5.88E-01	1.4	6.10E+01	4.27E+03	1.61E-06
Tetrachloroethene	3.21E-02	8	14.6	4.24E-01	1.4	6.10E+01	4.27E+03	1.16E-06
Trichloroethene	3.41E-03	8	14.6	4.51E-02	1.4	6.10E+01	4.27E+03	1.24E-07

E - Emission Rate (mg/hr).
s - Silt content (%).
p - Moisture content in soil (%).
H - Height of the box (m).
W - Width of the box (m).
u - Wind speed (m/hr).
Ca - Calculated chemical concentration in the air (mg/m3).

Table 8-29
Estimated Chemical Concentration in the Air at Spray Pond Calculated Using the Box Model

	Subsurface Soil Concentration (mg/Kg)	s (%)	p (%)	E (mg/hr)	H (m)	W (m)	u (m/hr)	Ca (mg/m3)
2-Methyl Naphthalene	3.98E+00	8	14.6	5.26E+01	1.4	6.10E+01	4.27E+03	1.44E-04
Acenaphthene	4.08E+00	8	14.6	5.39E+01	1.4	6.10E+01	4.27E+03	1.48E-04
Anthracene	1.21E+01	8	14.6	1.60E+02	1.4	6.10E+01	4.27E+03	4.39E-04
Benzo[a]anthracene	1.20E+01	8	14.6	1.59E+02	1.4	6.10E+01	4.27E+03	4.35E-04
Benzo[a]pyrene	1.85E+01	8	14.6	2.44E+02	1.4	6.10E+01	4.27E+03	6.71E-04
Benzo[b]fluoranthene	9.14E+00	8	14.6	1.21E+02	1.4	6.10E+01	4.27E+03	3.32E-04
Benzo[g,h,i]pyrene	7.32E+00	8	14.6	9.67E+01	1.4	6.10E+01	4.27E+03	2.66E-04
Benzo[k]fluoranthene	1.63E+01	8	14.6	2.15E+02	1.4	6.10E+01	4.27E+03	5.91E-04
Chrysene	1.30E+01	8	14.6	1.72E+02	1.4	6.10E+01	4.27E+03	4.72E-04
Dibenzofuran	2.71E+00	8	14.6	3.58E+01	1.4	6.10E+01	4.27E+03	9.83E-05
Fluoranthene	3.19E+01	8	14.6	4.21E+02	1.4	6.10E+01	4.27E+03	1.16E-03
Fluorene	4.54E+00	8	14.6	6.00E+01	1.4	6.10E+01	4.27E+03	1.65E-04
Indeno[1,2,3-c,d]pyrene	4.54E+00	8	14.6	6.00E+01	1.4	6.10E+01	4.27E+03	1.65E-04
Phenanthrene	5.43E+01	8	14.6	7.17E+02	1.4	6.10E+01	4.27E+03	1.97E-03
Pyrene	3.33E+01	8	14.6	4.40E+02	1.4	6.10E+01	4.27E+03	1.21E-03

s - Silt content (%).
p - Moisture content in soil (%).
H - Height of the box (m).
W - Width of the box (m).
u - Wind speed (m/hr).
Ca - Calculated chemical concentration in the air (mg/m3).

8.3.1.6 Risk Evaluation

Carcinogenic Risks

Of the more than 50 COPCs identified in Section 8.2, 19 are classified as probable carcinogens by the EPA. The EPA classification system, based on the strength of evidence that a chemical is a human carcinogen, places each chemical in one of the following classes: A - sufficient evidence; B1 - limited human evidence but sufficient animal evidence; B2 - inadequate human evidence, but sufficient evidence in animals (Classes A, B1, and B2 are considered probable carcinogens); C - no evidence in humans and limited evidence in animals; D - no adequate data (non-classifiable); and E - evidence of non-carcinogenicity. Table 8-30 summarizes the available toxicity values for carcinogenic chemicals of concern.

The carcinogenic slope factors (SF) for the carcinogenic chemicals of concern were used with estimated chemical intakes to estimate carcinogenic risk. A carcinogenic slope factor is the probability that a unit dose taken over a 70-year lifetime will produce a carcinogenic effect. The SF is the 95% UCL of the probability that such an effect would occur. This means that, based on the experimental data used to develop the SF, there is a 5 percent chance that the probability of response could be greater than the stated SF. This approach also assumes that the dose-response relationship is typified by the linear portion of the dose-response curve for the chemical at low doses. In these cases, the slope of the dose-response curve is equal to the carcinogenic slope factor. Risk is, therefore, considered directly proportional to chemical intakes at low levels of exposure.

The incremental probability of an individual developing cancer over a lifetime exposure was estimated for the chemicals of concern, classified as carcinogens, by using the following equation:

$$Risk_i = CDI_i \times SF_i$$

Where:

$Risk_i$ = Upper bound of lifetime individual risk associated with exposure to that chemical (unitless),

CDI_i = Average daily intake of chemical over a 70-year lifetime exposure (mg/kg-day), and

Table 8-30
Toxicity Values for the Carcinogenic Effects of Chemicals of Concern

Chemical	Oral Slope Factor (mg/kg-day)$^{-1}$	Inhalation Slope Factor (mg/kg-day)$^{-1}$	Weight-of-Evidence Classification	Source
Aluminum	NA	NA	NA	NA
Arsenic	1.75	15.1	A	IRIS
Barium	NA	NA	NA	NA
Beryllium	4.3	8.4	B2	IRIS, HEAST
Cadmium	NA	6.1	B1	HEAST
Calcium	NA	NA	NA	NA
Chromium (III)	NA	NA	NA	NA
Chromium (VI)	NA	41	A	HEAST
Copper	NA	NA	D	IRIS
Lead	NA	NA	B2	IRIS
Magnesium	NA	NA	NA	NA
Manganese	NA	NA	D	IRIS
Mercury	NA	NA	D	IRIS
Nickel	NA	NA	NA	NA
Silver	NA	NA	D	IRIS
Sodium	NA	NA	NA	NA
Thallium	NA	NA	D	IRIS
Vanadium	NA	NA	NA	NA
Zinc	NA	NA	D	IRIS
Acetone	NA	NA	D	IRIS
1,1-Dichloroethane	NA	NA	C	IRIS
1,1-Dichloroethene	0.6	0.175	C	IRIS, EPA Reg. 3
1-2-Dichloroethene	NA	NA	NA	NA

Table 8-30
Toxicity Values for the Carcinogenic Effects of Chemicals of Concern

Chemical	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	Weight-of-Evidence Classification	Source
Aldrin	17	17	B2	IRIS
Chlordane (gamma)	1.3	1.3	B2	IRIS
alpha-BHC	6.3	6.3	B2	IRIS
beta-BHC	1.8	1.8	C	IRIS
beta-Endosulfan	NA	NA	NA	IRIS
Endrin aldehyde	NA	NA	D	IRIS
DDT	0.34	0.34	B2	IRIS
PCB 1260	7.7	NA	B2	IRIS

IRIS - Integrated Risk Information System (USEPA, 1992).
HEAST - Health Effects Assessment Summary Tables, Annual FY=1992 (USEPA, 1992).
NA - Oral slopes values were not available from either the IRIS or HEAST summary tables.
[1] Benzo(a)pyrene slope factor will be used to evaluate PAHs.
[2] Calculated using the relative potency factor to benzo[a]pyrene.

SF_i = Chemical-specific carcinogenic slope factor (mg/kg-day).

It should be noted that the slope factor is the upper 95% UCL estimate of human risk extrapolated from the multistage model dose-response curve and that chronic daily intake is based on reasonable maximum exposure (95% UCL on the arithmetic mean); therefore, this equation results in an extremely conservative estimate of the carcinogenic risk. This equation is applicable for carcinogenic risks below 1E-02. If risks above 1E-02 were obtained, the one-hit equation given in RAGS (EPA, 1989a) was used to calculate carcinogenic risks. The one-hit equation is given as:

$$Risk_i = 1 - \exp(-CDI_i \times SF_i)$$

Where:

$Risk_i$ = unitless probability of an individual developing cancer from $carcinogen_i$;
exp = the exponential;
CDI_i = chronic daily intake averaged over a lifetime (mg/kg-day); and,
SF_i = slope factor $(mg/kg\text{-}day)^{-1}$

Slope factors were obtained primarily from the Integrated Risk Information System (IRIS) (EPA 1992b) and from the most recent issue of the Health Effects Assessment Summary Tables (HEAST) (EPA 1992c). IRIS was used as the primary source because the slope factors provided in the data base have undergone peer review. If no slope factors for a particular compound were found in IRIS, HEAST was consulted. PAHs at the spray pond area were transformed to Benzo(a)pyrene equivalency units, using factors given in the document, A Comparative Potency Approach for Estimating Cancer Risks Associated with Exposures to Mixtures of Polyaromatic Hydrocarbons (ICF 1988).

The oral slope factors, given in Table 8-30, were used to calculate carcinogenic risks for each compound in each scenario. Exposures via the dermal absorption pathway were calculated and expressed as absorbed doses. Theoretically, dermal slope factors should be used to calculate carcinogenic risk from absorbed doses; however, dermal slope factors are not readily available in the literature, and, even if available, have not been verified by EPA or undergone peer review. Although oral slope factors are usually based on administered doses, it was assumed, for the purposes of this risk assessment, that administered doses yield the same response as absorbed doses.

The one-hit dose-response equation was used to calculate risks from dermal exposures (EPA, 1992c).

Chemical-specific risks for the compounds of concern are presented in Tables 8-31 through 8-38 and summarized in Table 8-39. The total carcinogenic risk in each pathway was calculated by summing the carcinogenic risks posed by each of the carcinogens in that pathway. This method of adding risks, recommended by EPA in its Guidelines for the Health Risk Assessment of Chemical Mixtures (EPA 1986b), may be overly conservative because the slope factors, as an upper 95th percentile estimate of potency, are not strictly additive.

Carcinogenic Risks from potential future ground water ingestion exceeded the target range of 1.0E-04 to 1.0E-06 for both adults and children. Carcinogenic risks from ground water ingestion exposures for adults and children were 8.09E-03 and 3.02E-3 for all wells and 4.71E-02 and 1.76E-02 for adults and children, respectively, for MW-9. Vinyl chloride, tetrachloroethene, and arsenic contributed nearly all of the carcinogenic risks in the ground water ingestion scenarios evaluated.

These risks are probably overestimations of potential risks from the site. It is highly unlikely that the site would be used as a residential setting because of the industrial use of the area. Furthermore, all modern residences usually tie into the city water supply. Also, site ground water is turbid and is unlikely to be ingested prior to pretreatment. The industrial setting of the site also makes potable ground water use unlikely.

Surface soil risks were evaluated for incidental ingestion and dermal absorption. Risks to current receptors (i.e., on site workers and trespassers) are below or within the target risk range of 1E-04 to 1E-06, ranging from 2.66E-07 to 4.29E-05. Future commercial and recreational scenarios also yielded risks that were within or below the target risk range, with risks ranging from 8.56E-07 to 4.29E-05. Future residential risks were above the target risk range for both children and adults for incidental ingestion(2.69E-04 and 1.44E-04, respectively). These risks are probably overestimates of actual site risks because the soils used to characterize the site were obtained exclusively from along the railroad tracks. Remedial

Table 8-31
Carcinogenic Risks from Ground Water Exposure (Entire Site)

	Ground Water Ingestion		Slope Factor	Carcinogenic Risk GW Ingestion		Ground Water Inhalation		Slope Factor	Carcinogenic Risk GW Inhalation		Ground Water Dermal Absorption		Slope Factor	Carcinogenic Risk Dermal Absorption	
COMPOUND:	Adult	Child	(mg/kg-day)-1	Adult	Child	Adult	Child	(mg/kg-day)-1	Adult	Child	Adult	Child	(mg/kg-day)-1	Adult	Child
Silver	2.78E-06	1.04E-06	NA	NA	NA	NA	NA	NA	NA	NA	3.81E-09	1.43E-09	NA	NA	NA
Arsenic	1.76E-04	6.56E-05	1.75E+00	3.08E-04	1.15E-04	NA	NA	1.51E+01	NA	NA	4.02E-07	1.51E-07	1.75E+00	7.03E-07	2.64E-07
Lead	7.91E-04	2.95E-04	NA	NA	NA	NA	NA	NA	NA	NA	7.22E-09	2.71E-09	NA	NA	NA
Aluminum	3.01E-01	1.12E-01	NA	NA	NA	NA	NA	NA	NA	NA	6.85E-04	2.58E-04	NA	NA	NA
Barium	3.82E-03	1.42E-03	NA	NA	NA	NA	NA	NA	NA	NA	8.70E-06	3.27E-06	NA	NA	NA
Beryllium	1.74E-05	6.49E-06	4.30E+00	7.47E-05	2.79E-05	NA	NA	8.40E+00	NA	NA	3.96E-08	1.49E-08	4.30E+00	1.70E-07	6.40E-08
Chromium	4.30E-04	1.60E-04	NA	NA	NA	NA	NA	4.10E+01	NA	NA	9.80E-07	3.68E-07	NA	NA	NA
Copper	6.42E-04	2.40E-04	NA	NA	NA	NA	NA	NA	NA	NA	1.46E-06	5.50E-07	NA	NA	NA
Iron	8.23E-01	3.07E-01	NA	NA	NA	NA	NA	NA	NA	NA	1.88E-03	7.05E-04	NA	NA	NA
Potassium	4.32E-01	1.61E-01	NA	NA	NA	NA	NA	NA	NA	NA	9.85E-04	3.70E-04	NA	NA	NA
Manganese	3.50E+01	1.31E+01	NA	NA	NA	NA	NA	NA	NA	NA	7.98E-02	3.00E-02	NA	NA	NA
Sodium	3.90E-01	1.46E-01	NA	NA	NA	NA	NA	NA	NA	NA	8.89E-04	3.34E-04	NA	NA	NA
Thallium	6.27E-03	2.34E-03	NA	NA	NA	NA	NA	NA	NA	NA	1.43E-05	5.37E-06	NA	NA	NA
Zinc	1.94E-03	7.23E-04	NA	NA	NA	NA	NA	NA	NA	NA	4.42E-06	1.66E-06	NA	NA	NA
1,1-Dichloroethene	2.21E-05	8.24E-06	6.00E-01	1.32E-05	4.94E-06	NA	NA	1.75E-01	NA	NA	3.02E-08	1.13E-08	6.00E-01	1.81E-08	6.81E-09
1,1-Dichloroethane	1.14E-04	4.27E-05	NA	NA	NA	1.14E-08	1.06E-08	NA	NA	NA	4.18E-06	1.57E-06	NA	NA	NA
trans-1,2-Dichloroethene	9.19E-05	3.43E-05	NA	NA	NA	3.07E-09	2.87E-09	NA	NA	NA	1.87E-06	7.01E-07	NA	NA	NA
cis-1,2-Dichloroethene	4.91E-03	1.83E-03	NA	NA	NA	2.75E-07	2.57E-07	NA	NA	NA	1.12E-04	4.21E-05	NA	NA	NA
Methylene Chloride	7.16E-05	2.67E-05	7.50E-03	5.37E-07	2.01E-07	1.75E-09	1.63E-09	1.65E-03	2.89E-12	2.70E-12	1.63E-06	6.14E-07	7.50E-03	1.22E-08	4.60E-09
Vinyl Chloride	3.84E-03	1.43E-03	1.90E+00	7.30E-03	2.72E-03	5.04E-08	4.70E-08	3.00E-01	1.51E-08	1.41E-08	3.94E-05	1.48E-05	1.90E+00	7.48E-05	2.81E-05
Tetrachloroethene	7.51E-03	2.81E-03	5.20E-02	3.91E-04	1.46E-04	7.47E-07	6.97E-07	2.00E-03	1.49E-09	1.39E-09	1.25E-04	4.70E-05	5.20E-02	6.50E-06	2.44E-06
Trichloroethene	6.47E-04	2.42E-04	1.10E-02	7.12E-06	2.66E-06	6.43E-08	6.00E-08	6.00E-03	3.86E-10	3.60E-10	7.08E-05	2.66E-05	1.10E-02	7.79E-07	2.93E-07
alpha-BHC	2.71E-07	1.01E-07	6.30E+00	1.71E-06	6.38E-07	1.62E-11	1.51E-11	6.30E+00	1.02E-10	9.51E-11	9.89E-09	3.72E-09	6.30E+00	6.23E-08	2.34E-08
DDT	3.06E-06	1.14E-06	3.40E-01	1.04E-06	3.89E-07	2.01E-13	1.88E-13	3.40E-01	6.83E-14	6.38E-14	1.12E-07	4.20E-08	3.40E-01	3.80E-08	1.43E-08
			Carcinogenic Risk =	8.09E-03	3.02E-03			Carcinogenic Risk =	1.71E-08	1.60E-08			Carcinogenic Risk =	8.31E-05	3.12E-05

Table 8-32
Carcinogenic Risks from Ground Water Exposure (MW-9 Only)

COMPOUND:	Ground Water Ingestion Adult	Ground Water Ingestion Child	Slope Factor (mg/kg-day)-1	Carcinogenic Risk GW Ingestion Adult	Carcinogenic Risk GW Ingestion Child	Ground Water Inhalation Adult	Ground Water Inhalation Child	Slope Factor (mg/kg-day)-1	Carcinogenic Risk GW Inhalation Adult	Carcinogenic Risk GW Inhalation Child	Ground Water Dermal Absorption Adult	Ground Water Dermal Absorption Child	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Dermal Absorption Adult	Carcinogenic Risk Dermal Absorption Child
1,1-Dichloroethene	2.21E-05	8.24E-06	6.00E-01	1.32E-05	4.94E-06	2.19E-06	2.05E-06	1.75E-01	3.84E-07	3.58E-07	8.05E-07	3.03E-07	6.00E-01	4.83E-07	1.82E-07
1,1-Dichloroethane	9.39E-04	3.51E-04	NA	NA	NA	3.14E-05	2.93E-05	NA	NA	NA	1.91E-05	7.16E-06	NA	NA	NA
1,2-Dichloroethene	7.87E-04	2.94E-04	NA	NA	NA	4.41E-05	4.12E-05	NA	NA	NA	1.79E-05	6.74E-06	NA	NA	NA
cis-1,2-Dichloroethene	2.35E-02	8.77E-03	NA	NA	NA	5.74E-04	5.36E-04	1.65E-03	9.47E-07	8.84E-07	5.35E-04	2.01E-04	NA	NA	NA
Methylene Chloride	7.05E-05	2.63E-05	7.50E-03	5.28E-07	1.97E-07	3.06E-04	2.86E-04	NA	NA	NA	2.41E-04	9.05E-05	7.50E-03	1.81E-06	6.79E-07
Vinyl Chloride	2.35E-02	8.77E-03	1.90E+00	4.46E-02	1.67E-02	7.00E-06	6.53E-06	3.00E-01	2.10E-06	1.96E-06	1.17E-06	4.41E-07	1.90E+00	2.23E-06	8.37E-07
Tetrachloroethene	4.70E-02	1.75E-02	5.20E-02	2.44E-03	9.12E-04	4.67E-03	4.36E-03	6.00E-03	2.80E-05	2.61E-05	5.14E-03	1.93E-03	NA	NA	NA
Trichloroethene	2.35E-03	8.77E-04	1.10E-02	2.58E-05	9.64E-06	1.40E-04	1.31E-04	NA	NA	NA	8.57E-05	3.22E-05	5.20E-02	4.45E-06	1.67E-06
			Carcinogenic Risk =	4.71E-02	1.76E-02			Carcinogenic Risk =	3.14E-05	2.93E-05			Carcinogenic Risk =	8.97E-06	3.37E-06

NA = Not Available.

(a) Risk calculated using One-Hit Equation.

Table 8-33
Carcinogenic Risks - Surface Soils
Present

COMPOUND:	Surface Soil Present Ingestion CDI Workers	Trespassers	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Surface Soil Ingestion Workers	Trespassers	Surface Soils Dermal Absorption CDI Workers	Trespassers	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Dermal Absorption Workers	Trespassers
LEAD	1.00E-04	2.31E-05	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	2.36E-05	5.43E-06	1.75E+00 a	4.13E-05	9.51E-06	NA	NA	1.75E+00	NA	NA
BERYLLIUM	2.04E-07	4.71E-08	4.30E+00 a	8.79E-07	2.03E-07	NA	NA	4.30E+00	NA	NA
CADMIUM	7.41E-08	1.71E-08	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM	4.63E-03	1.07E-03	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	1.87E-05	4.31E-06	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	4.89E-05	1.13E-05	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	1.83E-03	4.23E-04	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	3.32E-05	7.65E-06	NA	NA	NA	NA	NA	NA	NA	NA
ALDRIN	3.74E-09	8.62E-10	1.70E+01 a	6.36E-08	1.46E-08	NA	NA	1.70E+01	NA	NA
beta-BHC	8.93E-09	2.06E-09	1.80E+00 a	1.61E-08	3.70E-09	NA	NA	1.80E+00	NA	NA
ENDRIN ALDEHYDE	9.12E-09	2.10E-09	NA	NA	NA	NA	NA	NA	NA	NA
gamma-CHLORDANE	1.83E-09	4.23E-10	1.30E+00 a*	2.39E-09	5.50E-10	NA	NA	1.30E+00	NA	NA
PCB 1260	8.00E-08	1.84E-08	7.70E+00 a	6.16E-07	1.42E-07	3.00E-07	3.45E-08	7.70E+00	2.31E-06	2.66E-07
DDT	5.22E-09	1.20E-09	3.40E-01 a	1.78E-09	4.09E-10	NA	NA	3.40E-01	NA	NA
		Carcinogenic Risk =		4.29E-05	9.87E-06		Carcinogenic Risk =		2.31E-06	2.66E-07

(a) = IRIS.
NA = Not Available
* = Toxicity values were not available for gamma-chlordane; therefore, the chlordane value was used.

Table 8-34
Carcinogenic Risks - Surface Soils
Future Residential

COMPOUND:	Surface Soil Ingestion CDI Adults	Children	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Surface Soil Ingestion Adults	Children	Surface Soils Dermal Absorption CDI Adults	Children	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Dermal Absorption Adults	Children
LEAD	3.37E-04	6.29E-04	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	7.93E-05	1.48E-04	1.75E+00 a	1.39E-04	2.59E-04	NA	NA	1.75E+00	NA	NA
BERYLLIUM	6.87E-07	1.28E-06	4.30E+00 a	2.95E-06	5.51E-06	NA	NA	4.30E+00	NA	NA
CADMIUM	2.49E-07	4.65E-07	NA	NA	NA	NA	NA	NA	NA	NA
CALCIUM	1.56E-02	2.90E-02	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	6.28E-05	1.17E-04	NA	NA	NA	NA	NA	NA	NA	NA
COPPER	1.64E-04	3.07E-04	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	6.16E-03	1.15E-02	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	1.12E-04	2.08E-04	NA	NA	NA	NA	NA	NA	NA	NA
ALDRIN	1.26E-08	2.35E-08	1.70E+01 a	2.14E-07	3.99E-07	NA	NA	1.70E+01	NA	NA
beta-BHC	3.00E-08	5.60E-08	1.80E+00 a	5.40E-08	1.01E-07	NA	NA	1.80E+00	NA	NA
ENDRIN ALDEHYDE	3.06E-08	5.72E-08	NA	NA	NA	NA	NA	NA	NA	NA
gamma-CHLORDANE	6.16E-09	1.15E-08	1.30E+00 a*	8.01E-09	1.50E-08	NA	NA	1.30E+00	NA	NA
PCB 1260	2.69E-07	5.02E-07	7.70E+00 a	2.07E-06	3.86E-06	1.39E-06	7.48E-07	7.70E+00	1.07E-05	5.76E-06
DDT	1.76E-08	3.28E-08	3.40E-01 a	5.97E-09	1.11E-08	NA	NA	3.40E-01	NA	NA
		Carcinogenic Risk =		1.44E-04	2.69E-04	Carcinogenic Risk =			1.07E-05	5.76E-06

a = IRIS.
NA = Not Available.
* = Slope factor for chlordane was used.

Table 8-35
Carcinogenic Risks - Surface Soils
Future Recreational

COMPOUND:	Surface Soil Ingestion CDI Adults	Children	Slope Factor (mg/kg-day)-1		Carcinogenic Risk Surface Soil Ingestion Adults	Children	Surface Soils Dermal Absorption CDI Adults	Children	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Dermal Absorption Adults	Children
LEAD	5.01E-05	9.35E-05	NA		NA	NA	NA	NA	NA	NA	NA
ARSENIC	1.18E-05	2.20E-05	1.75E+00	a	2.06E-05	3.85E-05	NA	NA	1.75E+00	NA	NA
BERYLLIUM	1.02E-07	1.90E-07	4.30E+00	a	4.39E-07	8.19E-07	NA	NA	4.30E+00	NA	NA
CADMIUM	3.70E-08	6.90E-08	NA		NA	NA	NA	NA	NA	NA	NA
CALCIUM	2.31E-03	4.31E-03	NA		NA	NA	NA	NA	NA	NA	NA
CHROMIUM	9.33E-06	1.74E-05	NA		NA	NA	NA	NA	NA	NA	NA
COPPER	2.44E-05	4.56E-05	NA		NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	9.16E-04	1.71E-03	NA		NA	NA	NA	NA	NA	NA	NA
ZINC	1.66E-05	3.09E-05	NA		NA	NA	NA	NA	NA	NA	NA
ALDRIN	1.87E-09	3.48E-09	1.70E+01	a	3.17E-08	5.92E-08	NA	NA	1.70E+01	NA	NA
beta-BHC	4.46E-09	8.32E-09	1.80E+00	a	8.02E-09	1.50E-08	NA	NA	1.80E+00	NA	NA
ENDRIN ALDEHYDE	4.55E-09	8.50E-09	NA		NA	NA	NA	NA	NA	NA	NA
gamma-CHLORDANE	9.16E-10	1.71E-09	1.30E+00	a*	1.19E-09	2.22E-09	NA	NA	1.30E+00	NA	NA
PCB 1260	3.99E-08	7.46E-08	7.70E+00	a	3.08E-07	5.74E-07	2.07E-07	1.11E-07	7.70E+00	1.59E-06	8.56E-07
DDT	2.61E-09	4.87E-09	3.40E-01	a	8.87E-10	1.66E-09	NA	NA	3.40E-01	NA	NA
		Carcinogenic Risk =			2.14E-05	3.99E-05	Carcinogenic Risk =			1.59E-06	8.56E-07

(a) = IRIS.

NA = Not Available

* = Toxicity values were not available for gamma-chlordane; therefore, chlordane values were used.

Table 8-36
Carcinogenic Risks - Surface Soils
Future Commercial

COMPOUND:	Surface Soil Ingestion CDI Adults	Slope Factor (mg/kg-day)-1		Carcinogenic Risk Surface Soil Ingestion Adults	Surface Soils Dermal Absorption CDI Adults	Slope Factor (mg/kg-day)-1	Carcinogenic Risk Dermal Absorption Adults
LEAD	1.00E-04	NA		NA	NA	NA	NA
ARSENIC	2.36E-05	1.75E+00	a	4.13E-05	NA	1.75E+00	NA
BERYLLIUM	2.04E-07	4.30E+00	a	8.79E-07	NA	4.30E+00	NA
CADMIUM	7.41E-08	NA		NA	NA	NA	NA
CALCIUM	4.63E-03	NA		NA	NA	NA	NA
CHROMIUM	1.87E-05	NA		NA	NA	NA	NA
COPPER	4.89E-05	NA		NA	NA	NA	NA
MAGNESIUM	1.83E-03	NA		NA	NA	NA	NA
ZINC	3.32E-05	NA		NA	NA	NA	NA
ALDRIN	3.74E-09	1.70E+01	a	6.36E-08	NA	1.70E+01	NA
beta-BHC	8.93E-09	1.80E+00	a	1.61E-08	NA	1.80E+00	NA
ENDRIN ALDEHYDE	9.12E-09	NA		NA	NA	NA	NA
gamma-CHLORDANE	1.83E-09	1.30E+00	a	2.39E-09	NA	1.30E+00	NA
PCB 1260	8.00E-08	7.70E+00	a	6.16E-07	3.00E-07	7.70E+00	2.31E-06
DDT	5.22E-09	3.40E-01	a	1.78E-09	NA	3.40E-01	NA
	Carcinogenic Risk =			4.29E-05	Carcinogenic Risk =		2.31E-06

a = IRIS.

* = Toxicity values were not available for gamma-chlordane; therefore, chlordane values were used.

NA = Not Available.

Table 8-37
Carcinogenic Risks in Subsurface Soils (Entire Site)
Future: Construction

COMPOUND:	Subsurface Soil Ingestion SDI Workers	Oral SF (mg/kg-day)-1	Carcinogenic Risk Subsurface Soil Ingestion Workers	Subsurface Soil Inhalation SDI Workers	Inhalation SF (mg/kg-day)		Carcinogenic Risk Subsurface Soil Inhalation Workers	Subsurface Soil Dermal Absorption SDI Workers	SF (mg/kg-day)	Carcinogenic Risk Dermal Absorption Workers
MERCURY	1.01E-09	NA	NA	5.07E-10	NA		NA	NA	NA	NA
LEAD	9.16E-07	NA	NA	4.61E-07	NA		NA	NA	NA	NA
ARSENIC	1.06E-07	1.75E+00	1.86E-07	5.31E-08	1.51E+01	b	8.02E-07	NA	1.75E+00	NA
ALUMINUM	3.09E-04	NA	NA	1.55E-04	NA		NA	NA	NA	NA
BERYLLIUM	3.70E-09	NA	NA	1.86E-09	8.40E+00		1.56E-08	NA	NA	NA
CALCIUM	8.92E-05	NA	NA	4.48E-05	NA		NA	NA	NA	NA
CHROMIUM	3.51E-07	NA	NA	1.76E-07	4.10E+01	*	7.22E-06	NA	NA	NA
COPPER	1.98E-07	NA	NA	9.94E-08	NA		NA	NA	NA	NA
MAGNESIUM	5.86E-05	NA	NA	2.94E-05	NA		NA	NA	NA	NA
MANGANESE	4.46E-06	NA	NA	2.24E-06	NA		NA	NA	NA	NA
SODIUM	1.66E-06	NA	NA	8.33E-07	NA		NA	NA	NA	NA
THALLIUM	2.45E-06	NA	NA	1.23E-06	NA		NA	NA	NA	NA
VANADIUM	4.36E-07	NA	NA	2.19E-07	NA		NA	NA	NA	NA
ZINC	8.37E-07	NA	NA	4.20E-07	NA		NA	NA	NA	NA
DDT	4.01E-09	3.40E-01	1.36E-09	2.01E-09	3.40E-01	b	6.84E-10	NA	3.40E-01	NA
ACETONE	3.04E-08	NA	NA	1.53E-08	NA		NA	NA	NA	NA
METHYLENE CHLORIDE	7.17E-10	7.50E-03	5.37E-12	3.60E-10	NA		NA	NA	7.50E-03	NA
TETRACHLOROETHENE	5.17E-10	5.20E-02	2.69E-11	2.59E-10	2.00E-03		5.19E-13	NA	5.20E-02	NA
TRICHLOROETHENE	5.49E-11	1.10E-02	6.04E-13	2.76E-11	6.00E-03		1.65E-13	NA	1.10E-02	NA
	Carcinogenic Risk =		1.87E-07	Carcinogenic Risk =			8.04E-06	Carcinogenic Risk =		NA

(a) = IRIS.
(b) = HEAST FY 1992.
NA = Not Available.
* = Inhalation Slope factor for Chromium III.

Table 8-38
Carcinogenic Risks in Subsurface Soils (Spray Pond)
Future: Construction

COMPOUND:	Subsurface Soil Ingestion SDI Workers	Oral SF (mg/kg-day)-1		Carcinogenic Risk Subsurface Soil Ingestion Workers	Subsurface Soil Inhalation SDI Workers	Inhalation SF (mg/kg-day)-1		Carcinogenic Risk Subsurface Soil . Inhalation Workers	Subsurface Soil Dermal Absorption SDI Workers	Dermal SF (mg/kg-day)		Carcinogenic Risk Dermal Absorption Workers
2-Methyl Naphthalene	6.41E-08	NA		NA	3.30E-08	NA		NA	NA	NA		NA
Acenaphthene	6.57E-08	NA		NA	3.30E-08	NA		NA	NA	NA		NA
Anthracene	1.95E-07	NA		NA	9.78E-08	NA		NA	NA	NA		NA
Benzo[a]anthracene	1.93E-07	1.06E+00	(1)	2.05E-07	9.70E-08	8.85E-01	(1)	8.58E-08	NA	1.06E+00	(1)	NA
Benzo[a]pyrene	2.98E-07	7.30E+00	(1)	2.17E-06	1.50E-07	6.10E+00	(1)	9.12E-07	NA	7.30E+00	(1)	NA
Benzo[b]fluoranthene	1.47E-07	1.02E+00	(1)	1.50E-07	7.39E-08	8.54E-01	(1)	6.31E-08	NA	1.02E+00	(1)	NA
Benzo[g,h,i]pyrene	1.18E-07	NA		NA	5.92E-08	NA		NA	NA	NA		NA
Benzo[k]fluoranthene	2.62E-07	4.82E-01	(1)	1.26E-07	1.32E-07	4.03E-01	(1)	5.30E-08	NA	4.82E-01	(1)	NA
Chrysene	2.09E-07	3.21E-02		6.72E-09	1.05E-07	2.68E-02	(1)	2.82E-09	NA	3.21E-02	(1)	NA
Dibenzofuran	4.38E-08	NA		NA	2.19E-08	NA		NA	NA	NA		NA
Fluoranthene	5.14E-07	NA		NA	2.58E-07	NA		NA	NA	NA		NA
Fluorene	7.31E-08	NA		NA	3.67E-08	NA		NA	NA	NA		NA
Ideno[1,2,3-c,d]pyrene	7.31E-08	1.69E+00	(1)	1.24E-07	3.67E-08	1.42E+00	(1)	5.19E-08	NA	1.69E+00	(1)	NA
Phenanthrene	8.74E-07	NA		NA	4.39E-07	NA		NA	NA	NA		NA
Pyrene	5.38E-07	NA		NA	2.69E-07	NA		NA	NA	NA		NA
		Carcinogenic Risk =		2.79E-06		Carcinogenic Risk =		1.17E-06		Carcinogenic Risk =		NA

(a) NA = Not Available.

Table 8-39
SUMMARY OF CARCINOGENIC RISKS

	INGESTION	INHALATION	DERMAL	TOTAL SITE RISK
GROUND WATER				
FUTURE				
All Wells				
Adults	8.09E-03	1.17E-08	8.31E-05	8.17E-03
Children	3.02E-03	1.60E-08	3.12E-05	3.05E-03
MW-9 Only*				
Adults	4.71E-02	3.14E-05	8.97E-06	4.71E-02
Children	1.76E-02	2.93E-05	3.37E-06	1.76E-02
Entire Site Minus MW-9				
Adults	3.25E-04	1.27E-10	2.06E-06	3.27E-04
Children	1.21E-04	1.18E-10	7.73E-07	1.22E-04
SURFACE SOILS				
PRESENT				
Workers	4.29E-05	-	2.31E-06	4.52E-05
Trespassers	9.87E-06	-	2.66E-07	1.01E-05
FUTURE				
Residential				
Adults	1.44E-04	-	1.07E-05	1.55E-04
Children	2.69E-04	-	5.76E-06	2.75E-04
Recreational				
Adults	2.14E-05	-	1.59E-06	2.30E-05
Children	3.99E-05	-	8.56E-07	4.08E-05
Commercial				
Adults	4.29E-05	-	2.31E-06	4.52E-05
SUBSURFACE SOILS				
FUTURE EXCAVATION				
Entire Site				
Workers	1.87E-07	8.04E-06	NA	8.23E-06
Spray Pond Area				
Workers	2.79E-06	1.17E-06	NA	3.96E-06

NA - Not available.

* - Volatile Organics Compounds only.

actions aimed at reducing surface soil risks should be limited to the area along the railroad tracks. Arsenic contributes 96.5 percent of the total site risk for residential scenarios.

Subsurface soil cancer risk estimates were below the acceptable target risk range for the entire site and for the spray pond area for both ingestion and inhalation exposure scenarios.

The total individual lifetime carcinogenic risk for the site is considered equal to the sum of the risks calculated for each exposure pathway as follows:

Risk (multipathway) = Risk (dermal) + Risk (ingestion) + Risk (inhalation)

Table 8-39 presents carcinogenic risks for each potential receptor population at the Tacony Warehouse site.

Carcinogenic risks summed over pathways were above the target range for all receptor populations, except future construction workers, future commercial workers, future recreational users, and current workers and trespassers of the site. Most of the risk to the other populations is from ingestion of arsenic in ground water and surface soils, and inhalation of vinyl chloride while showering.

Non-carcinogenic Hazards

Reference doses (RfDs) for chronic and subchronic exposures developed by the EPA are used to estimate the daily dose of a chemical to which humans, including sensitive subpopulations, can be exposed without an appreciable risk of deleterious effects during a lifetime. The RfD is usually based on the highest level tested in animal experiments at which no adverse effects (NOAEL) were demonstrated. If a NOAEL is not available, the Lowest Observed Adverse Effect Level (LOAEL) is used. The NOAEL or LOAEL is adjusted by uncertainty and modifying factors to obtain an RfD. Verified RfDs, which have been peer reviewed and accepted by the EPA, are shown in Table 8-40 for the chemicals of concern. RfDs were obtained primarily from the IRIS (EPA, 1992b) and from the most recent issue of the HEAST (EPA, 1992c). IRIS was searched first because the RfDs provided in the data base have undergone peer review. If no RfD for a particular compound was found in IRIS, HEAST was then consulted. The HEAST

Table 8-40
Toxicity Values for the Non-Carcinogenic Effects of Chemicals of Concern

Chemical	Subchronic Oral RfD	Chronic Oral RfD mg/kg-day	Inhalation Subchronic RfC (mg/m^3)	Inhalation Chronic RfC	Confidence Level[1]	Critical Effect	UF and MF[2] for Chronic Oral RfD	RfD Source
Aluminum	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	3E-4	3E-4	NA	NA	medium	hyperpigmentation, keratosis, and possible vascular complications	UF=3 MF=1	IRIS HEAST
Barium	7E-2	7E-2	5E-3	5E-4	medium	increased blood pressure	UF=3 MF=1	IRIS HEAST
Beryllium	5E-3	5E-3	NA	NA	low	no adverse effects	UF=100 MF=1	IRIS HEAST
Cadmium	NA	5E-4	NA	NA	high	significant proteinuria	NA	IRIS
Calcium	NA	NA	NA	NA	NA	NA	NA	NA
Chromium (III)	1	1	NA	2E-6	Low	no effects observed	UF=100 MF=1	IRIS HEAST EPA, Reg. 3
Chromium (VI)	2E-2	5E-5	NA	NA	Low	no effects observed	UF=500 MF=1	IRIS HEAST
Copper	1.3 mg/L[3]	1.3mg/L[3]	NA	NA	NA	local irritation	NA	IRIS HEAST
Lead	NA	NA	NA	NA	NA	CNS effects	NA	HEAST
Magnesium	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	1E-1	5E-3	4E-4	4E-4	varied	CNS effects	UF=1 MF=1	IRIS HEAST
Mercury	3E-4	3E-4	3E-4	3E-4	NA	kidneys	UF=1,000	HEAST
Nickel	2E-2	2E-2	NA	NA	medium	whole body	UF=300 MF=1	IRIS HEAST
Silver	5E-3	5E-3	NA	NA	low	skin	UF=3 MF=1	IRIS HEAST

Table 8-40 (Continued)
Toxicity Values for the
Non-Carcinogenic Effects of Chemicals of Concern

Chemical	Subchronic Oral RfD	Chronic Oral RfD mg/kg-day	Inhalation Subchronic RfC (mg/m^3)	Inhalation Chronic RfC	Confidence Level[1]	Critical Effect	UF and MF[2] for Chronic Oral RfD	RfD Source
Sodium	NA	NA	NA	NA	NA	NA	NA	NA
Thallium	7E-4	7E-5	NA	NA	NA	no adverse effects	UF=3,000 for H,A,S MF=3	HEAST
Vanadium	7E-3	7E-3	NA	NA	NA	none observed	UF=100	HEAST
Zinc	2E-1	3E-1	NA	NA	NA	none observed	UF=10	IRIS HEAST
Acetone	1	0.1	NA	NA	low	liver and kidneys	UF-1,000 MF-1	IRIS HEAST
1,1-Dichloroethane	NA	1E-1	5	5E-1	NA	damage to kidneys	UF=1,000	IRIS HEAST
1,1-Dichloroethene	9E-3	9E-2	NA	NA	medium	decreased hematocrit, liver lesions	UF=1,000 MF=1	IRIS HEAST
1,2-Dichloroethene	NA	2E-2	NA	NA	low	NA	UF=1,000 MF=1	HEAST EPA, Reg. 3
cis-1,2-Dichloroethene	1E-1	1E-2	NA	NA	NA	decreased hematocrit, liver lesions	UF=3,000 MF=1	HEAST
trans-1,2-Dichloroethene	NA	2E-2	NA	NA	NA	increased alkaline phosphatase	NA	HEAST EPA, Reg. 3
Methylene chloride	6E-2	6E-2	3	3	medium	liver toxicity	UF=100	IRIS HEAST
Tetrachloroethene	1E-1	1E-2	NA	NA	medium	liver toxicity	UF=1,000 MF=1	IRIS
Trichloroethene	NA	6E-3	NA	NA	NA	NA	NA	EPA, Reg. 3
Vinyl chloride	NA	NA	NA	NA	NA	NA	NA	IRIS

Table 8-40 (Continued)
Toxicity Values for the
Non-Carcinogenic Effects of Chemicals of Concern

Chemical	Subchronic Oral RfD	Chronic Oral RfD mg/kg-day	Inhalation Subchronic RfC (mg/m^3)	Inhalation Chronic RfC	Confidence Level[1]	Critical Effect	UF and MF[2] for Chronic Oral RfD	RfD Source
Acenaphthene	6E-1	6E-2	NA	NA	low	hepatotoxicity	UF=3,000 MF=1	IRIS HEAST
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA
Anthracene	3	3E-1	NA	NA	low	no observed effects	UF=3,000 MF=1	IRIS HEAST
Benzo[a]anthracene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[b]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[g,h,i]pyrene	NA	NA	NA	NA	NA	NA	NA	NA
Benzo[k]fluoranthene	NA	NA	NA	NA	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	HEAST
Fluoranthene	4E-1	4E-2	NA	NA	low	liver	UF=3,000 MF=1	IRIS HEAST
Fluorene	4E-1	4E-2	NA	NA	low	decreased RBC	UF=3,000 MF=1	IRIS HEAST
Indeno[1,2,3-cd]pyrene	NA	NA	NA	NA	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA	NA	NA	NA	NA
Naphthalene	4E-2	4E-2	NA	NA	NA	decreased weight	UF=1,000	HEAST
Phenanthrene	NA	NA	NA	NA	NA	NA	NA	NA
Pyrene	3E-1	3E-2	NA	NA	low	kidney effects	UF=3,000 for H,A,S MF=1	IRIS HEAST

Table 8-40 (Continued)
Toxicity Values for the Non-Carcinogenic Effects of Chemicals of Concern

Chemical	Subchronic Oral RfD	Chronic Oral RfD mg/kg-day	Inhalation Subchronic RfC (mg/m^3)	Inhalation Chronic RfC	Confidence Level[1]	Critical Effect	UF and MF[2] for Chronic Oral RfD	RfD Source
gamma-Chlordane	6E-5	6E-5	NA	NA	low	regional liver hypertrophy in females	UF=1,000 for H,A,S MF=1	IRIS HEAST
Aldrin	3E-5	3E-5	NA	NA	medium	liver lesions		IRIS HEAST
alpha-BHC	NA	NA	NA	NA	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA	NA	NA	NA	NA
beta-Endosulfan	5E-5	5E-5	NA	NA	NA	kidney toxicity	NA	IRIS HEAST
DDT	5E-4	5E-4	NA	NA	medium	liver toxicity	UF=100 for H,A NF=1	IRIS HEAST
Endrin aldehyde[4]	3E-4	3E-4	NA	NA	medium	mild histological lesions in liver	UF=100 for H,A MF=1	IRIS
PCB 1260	NA	NA	NA	NA	NA	NA	NA	NA

IRIS - Integrated Risk Information System (USEPA, accessed September 16, 1992)
HEAST - Health Effects Assessment Summary Tables, FY-1992 (EPA, March 1992) and Supplement A (July 1992)
1 - Confidence level from IRIS.
2 - UF = Uncertainty Factor; MF = Modifying Factor
Uncertainty Adjustments:
H = variation in human sensitivity
A = animal to human extrapolation
S = extrapolation from subchronic to chronic NOAEL
L = extrapolation from LOAEL to NOAEL
3 - Current drinking water standard; Drinking Water Criteria document concluded toxicity data were inadequate for calculation of an RfD for copper.
4 - Values for Endrin used.
NA - Oral and inhalation reference doses were not available from either IRIS, HEAST, or EPA Region 3 summary tables.
CNS - Central Nervous System.

was the sole source used for subchronic RfDs. If an RfC was available for a compound lacking a RfD, the RfC was adjusted where applicable for exposure dose and body weight by multiplying by either 2 liters/day (oral) or 20 m^3/day (inhalation), and dividing by 70 kg body weight.

The RfDs given in Table 8-40 were used to calculate hazard quotients for each compound in each scenario. Exposures via the dermal absorption pathway were calculated and expressed as absorbed doses. Theoretically, dermal RFDs should be used to calculate non-carcinogenic risk from absorbed doses; however, dermal RFDs are not readily available in the literature and, even if available, have not been verified by EPA or undergone peer review. Although RFDs are usually based on administered doses, it was assumed, for the purposes of this risk assessment, that administered doses yielded the same response as absorbed doses (i.e., a 1:1 ratio exists between administered and absorbed doses).

The potential for non-carcinogenic toxicity to occur in an exposed individual was evaluated by comparing the exposure level of each chemical with a chemical-specific reference dose, as follows:

$$HQ_i = CDI_i/RfD_i$$

Where:

HQ_i = Chemical-specific hazard quotient
CDI_i = Daily intake of chemical (mg/kg-day)
RfD_i = Reference dose for chronic exposure to the chemical (mg/kg-day)

The hazard quotients are summed for all compounds in each scenario to calculate hazard indices. If the hazard quotient is less than one, it is unlikely that even sensitive populations would experience adverse health effects due to exposure to the chemical. If the index exceeds unity, however, adverse non-carcinogenic health effects may occur (EPA, 1989a). If a hazard index is above one, the chemicals are separated by target organ and reanalyzed for hazardous effects.

The hazard characterization for non-carcinogenic effects are given in Tables 8-41 through 8-48 and summarized in Table 8-49. To assess the overall potential for non-carcinogenic effects posed by exposure to multiple chemicals, a hazard index (HI) equal to the sum of the hazard quotients was

Table 8-41
Non-Carcinogenic Hazards Associated with Ground Water Exposure (Entire Site)

COMPOUND:	CDI Ground Water Ingestion		Chronic Oral RfD	Subchronic Oral RfD	Hazard Index GW Ingestion		CDI Ground Water Inhalation		Chronic Inh RfD	Subchronic Inh RfD	Hazard Index GW Inhalation		CDI Ground Water Dermal Absorption		Chronic Oral RfD	Subchronic Oral RfD	Hazard Index Dermal Absorption	
	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child
Silver	6.49E-06	1.21E-05	5.00E-03	5.00E-03	1.30E-03	2.42E-03	NA	NA	NA	NA	NA	NA	8.88E-09	1.67E-08	5.00E-03	5.00E-03	1.78E-06	3.34E-06
Arsenic	4.11E-04	7.67E-04	3.00E-04	3.00E-04	1.37E+00	2.56E+00	NA	NA	NA	NA	NA	NA	9.37E-07	1.76E-06	3.00E-04	3.00E-04	3.12E-03	5.87E-03
Lead	1.85E-03	3.45E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.68E-06	3.16E-06	NA	NA	NA	NA
Aluminum	7.01E-01	1.31E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1.60E-03	3.00E-03	NA	NA	NA	NA
Barium	8.90E-03	1.66E-02	7.00E-02	7.00E-02	1.27E-01	2.37E-01	NA	NA	1.43E-04	1.43E-03	NA	NA	2.03E-05	3.81E-05	7.00E-02	7.00E-02	2.90E-04	5.45E-04
Beryllium	4.05E-05	7.57E-05	5.00E-03	5.00E-03	8.11E-03	1.51E-02	NA	NA	NA	NA	NA	NA	9.24E-08	1.74E-07	5.00E-03	5.00E-03	1.85E-05	3.47E-05
Chromium	1.00E-03	1.87E-03	8.56E-01	8.60E-01	1.17E-03	2.18E-03	NA	NA	5.71E-07	NA	NA	NA	2.29E-06	4.30E-06	8.56E-01	8.60E-01	2.67E-06	5.00E-06
Copper	1.50E-03	2.80E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3.42E-06	6.42E-06	NA	NA	NA	NA
Iron	1.92E+00	3.59E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4.38E-03	8.23E-03	NA	NA	NA	NA
Potassium	1.01E+00	1.88E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.30E-03	4.32E-03	NA	NA	NA	NA
Manganese	8.16E+01	1.52E+02	5.00E-03	1.00E-01	1.63E+04	1.52E+03	NA	NA	1.14E-04	1.14E-04	NA	NA	1.86E-01	3.50E-01	5.00E-03	1.00E-01	3.72E+01	3.50E+00
Sodium	9.10E-01	1.70E+00	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.07E-03	3.90E-03	NA	NA	NA	NA
Thallium	1.46E-02	2.73E-02	7.00E-05	7.00E-04	2.09E+02	3.90E+01	NA	NA	NA	NA	NA	NA	3.34E-05	6.27E-05	7.00E-05	7.00E-04	4.77E-01	8.95E-02
Zinc	4.52E-03	8.44E-03	3.00E-01	2.00E-01	1.51E-02	4.22E-02	NA	NA	NA	NA	NA	NA	1.03E-05	1.94E-05	3.00E-01	2.00E-01	3.44E-05	9.68E-05
1,1-Dichloroethene	5.15E-05	9.61E-05	9.00E-03	9.00E-03	5.72E-03	1.07E-02	NA	NA	NA	NA	NA	NA	7.05E-08	1.32E-07	9.00E-03	9.00E-03	7.83E-06	1.47E-05
1,1-Dichloroethane	2.67E-04	4.99E-04	1.00E-01	NA	2.67E-03	NA	2.65E-08	1.24E-07	1.43E-01	1.43E+00	1.86E-07	8.67E-08	9.74E-06	1.83E-05	1.00E-01	NA	9.74E-05	NA
trans-1,2-Dichloroethene	2.15E-04	4.00E-04	2.00E-02	NA	1.07E-02	NA	7.16E-09	3.34E-08	NA	NA	NA	NA	4.35E-06	8.18E-06	2.00E-02	NA	2.18E-04	NA
cis-1,2-Dichloroethene	1.15E-02	2.14E-02	1.00E-02	1.00E-01	1.15E+00	2.14E-01	6.42E-07	3.00E-06	NA	NA	NA	NA	2.61E-04	4.91E-04	1.00E-02	1.00E-01	2.61E-02	4.91E-03
Methylene Chloride	1.67E-04	3.12E-04	6.00E-02	6.00E-02	2.79E-03	5.20E-03	4.09E-09	1.91E-08	8.57E-01	8.57E-01	4.77E-09	2.22E-08	3.81E-06	7.16E-06	6.00E-02	6.00E-02	6.35E-05	1.19E-04
Vinyl Chloride	8.96E-03	1.67E-02	NA	NA	NA	NA	1.18E-07	5.48E-07	NA	NA	NA	NA	9.19E-05	1.73E-04	NA	NA	NA	NA
Tetrachloroethene	1.75E-02	3.27E-02	1.00E-02	1.00E-01	1.75E+00	3.27E-01	1.74E-06	8.13E-06	NA	NA	NA	NA	2.92E-04	5.48E-04	1.00E-02	1.00E-01	2.92E-02	5.48E-03
Trichloroethene	1.51E-03	2.82E-03	6.00E-03	NA	2.52E-01	NA	1.50E-07	7.00E-07	NA	NA	NA	NA	1.65E-04	3.10E-04	6.00E-03	NA	2.75E-02	NA
alpha-BHC	6.33E-07	1.18E-06	NA	NA	NA	NA	3.77E-11	1.76E-10	NA	NA	NA	NA	2.31E-08	4.34E-08	NA	NA	NA	NA
DDT	7.15E-06	1.33E-05	5.00E-04	5.00E-04	1.43E-02	2.67E-02	4.69E-13	2.19E-12	NA	NA	NA	NA	2.61E-07	4.90E-07	5.00E-04	5.00E-04	5.22E-04	9.80E-04
		Hazard Index =			1.65E+04	1.57E+03		Hazard Index =			1.91E-07	1.09E-07		Hazard Index =			3.78E+01	3.61E+00

NA = Not available

Table 8-42
Non-Carcinogenic Hazards Associated with Ground Water Exposure (MW-9 Only)

COMPOUND:	CDI Ground Water Ingestion		Chronic Oral RfD	Subchronic Oral RfD	Hazard Index GW Ingestion		CDI Ground Water Inhalation		Chronic Inh RfD	Subchronic Inh RfD	Hazard Index GW Inhalation		CDI Ground Water Dermal Absorption		Chronic Oral RfD	Subchronic Oral RfD	Hazard Index Dermal Absorption	
	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child	Adult	Child	(mg/kg-day)	(mg/kg-day)	Adult	Child
1,1-Dichloroethene	5.15E-05	9.61E-05	3.00E-01	2.00E-01	1.72E-04	4.81E-04	5.12E-06	2.39E-05	NA	NA	NA	NA	1.86E-06	3.53E-06	3.00E-01	2.00E-01	6.26E-06	1.77E-05
1,1-Dichloroethane	2.19E-03	4.09E-03	9.00E-03	9.00E-03	2.44E-01	4.55E-01	7.32E-05	3.42E-04	1.43E-01	1.43E+00	5.12E-04	2.39E-04	4.45E-05	8.36E-05	9.00E-03	9.00E-03	4.94E-03	9.29E-03
trans-1,2-Dichloroethene	1.84E-03	3.43E-03	1.00E-01	NA	1.84E-02	NA	1.03E-04	4.80E-04	NA	NA	NA	NA	4.19E-05	7.86E-05	1.00E-01	NA	4.19E-04	NA
cis-1,2-Dichloroethene	5.48E-02	1.02E-01	2.00E-02	NA	2.74E+00	NA	1.34E-03	6.25E-03	NA	NA	NA	NA	1.25E-03	2.35E-03	2.00E-02	NA	6.25E-02	NA
Methylene Chloride	1.64E-04	3.07E-04	1.00E-01	1.00E+00	1.64E-03	3.07E-04	7.19E-04	3.35E-03	8.57E-01	8.57E-01	8.39E-04	3.91E-03	5.62E-04	1.06E-03	1.00E-01	1.00E+00	5.62E-03	1.06E-03
Vinyl Chloride	5.48E-02	1.02E-01	1.00E-02	1.00E-01	5.48E+00	1.02E+00	1.63E-05	7.62E-05	NA	NA	NA	NA	2.74E-06	5.14E-06	1.00E-02	1.00E-01	2.74E-04	5.14E-05
Tetrachloroethene	1.10E-01	2.05E-01	6.00E-02	6.00E-02	1.83E+00	3.41E+00	1.09E-02	5.08E-02	NA	NA	NA	NA	1.20E-02	2.25E-02	6.00E-02	6.00E-02	2.00E-01	3.76E-01
Trichloroethene	5.48E-03	1.02E-02	NA	NA	NA	NA	3.27E-04	1.52E-03	NA	NA	NA	NA	2.00E-04	3.76E-04	NA	NA	NA	NA
		Hazard Index =			1.03E+01	4.89E+00		Hazard Index =			1.35E-03	4.15E-03		Hazard Index =			2.74E-01	3.86E-01

a = Calculated from an Inhalati on RfC and converted using 20m3/day and 70 kg body weight.

NA = Not available

Table 8-43
Non-Carcinogenic Hazard Indices - Surface Soils
Present

COMPOUND:	Surface Soil Ingestion CDI Workers	Surface Soil Ingestion CDI Trespassers	Chronic Oral RfD (mg/kg-day)		Non-Carcinogenic HQ Surface Soil Ingestion Workers	Non-Carcinogenic HQ Surface Soil Ingestion Trespassers	Surface Soils Dermal Absorption CDI Workers	Surface Soils Dermal Absorption CDI Trespassers	Chronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Dermal Absorption Workers	Non-Carcinogenic HQ Dermal Absorption Trespassers
LEAD	2.81E-04	5.39E-05	NA		NA	NA	NA	NA	NA	NA	NA
ARSENIC	6.60E-05	1.27E-05	3.00E-04	a	2.20E-01	4.23E-02	NA	NA	3.00E-04	NA	NA
BERYLLIUM	5.72E-07	1.10E-07	5.00E-03	a	1.14E-04	2.20E-05	NA	NA	5.00E-03	NA	NA
CADMIUM	2.07E-07	3.98E-08	5.00E-04	a	4.15E-04	7.97E-05	NA	NA	5.00E-04	NA	NA
CALCIUM	1.30E-02	2.49E-03	NA		NA	NA	NA	NA	NA	NA	NA
CHROMIUM	5.23E-05	1.01E-05	8.58E-01	a,b	6.10E-05	1.17E-05	NA	NA	8.58E-01	NA	NA
COPPER	1.37E-04	2.63E-05	NA		NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	5.14E-03	9.86E-04	NA		NA	NA	NA	NA	NA	NA	NA
ZINC	9.30E-05	1.78E-05	3.00E-01	a	3.10E-04	5.95E-05	NA	NA	3.00E-01	NA	NA
ALDRIN	1.05E-08	2.01E-09	3.00E-05	a	3.49E-04	6.70E-05	NA	NA	3.00E-05	NA	NA
beta-BHC	2.50E-08	4.80E-09	NA		NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	2.55E-08	4.90E-09	3.00E-04	c	8.51E-05	1.63E-05	NA	NA	3.00E-04	NA	NA
gamma-CHLORDANE	5.14E-09	9.86E-10	6.00E-05	a	8.56E-05	1.64E-05	NA	NA	6.00E-05	NA	NA
PCB 1260	2.24E-07	4.30E-08	NA		NA	NA	8.39E-07	8.05E-08	NA	NA	NA
DDT	1.46E-08	2.81E-09	5.00E-04	a	2.93E-05	5.62E-06	NA	NA	5.00E-04	NA	NA
		Hazard Index =			2.22E-01	4.25E-02		Hazard Index =		NA	NA

(a) = IRIS.

(b) = A 1:6 ratio of Chromium (+3) to Chromium(+6) was used for determining the RfD.

(c) = A toxicity value for endrin aldehyde was not available; therefore, the RfD for endrin was used.

NA = Not Available

Table 8-44
Non-Carcinogenic Hazards Indices - Surface Soils
Future Residential

COMPOUND:	Surface Soil Ingestion CDI Adults	Children	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic Risk Surface Soil Ingestion Adults	Children	Surface Soils Dermal Absorption CDI Adults	Children	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic Risk Dermal Absorption Adults	Children
LEAD	7.86E-04	7.34E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	1.85E-04	1.73E-03	3.00E-04 a	3.00E-04	6.16E-01	5.75E+00	NA	NA	3.00E-04	3.00E-04	NA	NA
BERYLLIUM	1.60E-06	1.50E-05	5.00E-03 a	5.00E-03	3.21E-04	2.99E-03	NA	NA	5.00E-03	5.00E-03	NA	NA
CADMIUM	5.81E-07	5.42E-06	5.00E-04 a	NA	1.16E-03	NA	NA	NA	5.00E-04	NA	NA	NA
CALCIUM	3.63E-02	3.39E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	1.47E-04	1.37E-03	8.58E-01 a,b	8.60E-01	1.71E-04	1.59E-03	NA	NA	8.58E-01	8.60E-01	NA	NA
COPPER	3.84E-04	3.58E-03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	1.44E-02	1.34E-01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	2.60E-04	2.43E-03	3.00E-01 a	3.00E-01	8.68E-04	8.10E-03	NA	NA	3.00E-01	3.00E-01	NA	NA
ALDRIN	2.93E-08	2.74E-07	3.00E-05 a	3.00E-05	9.77E-04	9.12E-03	NA	NA	3.00E-05	3.00E-05	NA	NA
beta-BHC	7.00E-08	6.53E-07	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	7.15E-08	6.67E-07	3.00E-04 c	3.00E-04	2.38E-04	2.22E-03	NA	NA	3.00E-04	3.00E-04	NA	NA
gamma-CHLORDANE	1.44E-08	1.34E-07	6.00E-05 a	6.00E-05	2.40E-04	2.24E-03	NA	NA	6.00E-05	6.00E-05	NA	NA
PCB 1260	6.27E-07	5.86E-06	NA	NA	NA	NA	3.24E-06	8.73E-06	NA	NA	NA	NA
DDT	4.10E-08	3.82E-07	5.00E-04 a	5.00E-04	8.19E-05	7.65E-04	NA	NA	5.00E-04	5.00E-04	NA	NA
		Hazard Index =			6.20E-01	5.78E+00	Hazard Index =				NA	NA

a = IRIS.
b = A 1:6 ratio of Chromium (+3) to Chromium (+6) was used for determining the Rfd.
c = A toxicity value for endrin aldehyde was no available; therefore, the RfD for endrin was used.
NA = Not Available.

Table 8-45
Non-Carcinogenic Hazard Indices - Surface Soils
Future: Recreational

COMPOUND:	Surface Soil Ingestion CDI Adults	Children	Chronic Oral RfD (mg/kg-day)		Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Surface Soil Ingestion Adults	Children	Surface Soils Dermal Absorption CDI Adults	Children	Chronic Oral RfD (mg/kg-day)	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Dermal Absorption Adults	Children
LEAD	1.17E-04	1.09E-03	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
ARSENIC	2.75E-05	2.56E-04	3.00E-04	a	3.00E-04	9.16E-02	8.55E-01	NA	NA	3.00E-04	3.00E-04	NA	NA
BERYLLIUM	2.38E-07	2.22E-06	5.00E-03	a	5.00E-03	4.76E-05	4.44E-04	NA	NA	5.00E-03	5.00E-03	NA	NA
CADMIUM	8.63E-08	8.05E-07	5.00E-04		NA	1.73E-04	NA	NA	NA	5.00E-04	NA	NA	NA
CALCIUM	5.39E-03	5.03E-02	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
CHROMIUM	2.18E-05	2.03E-04	8.58E-01	a,b	8.60E-01	2.54E-05	2.36E-04	NA	NA	8.58E-01	8.60E-01	NA	NA
COPPER	5.70E-05	5.32E-04	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
MAGNESIUM	2.14E-03	1.99E-02	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
ZINC	3.87E-05	3.61E-04	3.00E-01	a	2.00E-01	1.29E-04	1.80E-03	NA	NA	3.00E-01	2.00E-01	NA	NA
ALDRIN	4.36E-09	4.07E-08	3.00E-05	a	3.00E-05	1.45E-04	1.36E-03	NA	NA	3.00E-05	3.00E-05	NA	NA
beta-BHC	1.04E-08	9.71E-08	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA
ENDRIN ALDEHYDE	1.06E-08	9.92E-08	3.00E-04	c	3.00E-04	3.54E-05	3.31E-04	NA	NA	3.00E-04	3.00E-04	NA	NA
gamma-CHLORDANE	2.14E-09	1.99E-08	6.00E-05	a	6.00E-05	3.56E-05	3.32E-04	NA	NA	6.00E-05	6.00E-05	NA	NA
PCB 1260	9.32E-08	8.70E-07	NA		NA	NA	NA	4.82E-07	1.30E-06	NA	NA	NA	NA
DDT	6.09E-09	5.68E-08	5.00E-04	a	5.00E-04	1.22E-05	1.14E-04	NA	NA	5.00E-04	5.00E-04	NA	NA
		Hazard Index =				9.22E-02	8.59E-01		Hazard Index =			NA	NA

(a) - IRIS

(b) = A 1:6 ratio of Chromium(+3) to Chromium(+6) was used for detemining the RfD.

(c) = A toxicity value for endrin aldehyde was not available; therefore, the RfD for endrin was used.

NA = Not Available

Table 8-46
Non-Carcinogenic Hazards Indices - Surface Soils
Future Commercial

COMPOUND:	Surface Soil Ingestion CDI Adults	Chronic Oral RfD (mg/kg-day)		Non-Carcinogenic HQ Surface Soil Ingestion Adults	Surface Soils Dermal Absorption CDI Adults	Chronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Dermal Absorption Adults
LEAD	2.81E-04	NA		NA	NA	NA	NA
ARSENIC	6.60E-05	3.00E-04	a	2.20E-01	NA	3.00E-04	NA
BERYLLIUM	5.72E-07	5.00E-03	a	1.14E-04	NA	5.00E-03	NA
CADMIUM	2.07E-07	NA		NA	NA	NA	NA
CALCIUM	1.30E-02	NA		NA	NA	NA	NA
CHROMIUM	5.23E-05	8.58E-01	a	6.10E-05	NA	8.58E-01	NA
COPPER	1.37E-04	NA		NA	NA	NA	NA
MAGNESIUM	5.14E-03	NA		NA	NA	NA	NA
ZINC	9.30E-05	2.00E-02	a	4.65E-03	NA	2.00E-02	NA
ALDRIN	1.05E-08	3.00E-05	a	3.49E-04	NA	3.00E-05	NA
beta-BHC	2.50E-08	NA		NA	NA	NA	NA
ENDRIN ALDEHYDE	2.55E-08	3.00E-04	a	8.51E-05	NA	3.00E-04	NA
gamma-CHLORDANE	5.14E-09	6.00E-05	a	8.56E-05	NA	6.00E-05	NA
PCB 1260	2.24E-07	NA		NA	8.39E-07	NA	NA
DDT	1.46E-08	5.00E-04	a	2.93E-05	NA	5.00E-04	NA
	Non-Carcinogenic Hazard Index =			2.26E-01	Non-Carcinogenic Hazard Index =		NA

a = IRIS.

b = A 1:6 ratio of Chromium (+3) to Chromium (+6) was used for determining the RfD.

c = A toxicity value for endrin aldehyde was not available; therefore, endrin was used.

NA = Not Available.

Table 8-47
Noncarcinogenic Hazards in Subsurface Soils (Entire Site)
Future: Construction

COMPOUND:	Subsurface Soil Ingestion SDI Workers	Subchronic Oral RfD (mg/kg-day)		Non-Carcinogenic HQ Subsurface Soil Ingestion Workers	Subsurface Soil Inhalation SDI Workers	Subchronic Inhalation RfD (mg/kg-day)		Non-Carcinogenic HQ Subsurface Soil Inhalation Workers	Subsurface Soil Dermal Absorption Workers	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Dermal Absorption Workers
MERCURY	2.87E-07	3.00E-04	b	9.55E-04	1.44E-07	8.57E-05		1.68E-03	NA	3.00E-04	NA
LEAD	2.61E-04	NA		NA	1.31E-04	NA		NA	NA	NA	NA
ARSENIC	3.00E-05	3.00E-04	b	1.00E-01	1.51E-05	NA		NA	NA	3.00E-04	NA
ALUMINUM	8.78E-02	NA		NA	4.41E-02	NA		NA	NA	NA	NA
BERYLLIUM	1.05E-06	5.00E-03	b	2.10E-04	5.26E-07	NA		NA	NA	5.00E-03	NA
CALCIUM	2.53E-02	NA		NA	1.27E-02	NA		NA	NA	NA	NA
CHROMIUM	9.97E-05	8.60E-01	b,c	1.16E-04	5.00E-05	NA		NA	NA	8.60E-01	NA
COPPER	5.62E-05	NA		NA	2.82E-05	NA		NA	NA	NA	NA
MAGNESIUM	1.66E-02	NA		NA	8.35E-03	NA		NA	NA	NA	NA
MANGANESE	1.27E-03	1.00E-01	b	1.27E-02	6.36E-04	1.14E-04	a	5.58E+00	NA	1.00E-01	NA
SODIUM	4.71E-04	NA	b	NA	2.36E-04	NA		NA	NA	NA	NA
THALLIUM	6.95E-04	7.00E-04		9.93E-01	3.49E-04	NA		NA	NA	7.00E-04	NA
VANADIUM	1.24E-04	7.00E-03	b	1.77E-02	6.22E-05	NA		NA	NA	7.00E-03	NA
ZINC	2.38E-04	2.00E-01	b	1.19E-03	1.19E-04	NA		NA	NA	2.00E-01	NA
DDT	1.14E-06	5.00E-04	b	2.28E-03	5.71E-07	NA		NA	NA	5.00E-04	NA
ACETONE	8.64E-06	1.00E+00	a	8.64E-06	4.34E-06	NA		NA	NA	1.00E+00	NA
METHYLENE CHLORIDE	2.03E-07	1.00E+00	b	2.03E-07	1.02E-07	8.57E-01		1.19E-07	NA	1.00E+00	NA
TETRACHLOROETHENE	1.47E-07	1.00E-01	b	1.47E-06	7.37E-08	NA		NA	NA	1.00E-01	NA
TRICHLOROETHENE	1.56E-08	6.00E-03	a	2.60E-06	7.82E-09	NA		NA	NA	6.00E-03	NA
	Hazard Index =			1.13E+00	Hazard Index =			5.58E+00	Hazard Index =		NA

(a) = IRIS.
(b) = HEAST FY 1992.
NA = Not Available.

Table 8-48
Noncarcinogenic Hazards in Subsurface Soils (Spray Pond)
Future: Construction

COMPOUND:	Subsurface Soil Ingestion SDI Workers	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Subsurface Soil Ingestion Workers	Subsurface Soil Inhalation SDI Workers	Subchronic Inhalation RfD (mg/kg-day)	Non-Carcinogenic HQ Subsurface Soil Inhalation Workers	Subsurface Soil Dermal Absorption Workers	Subchronic Oral RfD (mg/kg-day)	Non-Carcinogenic HQ Dermal Absorption Workers
2-Methyl Naphthalene	1.82E-05	NA	NA	9.36E-06	NA	NA	NA	NA	NA
Acenaphthene	1.87E-05	6.00E-01	3.11E-05	9.36E-06	NA	NA	NA	6.00E-01	NA
Anthracene	5.53E-05	3.00E+00	1.84E-05	2.78E-05	NA	NA	NA	3.00E+00	NA
Benzo[a]anthracene	5.49E-05	NA	NA	2.75E-05	NA	NA	NA	NA	NA
Benzo[a]pyrene	8.46E-05	NA	NA	4.24E-05	NA	NA	NA	NA	NA
Benzo[b]fluoranthene	4.18E-05	NA	NA	2.10E-05	NA	NA	NA	NA	NA
Benzo[g,h,i]pyrene	3.35E-05	NA	NA	1.68E-05	NA	NA	NA	NA	NA
Benzo[k]fluoranthene	7.45E-05	NA	NA	3.74E-05	NA	NA	NA	NA	NA
Chrysene	5.94E-05	NA	NA	2.98E-05	NA	NA	NA	NA	NA
Dibenzofuran	1.24E-05	NA	NA	6.22E-06	NA	NA	NA	NA	NA
Fluoranthene	1.46E-04	4.00E-01	NA	7.32E-05	NA	NA	NA	4.00E-01	NA
Fluorene	2.08E-05	4.00E-01	5.19E-05	1.04E-05	NA	NA	NA	4.00E-01	NA
Ideno[1,2,3-c,d]pyrene	2.08E-05	NA	NA	1.04E-05	NA	NA	NA	NA	NA
Phenanthrene	2.48E-04	NA	NA	1.25E-04	NA	NA	NA	NA	NA
Pyrene	1.52E-04	3.00E-01	5.07E-04	7.64E-05	NA	NA	NA	3.00E-01	NA
	Hazard Index =		6.09E-04	Hazard Index =		NA	Hazard Index =		NA

(a) = IRIS.
(b) = HEAST FY 1992.
NA = Not Available.

Table 8-49
SUMMARY OF NONCARCINOGENIC HAZARDS

	INGESTION	INHALATION	DERMAL	TOTAL SITE HAZARD
		GROUND WATER		
FUTURE				
All Wells				
Adults	1.65E+04	1.91E-07	3.78E+01	1.65E+04
Children	1.57E+03	1.09E-07	3.61E+00	1.57E+03
MW-9 Only*				
Adults	1.03E+01	1.35E-03	2.74E-01	1.06E+01
Children	4.89E+00	4.15E-03	3.86E-01	5.28E+00
Entire Site Minus MW-9				
Adults	2.37E+02	2.58E-09	5.59E-01	2.38E+02
Children	4.48E+01	1.21E-08	1.30E-01	4.49E+01
		SURFACE SOILS		
PRESENT				
Workers	2.22E-01	-	NA	2.22E-01
Trespassers	4.25E-02	-	NA	4.25E-02
FUTURE				
Residential				
Adults	6.20E-01	-	NA	6.20E-01
Children	5.78E+00	-	NA	5.78E+00
Recreational				
Adults	9.22E-02	-	NA	9.22E-02
Children	8.59E-01	-	NA	8.59E-01
Commercial				
Adults	2.26E-01	-	NA	2.26E-01
		SUBSURFACE SOILS		
FUTURE EXCAVATION				
Entire Site				
Workers	1.13E+00	5.56E+00	NA	6.69E+00
Spray Pond Area				
Workers	6.09E-04	NA	NA	6.09E-04

NA - Not available.

* - Volatile Organic Compounds only.

calculated (in accordance with EPA, 1989a), for each pathway. As with the hazard quotient, if the hazard index exceeds unity, there may be concern for potential adverse health effects from the exposure pathway.

For future ground water ingestion exposures, all hazard indices were above one with the majority of the hazard due to manganese and thallium. Dermal exposure during showering resulted in hazard indices greater than one with the majority of the hazard due to manganese. Hazard indices for the inhalation during showering scenarios were all less than one.

Surface soil hazard indices were all below one, except for the future residential exposures for children(5.78). The hazard quotient for arsenic exposures via surface soil ingestion exceeded one. Arsenic is the primary contributor of site hazards in surface soil exposures, contributing over 99 percent of the site hazards. Hyperpigmentation, keratosis, and vascular complications may occur with exposure to site soils. However, this is probably an overestimation of the site hazard because soil samples were obtained from a limited area along the railroad tracks. Except for the railroad tracks, the site is almost entirely paved. Thus, any remedial actions aimed at reducing risk should be limited to the area along the railroad tracks.

Subsurface soil hazard indices were below one for the former spray pond area. For the entire site, subsurface soil exposures via ingestion and inhalation were above the threshold level of one. For the ingestion pathway, arsenic and thallium are the primary contributors of hazard; however, because arsenic and thallium have different target organs, toxic effects from exposures are not expected. The spleen is the target organ affected by arsenic exposure. Because the thallium RfD is based on a NOAEL, no adverse effects were observed at the doses monitored. For the inhalation pathway, manganese had a hazard quotient above the threshold of one (5.56). The central nervous system is the target organ for manganese. Actual exposures are expected to be less. The manganese RfC is based on exposure to refinery dust, which is expected to be more toxic than site conditions. Converting the RfC to an RfD also introduces a high degree of uncertainty because exposure duration is not allowed for. Occupational exposures are expected to be chronic, with low doses over an extended period of time, producing a hazard; whereas site exposures are expected to be subchronic in nature.

The total individual hazard of non-carcinogenic effects from the site for each exposure population is considered equal to the sum of the hazards calculated for each exposure pathway as follows:

HI (multipathway) = HI (dermal) + HI (ingestion) + HI (inhalation)

Table 8-49 presents non-carcinogenic hazards for each potential receptor population at the Tacony Warehouse site. All non-carcinogenic hazards were above one for all ground water exposures. Non-carcinogenic hazards for surface soils are all below the threshold for all receptor populations, except for residential children. Subsurface soils yielded a hazard above one for construction workers involved in excavations.

8.3.1.7 Uncertainty Analysis

Although the methods used to calculate carcinogenic risk comply with EPA and industry standards, there are inherent uncertainties associated with the risk estimates discussed previously. These uncertainties exist for a number of reasons, including the following: (1) the need to extrapolate below the dose range of experimental tests; (2) the variability of the receptor population (e.g., smoker vs. non-smoker); (3) assumed dose-response relationships between animals and humans; (4) differences in the postulated versus actual exposure routes associated with the site; (5) overly conservative assumptions; (6) contribution of background risks; (7) sampling variability; and (8) unavailability of toxicity constants for quantitative evaluation.

The assumptions used to estimate exposure were consistently conservative in nature and biased toward protection of human health; therefore, it is likely that risks associated with the site have been overestimated. Additionally, summing all exposures for a given receptor population may yield an overestimation of risk. The residential exposure scenarios yielded unacceptable risks and hazards for ground water exposures. In reality, it is highly unlikely that the aquifer below the Tacony Warehouse site will ever be used as a potable ground water source. Its location in a tidal zone makes its ground water quality inferior and unpleasant for human consumption. Additionally, industrial use of the site vicinity makes it unlikely that residential use will take place on the property.

The EPA is constantly deriving and revising toxicity values (RfDs and SFs). At the time this risk assessment was prepared, a cancer slope factor was not available for lead even though it is classified by EPA as a B2 carcinogen. Inhalation reference doses or reference concentrations were not yet available for a number of compounds. The lack of toxicity values for COPCs contributes to the uncertainty with the risk estimates, and may lead to underestimating risks and hazards posed by the site.

Differences in individual nutrition, health, status, age, sex, and inherited predispositions may affect the likelihood of developing cancer (U.S. DHHS, 1985) more than site-attributed contaminants and there are variabilities in the receptor populations that will predispose certain individuals to developing toxic effects.

It was also assumed that individuals would be exposed to each chemical found on site that elicits an adverse health effect, although in reality, a compound may only have been detected in one or two areas of the site, overestimating risks and hazards posed by the site. Each of the three building blocks of the risk assessment process (monitoring data, exposure scenarios, and toxicity values) contribute uncertainties. This risk assessment is based on the assumption that the available monitoring data adequately describe the extent of constituents present in media at Tacony Warehouse. Environmental sampling produces uncertainties, largely because of the uneven distribution of constituents in environmental media. This source of uncertainty has been reduced by a well designed sampling plan, use of appropriate sampling techniques, and implementation of USATHAMA laboratory data validation and quality assurance/quality control (QA/QC) measures. Use of maximum or 95% UCL concentrations as exposure point concentrations results in estimation of the reasonable maximum exposure and reduces the likelihood of underestimating exposure.

Exposure scenarios and assumptions also contribute to uncertainties in the risk assessment. Exposure doses were calculated based on the assumption that current conditions (i.e., concentrations) would remain stable throughout the exposure period. In reality, natural attenuation processes are expected to reduce contaminant concentrations in ground water, soils, sediments, and surface water. Because actual exposure at the site is unknown, exposure scenarios were developed based on standard default factors, EPA exposure guidance documents, and professional judgment. The exposure scenarios selected are believed to represent reasonable maximum exposure.

8.3.2 Environmental Assessment

There are several potential ecological receptors in the vicinity of the Tacony Warehouse site. Potential ecological receptors include nesting shorebirds and migratory waterfowl residing in the area, as well as shellfish and other aquatic life in the local waters. Exposures of aquatic life and terrestrial wildlife (e.g., birds) downstream of the site would be expected to be minimal because potential contaminants released from the facility would be significantly diluted during transport from the site. Exposure of terrestrial wildlife at the site is unlikely because wildlife habitat is virtually nonexistent due to the fact that most of the area is paved. Exposure of bird species would be negligible based on occasional use. The most probable environmental receptor to surface water is aquatic life in the Delaware River immediately adjacent to the site.

In order to characterize the potential impact on these receptors, the 95% UCL surface water concentrations for each of the surface water indicator chemicals were compared to the Ambient Water Quality Criteria for Freshwater Aquatic Life (AWQC-FAL), as shown in Table 8-50. Because there is some tidal influence in the Delaware River at the Tacony site, surface water concentrations were also compared to the Ambient Water Quality Criteria for Marine Aquatic Life (AWQC-MAL), also shown in Table 8-50. These criteria for the protection of aquatic life specify pollutant concentrations, which should protect most, but not necessarily all, aquatic life and its uses if not exceeded (Federal Register Vol. 45, No. 231, Nov 28, 1990). Cadmium, copper, lead, silver, and zinc were above the AWQC-FAL for acute exposures. All chemicals, excluding arsenic, were above the AWQC-FAL for chronic exposures. All chemicals, excluding arsenic, were above the AWQC-MAL for acute exposures

Table 8-50
Water Quality Criteria and Surface Water Concentrations at the Tacony Site

Compound	95% UCL Surface Water Concentration (mg/L)	Freshwater		Marine		PADER	
		Acute (mg/L)	Chronic (mg/L)	Acute (mg/L)	Chronic (mg/L)	Continuous (µg/L)	Maximum (µg/L)
Aluminum	6.54E+01	NA	NA	NA	NA	NA	NA
Arsenic	8.37E-02	3.60E-01	1.90E-01	6.90E-02	3.60E-02	190	360
Barium	1.00E+00	NA	NA	NA	NA	NA	NA
Beryllium	8.49E-03	NA	NA	NA	NA	NA	NA
Cadmium	1.93E-01	3.90E-03	1.10E-03	4.30E-02	9.30E-03	1.56	6.20
Calcium	1.91E+02	NA	NA	NA	NA	NA	NA
Chromium	5.61E-01	1.70E+00	2.10E-01	NA	NA	300	2,431
Copper	6.56E+00	1.80E-02	1.20E-02	2.90E-03	2.90E-03	16.72	25.97
Iron	4.83E+03	NA	1.00E+03	NA	NA	NA	NA
Lead	6.72E+00	8.20E-02	3.20E-03	2.20E-01	8.50E-03	5.38	138.03
Magnesium	9.44E+01	NA	NA	NA	NA	NA	NA
Manganese	3.08E+00	NA	NA	NA	NA	NA	NA
Mercury	9.78E-04	2.40E-03	1.20E-05	2.10E-03	2.50E-05	0.01	2.40
Nickel	7.10E-01	1.40E+00	1.60E-01	7.50E-02	8.30E-03	233.6	1,998
Potassium	1.66E+01	NA	NA	NA	NA	NA	NA
Silver	6.07E-03	4.10E-03	NA	2.30E-03	2.00E-01	0.20	8.15
Sodium	1.05E+01	NA	NA	NA	NA	NA	NA
Thallium	9.88E-01	NA	NA	NA	NA	18	90
Vanadium	3.72E-01	NA	NA	NA	NA	NA	NA
Zinc	1.90E+01	1.20E-01	1.10E-01	9.50E-02	8.60E-02	149.44	164.99

(1)Federal Register, Vol. 45, No. 231, November 28, 1990.

All PADER Criteria are based on a hardness of 150 mg/L.

and all chemicals were above the AWQC-MAL for chronic exposures.

Pennsylvania Department of Environmental Resources also sets surface water criteria for maximum and continuous exposures. These values are given in Table 8-50. Cadmium, chromium, copper, lead, mercury, nickel, silver, thallium, and zinc are above the PADAR continuous criteria. Cadmium, copper, lead, thallium, and zinc exceeded maximum PADER criteria. All PADER values are based on a hardness of 150 mg CaO_3/L.

Although most chemicals of concern for surface water at the Tacony site have exceeded at least one of the AWQC, it is unlikely that aquatic life will be impacted from site surface water for a number of reasons. There are no true surface water bodies located on site. The samples were collected from storm drains and sumps, where highly developed aquatic life would not be expected to occur. It is unclear if the storm drain system is intact and draining into the Delaware River. Additionally, dilution of stormwater into the Delaware would be at least a hundred-thousand-fold. If the stormwater drain system is not intact, dilution would be even greater because the stormwater would percolate into the ground water before reaching the Delaware River.

Interim sediment quality criteria (SQC) for selected chemicals have been adopted by EPA's Office of Science and Technology for the protection of benthic organisms that spend a significant portion of their lives in river and stream bottoms (EPA, 1991d). SQC are dependent on organic content of the sediments. It was assumed that site sediments had an organic content of 1 percent. This is a conservative assumption because SQC will be higher for lower organic contents. Interim sediment criteria and sediment concentrations are presented in Table 8-51.

Site sediment concentrations were also compared to Effects Range-Moderate (ERM) and Effects Range-Low (ERL) values, presented in Table 8-51. The ERM and ERL values were established by the National Oceanic Atmospheric Administration (NOAA) using studies where effects were either predicted or observed in association with increasing contaminant concentrations. The ERL is the concentration in the lower 10th percentile in which effects had been observed. The ERM is the concentration approximately midway (50th percentile) in the

Table 8-51
Sediment Quality Criteria for COPC

Compound	95% UCL Sediment Concentration (mg/kg)	Interim Sediment Quality Criteria(1) 95% UCL		Biological Effects Range Criteria(2)	
		FCV(a) (mg/kg)	FRV(b) (mg/kg)	ERM(c) (mg/kg)	ERL(d) (mg/kg)
Aluminum	1.33E+04	NA(e)	NA	NA	NA
Arsenic	4.91E+01	NA	NA	8.60E+01	3.30E+01
Beryllium	1.56E+00	NA	NA	NA	NA
Cadmium	9.65E+00	NA	NA	9.00E+00	8.00E+00
Chromium	5.72E+02	NA	NA	1.45E+02	3.00E+01
Copper	8.18E+02	NA	NA	3.90E+02	7.00E+01
Iron	1.01E+05	NA	NA	NA	NA
Lead	2.56E+03	NA	NA	1.10E+02	3.50E+01
Magnesium	8.27E+03	NA	NA	NA	NA
Manganese	6.97E+02	NA	NA	NA	NA
Mercury	7.20E-01	NA	NA	1.30E+00	1.50E-01
Nickel	9.03E+01	NA	NA	5.00E+01	3.00E+01
Potassium	2.44E+03	NA	NA	NA	NA
Silver	1.79E+00	NA	NA	2.20E+00	1.00E+00
Sodium	7.87E+02	NA	NA	NA	NA
Thallium	5.18E+02	NA	NA	NA	NA
Vanadium	1.41E+02	NA	NA	NA	NA
Zinc	2.04E+03	NA	NA	2.70E+02	1.20E+02
Acetone	3.99E+00	NA	NA	NA	NA
1,4-Dichlorobenzene	3.70E-03	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	8.10E+01	NA	NA	NA	NA
Butylbenzyl phthalate	2.83E+01	NA	NA	NA	NA
Benzo[a]anthracene	2.24E+00	NA	NA	1.60E+03	2.30E+02
Benzo[g,h,i]perylene	1.70E+00	NA	NA	NA	NA
Di-n-butyl phthalate	5.39E+01	NA	NA	NA	NA
Fluoranthene	4.82E+00	4.70E+00	NA	3.60E+03	6.00E+02
Phenanthrene	5.59E+00	3.26E-01	NA	1.38E+03	2.25E+02
Pyrene	1.26E+01	NA	NA	2.20E+03	3.60E+02
gamma-Chlordane	3.90E-01	NA	NA	6.00E+00	5.00E-01
Heptachlor	6.44E-01	NA	NA	NA	NA
Isodrin	2.90E-01	NA	NA	NA	NA
PCB 1260	4.44E+01	NA	NA	4.00E+02	8.00E+01

(1) U.S. EPA/1991d.
(2) Long and Morgan, 1990.

Notes:
(a) FCV = Final Chronic Value; the concentration protecting aquatic life from chronic toxicity.
(b) FRV = Final Residue Value; the concentration protecting uses of aquatic life.
(c) ERM = Effects Range (moderate).
(d) ERL = Effects Range (low).
(e) NA = Not Available.

range of reported values associated with biological effects (Long and Morgan, 1990). Neither the ERM or ERL criteria were exceeded for organic constituents evaluated for sediments. All ERL values were exceeded for metals; ERM values for cadmium, copper, lead, nickel, and zinc were exceeded. Although several site sediment concentrations were several orders of magnitude above the SQC and ERM, these are sediment concentrations from the site storm drains and sump, not the Delaware River. There is expected to be little or no aquatic life in these site storm drain systems. Additionally, because of detrital material, organic content in the storm drains and sumps is expected to be well above 1 percent.

Although there are no designated wetlands areas in the vicinity of the Tacony Warehouse, there are several tidal flats present at the confluence of tributary streams into the Delaware River and land abutments; however, none of these areas are immediately adjacent to the site, and, therefore, these areas would not be expected to be impacted by runoff from the site. The land surrounding the site is intensely developed, so that few wooded areas exist, according to the USGS topographic map (Frankfort Quadrangle) for the area and visual observations.

8.4 CONCLUSIONS

The risk assessment for the Tacony Warehouse in Philadelphia, Pennsylvania, was done in accordance with available EPA guidance and documentation. The site was evaluated as a whole for most exposure scenarios, and divided into two areas to assess isolated areas with high concentrations of specific chemicals that were uncharacteristic of the entire site. Conservative assumptions were used throughout to estimate reasonable maximum exposures to potential receptor populations.

Carcinogenic risks were above the target risk range of 1E-04 to 1E-06 for future residents via ingestion of ground water and incidental ingestion of soil. Arsenic provides most of the risk in surface soil ingestion and arsenic, vinyl chloride, and tetrachloroethene provide most of the risk for ground water ingestion.

Non-carcinogenic indices exceeded unity for the potential future on-site residential populations (ingestion of ground water, dermal contact with ground water, and ingestion of surface soil) and future construction worker populations (ingestion of subsurface soil and inhalation of subsurface soil). Ingestion of manganese and thallium followed by arsenic, cis-1,2-DCE, and tetrachloroethene contribute most of the noncarcinogenic hazards through ground water ingestion. Arsenic is primarily responsible for the hazard associated with ingestion of surface soil. Arsenic and thallium are primarily responsible for the hazard associated with ingestion of subsurface soil. Manganese is solely responsible for the potential hazard associated with dust inhalation and dermal contact with ground water.

Although future exposure to chemicals from residential use of the shallow water-bearing zone has been evaluated for the purpose of this risk assessment and potentially significant risks and hazards were calculated, there are several factors that would make this pathway very unlikely. First, the site is located along the industrial waterfront of the Delaware River, within a commercial and light industrial area that is separated from residential areas of Philadelphia by Interstate 95. A section of the site lies within the 100-year flood plain. Subsequently, the likelihood of this area converting to residential in the future is slim. Second, the crystalline rocks of the Coastal Plain are dense and, when unaltered, are virtually impervious to water. Joints, fractures, and weathered zones, which comprise only a small part of the total rock volume, provide the majority of water storage and movement of small volumes of ground water in the bedrock. The bedrock in the vicinity of the site is at a depth of 35 feet below grade. Since the average water table depth at the site is 10 feet below grade, the total shallow water zone thickness is approximately 25 feet. Third, as indicated in Section 2.6.2 (Hydrogeology) of this report, the quality of the shallow ground water in the Philadelphia area has depreciated as a result of urban development. Most of the recharge area for the aquifer is covered either with pavement or buildings. As a result, the recharge rate in the area tends to be slow. As an example, Section 3.4.2 (Well Development and Well Redevelopment) of this report stated that during the well development process at the site, many of the wells revealed excessive draw down to the point of near dryness (i.e., the aquifer recharge did not facilitate sustained pumping). In addition, historic analysis of water table wells in the Philadelphia area indicate that ground water does not meet recommended standards for drinking water supplies or industrial cooling use. Subsequently, it is not likely that the shallow water-bearing zone in the vicinity of the site would ever be used for residential purposes. In addition, drinking water for distribution to residents in Philadelphia is collected in an intake on the Delaware River, approximately 2 miles upstream of the site.

Although current exposure to chemicals in the surface soil by on-site workers and trespassers at the site were investigated in this report, the likelihood of exposure from this pathway is remote. Over 96 percent of the site is paved. Consequently, the only bare soil available to human exposure is in the vicinity of the railroad tracks on the site. Since most activity at the site centers around the three buildings, it is doubtful that any appreciable incidental exposure to soil (via ingestion or dermal absorption) during work activities will occur. In addition, the site is encircled with cyclone fencing topped with barbed wire, and access to the site is controlled by a 24-hour guard gate. Subsequently, it is anticipated that unauthorized access to the site would be sporadic at best.

The potential for future residential exposure to chemicals in surface soils is anticipated to be even less than that for current worker exposure. In the event that residences are constructed on the site and the railroad tracks are still used, some protective barriers would have to be erected to protect residents from train-related dangers. In the event that the tracks are no longer in use, then it can be assumed that they would be removed from the site along with the surficial soil underlayment for safety and aesthetic purposes during the residential development process.

Hazard indices slightly greater than unity were calculated for future construction workers via inhalation of fugitive dusts (HI=5.56) and incidental ingestion of soil (HI=1.13). The fugitive dust model used to estimate exposures almost certainly provides an overestimate of dust exposures because (1) it was developed based on emissions from bulldozer operations during surface mining operations rather than the less intensive earth-moving operations involved in excavation activities that may occur at the Tacony site; (2) it assumes, very conservatively, that the bulldozer is operating

SECTION 9.0

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