PHASE III - SITE CHARACTERIZATION REPORT
FORMER C-E CAST FACILITY
MUSE, PENNSYLVANIA

DRAFT

Submitted to:

Pennsylvania Department of Environmental Resources

Prepared for:

Prospect Hill Management Corporation

Prepared by:

ABB Environmental Services, Inc.
Portland, Maine

Project No. 5832-24

December 1994

C-E CAST

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1.0 EXECUTIVE SUMMARY

ABB Environmental Services, Inc., at the request of Prospect Hill Management Company, a subsidiary of Combustion Engineering, has prepared this *Phase III Site Characterization Report* for the former C-E Cast facility located in Muse, Cecil Township, Washington County, Pennsylvania. This report was designed to fill in the data gaps remaining after the Phase II Field Investigation. The Phase III investigation further characterizes the nature and distribution of volatile organic compounds and semivolatile organic compounds in groundwater at the site and provided information about on-site soils necessary to develop the Remedial Action Plan.

Previous environmental activities at the site included construction and maintenance of an on-site landfill cell, permitting activities, and the two previous phases of this investigation. The first two phases of this investigation coincided with closure activities which included machine removal and demolition of the facility.

The purpose of the Phase III investigation was to more fully characterize groundwater and Area 1 soils at the site. Phase III activities included installation of five additional monitoring wells, a fourth round of groundwater monitoring from all the wells, an in-depth analysis of hydrogeology of the site, analysis of soil from Area 1 for hazardous characteristics, a topographic survey, and analysis of surface water and sediment samples.

The results of the Phase III - Site Characterization confirmed Area 1 and Area 2 as potential sources of groundwater contamination. Site-related compounds have migrated in relatively low concentrations via groundwater to off-site areas downgradient of Area 1. Groundwater impacted from Area 2 has remained within site boundaries.

Based on these results, ABB Environmental Services, Inc. recommends that impacted soil from Area 1 be treated on site with Low-Temperature Thermal Desorption. Upon PADER approval, soils exceeding PADER2 criteria for groundwater protection would be excavated, treated on-site, and backfilled. This remedial action would remove one of the sources of groundwater contamination. Once the source of contamination is removed from Area 1, contaminants in groundwater impacted from this area will attenuate through natural degradation.

To mitigate impact to groundwater from Area 2, the concrete cap atop the area will be re-sealed and stormwater will be diverted around the area. Perimeter monitoring wells would be monitored biannually to gauge the effectiveness of remedial activities and to determine if further action is needed.

2.0 INTRODUCTION

ABB Environmental Services, Inc. (ABB-ES), at the request of Prospect Hill Management Corporation (PHMC), a subsidiary of Combustion Engineering, has prepared this *Phase III Site Characterization Report* for the former C-E Cast facility (the Site) in Muse, Cecil Township, Washington County, Pennsylvania. The Phase III Site Characterization was designed to address data gaps remaining after the Phase II Site Investigation. At the Site, the Phase III investigation was designed to more fully characterize the nature and distribution of volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) in groundwater on-site and to provide information about on-site soils necessary to develop a soil remediation Work Plan.

Site investigation activities began with a monitoring well installation and soil sampling program on July 11, 1994 and proceeded through groundwater sampling completed on August 14, 1994. The investigation included soil boring and monitoring well installation, soil sampling, surface water and groundwater sampling, laboratory analysis and a topographic survey of exploration points.

This report satisfies the requirements the Pennsylvania Department of Environmental Resources' (PADER) interim *Environmental Investigation Guidelines* (March 1994) for a Phase III Site Characterization Report. Section 2.0 presents a site description and history as well as the regional physical characteristics. Section 2.0 also summarizes previous investigations. Section 3.0 describes the Phase III Site Characterization. Section 4.0 summarizes the physical aspects of the Site including topography, geology, and hydrogeology. Section 5.0 summarizes the analytical results and presents the Site conceptual model. Section 6.0 characterizes migration and exposure pathways. Section 7.0 contains conclusions and recommendations for the Phase IV Site Remediation.

2.1 SITE HISTORY

The C-E Cast facility is north of the Village of Muse. The H.C. Frick Coal Company (Frick) founded the village to house workers for its National No. 3 coal mine, which underlies the Site and part of the village (Figure 2-1). Frick and the United States Steel Co. (now USX) operated the coal mine from 1923 until January 26, 1953, when USX closed the mine. Coal mine-related facilities included a mule barn, a maintenance shop, coal storage sheds, lamp house, hoist house, and a blackwater lagoon (used for disposal of coal wash water). An entrance to the mine, Shaft No. 3, is located on-site (Figure 2-2).

In 1953, USX sold the real estate, but not the mine, to Chemical and Solvents, Inc., which managed a chemical recovery and recycling operation at the site. Chemical recovery facilities included a railroad siding where chemicals were unloaded, aboveground storage tanks where chemicals were stored, and a large distillation or "cracking" tower and other smaller stills where chemicals were recovered (see Figure 2-2). In 1968, the property was sold to Combustion Engineering. C-E Cast, a subsidiary of Combustion Engineering, continued the chemical recovery operations and manufactured and sold chemical additives and equipment to the castings industry. The chemical recovery operation was discontinued after two years, but manufacturing of additives and equipment continued until 1985.

In 1985, Combustion Engineering sold the C-E Cast business and leased the property to CastAmerica. CastAmerica ceased operations in May 1987, selling their patents and goodwill to Ashland Chemical.

Except for one building, the facility has been idle since 1987. This building was leased, in July 1987, by Castec for an equipment assembly and spare parts operation (see Figure 2-2). In late 1992, Combustion Engineering (~~now ABB, Inc.~~) decided to complete a voluntary closure of the facility. ABB-ES was retained to oversee the facility closure, including removal of process equipment and demolition of the plant buildings.

At the time of the Phase III investigation in July 1994, all site closure activities had been completed, including a closure site investigation, asbestos removal, equipment and building salvage, and demolition of all site buildings. Castec vacated Building 1 in December 1993. Salvage and demolition of Building 1 was completed in the spring of 1994.

2.2 PREVIOUS INVESTIGATIONS

Combustion Engineering, Inc. has conducted various environmental activities and site investigations at the former C-E Cast facility prior to the current Phase III investigation. These included construction and maintenance of a landfill on-site, permitting activities, and two previous site investigations.

2.2.1 Previous Environmental Work On-site

Previous environmental work at the C-E Cast facility includes construction of a landfill cell designed for the storage of waste generated before 1979. The cell was constructed as a result of a consent decree with PADER and was designed by Penn Environmental, now a unit of NUS Corporation. As part of this program, Penn Environmental also designed closures for the blackwater lagoon and for the decommissioning of the lagoons on the southern portion of the Site. In addition to the wastes, dump areas along the unnamed tributary to Brush Run were removed and the contents placed in the landfill cell. Work was completed in 1980.

A National Pollutant Discharge Elimination System (NPDES) Permit was obtained by Combustion Engineering as a result of these closure activities in 1979 and 1980. Monitoring of the discharge point was discontinued in the spring of 1993 based on recommendations and approval by PADER.

2.2.2 Site Closure Investigation

ABB-ES initiated the voluntary site closure investigation activities in the spring of 1993. Activities included the installation of six groundwater monitoring wells and one soil boring at the site (Figure 2-3). These explorations along the perimeter of the historically active portion of the site were designed to confirm the absence of any impact on soils from past site activities. The soil boring was completed in the former location of the black water lagoon. Three soil samples, groundwater samples from the six wells, and one sample of mine water from Shaft No. 3 were collected and analyzed for VOCs, SVOCs, and selected inorganics.

The soil samples contained total concentrations of VOCs ranging from 170 to 2,608 micrograms per kilogram (μg/kg), including chlorinated solvents and toluene, ethylbenzene, and xylenes. Two soil samples contained significant concentrations (77 and 640 μg/kg) of vinyl chloride, a relatively mobile and toxic VOC that can form from the natural biodegradation of some chlorinated solvents.

VOCs and SVOCs were detected in samples from four of the six monitoring wells and in the mine water sample (Table 2-1). The highest concentrations were detected in groundwater from monitoring well MW-2, located in the former railroad siding used for unloading chemicals next to the location of the former chemical reclamation activities. Groundwater from this well contained more than 485,000 micrograms per liter (μg/L) of VOCs (including chlorinated solvents and benzene, toluene, ethyl benzene, xylenes, and styrene [BTEXS]) and lower concentrations (less than 150 μg/L of total SVOCs) of semivolatile polycyclic aromatic hydrocarbons (PAHs) and phthalates. Vinyl chloride was detected in monitoring well MW-3 at 23 μg/L.

Lower concentrations of total VOCs were detected in monitoring wells MW-3 (26 μg/L), MW-5 (13 μg/L), and MW-6 (126 μg/L). These wells are located south and downgradient of the former storage tank area and black water lagoon, south of the facility, and east and downgradient of the facility, respectively.

The mine water sample contained 383 μg/L of VOCs (chlorinated solvents and BTEXS) and 202 μg/L of SVOCs (PAHs and phthalates). The mine water sample also contained a trace concentration (estimated at 3 μg/L) of vinyl chloride.

Upon receipt of the preliminary results, on August 12, 1993, Combustion Engineering, Inc., the property owner, formally notified PADER of the presence of these compounds in site groundwater.

2.2.3 Phase II Site Investigation

A Phase II Site Investigation was performed in September 1993 to further characterize the extent of VOCs and SVOCs detected at the Site and to provide the information necessary to support the evaluation of remedial alternatives. The Phase II Site Investigation included:

- completion of 67 soil borings;
- collection of 151 soil samples and field analysis for BTEXS and chlorinated solvents;
- installation of seven groundwater monitoring wells;
- field survey of new groundwater monitoring wells and selected soil borings;

- collection of three surface water samples for laboratory/field analysis for VOCs; and
- collection of one round groundwater samples from all existing wells and the mine shaft.

Samples were analyzed for VOCs and SVOCs.

In addition to the Phase II Site Investigation, three groundwater monitoring wells were installed as part of the landfill monitoring program, and a complete round of groundwater samples was collected in April 1994. Figure 2-3 shows Phase II soil boring, monitoring well, and surface soil and surface water sample locations. In March 1994, a Phase II Site Investigation Report was submitted to PADER. No comments were received from PADER on the report or its recommendations; however, PADER representatives were on-site during the Phase III investigation and provided recommendations concerning sampling locations.

Phase II activities focused on three areas (Figure 2-4). Two of these areas were 14
suspected source areas; the third area was investigated as a potential borrow area 16
for fill. The investigation included installation of 24 soil borings in Area 1, 20 soil 60 60
borings in Area 2, and 16 soil borings in Area 3, the potential borrow area. The
soil samples collected from the borings were analyzed for VOCs. The highest
concentrations of VOCs were detected in soils collected from Area 1. 16 or 23

24 Area 1 - In Area 1, VOCs were detected in soil collected from 17 of the 21
20 borings. Twenty-two soil samples were collected from 15 borings for extended run
16 analysis which provided concentrations of individual chlorinated solvents as well
as BTEXS.

60 A comparison of the results to PADER criteria indicate that soil collected from five borings (SB-N02, SB-N03, SB-N04, SB-N06, and SB-N06A) exceeds groundwater protection criteria. Results from the total halogenated VOC analysis indicate that soil collected from five borings (SB-N04, SB-N05, SB-N06, SB-N07, and SB-N17) contains concentrations of total halogenated compounds that are likely to exceed the soil remediation criteria for individual VOCs.

Six borings intercepted a 0.5 to 2-foot-thick layer of oily fill between zero and 4 feet below ground surface (bgs). The horizontal continuity of the oily fill layer is unknown; however, it appears to underlie the area along the former railroad bed between borings SB-N02 and SB-N05 and extending southeast toward SB-N07 and SB-N17.

Area 2 - In Area 2, halogenated VOCs were detected in soil collected from 16 of the ⑲ borings. Twenty-three soil samples were collected from 18 borings for extended run analysis.

Chlorinated VOCs and BTEXS were detected between 7 and 57 feet bgs in Area 2. Chlorinated solvents, and BTEXS were detected at concentrations greater than PADER2 criteria in a soil sample collected from SB-N04 at 17 feet bgs. Vinyl chloride was detected at significant concentrations (greater than 18 μg/kg] in five borings (SB-S05 through SB-S08, and SB-S10) from 7 feet to 35 feet bgs.

Area 3 - In Area 3, no VOCs were detected in the accelerated run analysis. The results from the extended run analysis indicated that soil collected from SB-N08 at 2 feet bgs exceeds PADER2 criteria.

3.0 PHASE III SITE CHARACTERIZATION

The Phase III Site Characterization investigation included the following actions designed to address data gaps identified during Phase II:

- characterize groundwater quality on the eastern perimeter of the Site downgradient of monitoring well MW-102 to confirm that contaminated groundwater is not leaving this portion of the Site;
- characterize aqueous contaminants and possible dense non-aqueous phase liquid (DNAPL) migration north of Area 1 along the former railroad bed to confirm that the oily substance identified in the fill has not migrated to the north along the clay surface or within the railroad bed materials;
- characterize groundwater quality on the southern perimeter of the Site, along the relict swale to confirm that contaminated groundwater is not leaving this portion of the Site;
- characterize groundwater flow, bedrock surface, and possible contaminant migration west of Area 2 to confirm that contaminated groundwater is not leaving this portion of the Site;
- characterize surface water at the inflow of the marsh to the north of the Site to confirm that site-related compounds are not impacting the marsh; and
- characterize the sediments both upgradient and downgradient from the marsh to confirm that Site-related compounds are not impacting the marsh.

Phase III field work, outlined in the Phase III Work Plan (Appendix A), included soil borings, subsurface soil sampling, monitoring well installation, groundwater sampling, surface water sampling, and a topographic survey. Exploration locations are shown on Figure 3-1.

3.1 SOIL BORINGS

Five soil borings were completed for the installation of monitoring wells and for characterization of soils along the perimeter of the site property and downgradient from Area 1. The soil borings were completed using both the hollow-stem auger and solid-stem auger drilling methods. Soil samples were collected using a 3-inch outside diameter 2-foot long split-spoon sampler, screened for VOCs using a photoionization detector (PID), and visually characterized and logged by an ABB-ES geologist. Soil boring logs are presented in Appendix B. Soil borings were completed with the installation of groundwater monitoring wells (see Section 3.2).

Four additional soil borings were completed in Area 1 to characterize soil for remedial alternatives. Borings were advanced by driving a 3-inch outside diameter split-spoon sampler. Soil samples were collected in appropriate containers and submitted to Enseco Northwest (now QUANTERRA, Inc.) of North Canton, Ohio for VOCs, SVOCs, hazardous waste characteristics (ignitability, reactivity, corrosivity, Toxicity Characteristic Leaching Procedure [TCLP] VOCs and SVOCs), and total organic carbon.

3.2 GROUNDWATER MONITORING WELL INSTALLATION

Five groundwater monitoring wells (MW-201 through MW-205) were completed to characterize contaminant distribution along the site perimeter and to further assess groundwater flow patterns across the Site (see Figure 3-1). Monitoring well location rationale and construction details are presented in Tables 3-1 and 3-2, respectively.

Monitoring wells were installed with 2-inch inside diameter, threaded, flush-joint, Schedule 40 polyvinyl chloride, with 10-foot lengths of 0.010-inch machine-slotted well screens. Wells were constructed with a washed silica sand filter pack around the well screen extending 2 feet above the top of the wellscreen. A minimum of 2 feet of bentonite pellets were installed above the filter pack, and the annulus was then backfilled with bentonite grout and completed with a protective casing and locking cap. The screened intervals were chosen to intercept the water table based on field observations with approximately 3 feet of wellscreen placed above the observed water table to allow for seasonal fluctuation. Monitoring well installation diagrams are presented in Appendix C.

Following completion, each well was developed to ensure an adequate hydrogeologic connection between the aquifer and the well. The wells were developed by alternately surging and pumping until the purge water was clear, or until field measurements of pH, specific conductivity, and temperature stabilized.

During the topographic survey, monitoring well MW-201 was determined to be off-site. This well was subsequently decommissioned following PADER procedures for well removal as per PHMC request.

3.3 GROUNDWATER SAMPLING

To assess the nature and distribution of Site chemicals in groundwater, samples were collected from the five new wells and 13 existing wells. Following the well development, new monitoring wells were allowed to equilibrate with the surrounding aquifer for a minimum of 14 days prior to sampling. All monitoring wells were then purged for a minimum of five well volumes or until dry. Field measurements of pH, temperature, and specific conductivity were recorded during purging. Purge water was containerized in DOT-approved 55-gallon drums for appropriate disposal.

Groundwater samples were collected in the appropriate pre-preserved containers and submitted to Enseco Northwest Laboratory of North Canton, Ohio for analysis. Groundwater samples collected from the new wells were analyzed for VOCs and SVOCs. Groundwater samples collected from existing wells were analyzed for VOCs only, except monitoring wells MW-2 and MW-102, which had a history of SVOC contamination during previous sampling events.

3.4 SURFACE WATER SAMPLING

Two surface water samples were collected to characterize groundwater and surface water interconnection and to assess surface water as a migration pathway for site-related compounds. Sample locations were chosen in the field based on discussions with PADER (see Figure 3-1). Surface water sample SW-201 was collected from a drainage ditch parallel to the railroad bed north of Area 1 to evaluate groundwater and surface water interaction in the vicinity of MW-203 and along the railroad bed. Surface water sample SW-202 was collected from an unnamed intermittent stream located to the south of the Site to evaluate surface water and groundwater interaction in the vicinity of MW-205. Surface water samples were submitted to Enseco Northwest Laboratory of North Canton, Ohio and analyzed for VOCs and SVOCs.

3.5 SEDIMENT SAMPLING

Five sediment samples, including one duplicate sample, were collected to characterize site impacts to stream and marsh sediments. The Phase III Work Plan initially specified two sediment samples; a second sample at each location was added in response to PADER's request for vertical characterization of sediments. Two samples, one each from 0 to 6 inches and 12 to 18 inches bgs, were collected from location SD-201 located upstream from the marsh area, downstream from Area 1 (see Figure 3-1). Two samples, one each from 0 to 6 inches and 12 to 18 inches bgs, were collected from location SD-202 located at the Site discharge into the marsh (see Figure 3-1).

Sediment samples were collected using stainless steel spoons, composited in the field and submitted to Enseco Northwest Laboratory for analysis of VOCs, SVOCs, and fraction organic carbon.

3.6 TOPOGRAPHICAL SURVEY

All new groundwater monitoring wells, MW-201 through MW-205, were surveyed by Mounts Engineering to a vertical accuracy of 0.01 feet and a horizontal accuracy of 0.1 feet. Locations of soil samples collected for remedial characteristics were surveyed for a horizontal accuracy of 0.1 feet.

4.0 PHYSICAL SITE CHARACTERISTICS

The physical characteristics of Site topography, geology and hydrogeology are presented in this Section.

4.1 GEOGRAPHIC SETTING

The Site is located on a hill north of Muse (see Figure 2-1). The 83-acre property contains approximately 17 acres of coal mine tailings. Approximately 10 acres were developed with buildings, tank farms, and parking. The remaining 56 acres were unused.

Frick opened the National No. 3 mine in 1923 to work Pittsburgh coal. National No. 3 is approximately 11,300 acres in extent, and is L-shaped, with the longer leg oriented approximately N25E and the shorter N65W. An entrance to the mine, Shaft No. 3, is located on-site. This shaft is 312 feet deep from a ground surface elevation of approximately 1,200 feet mean sea level (MSL). Limited data regarding mine operations are available; records from the mine apparently were lost when operations ceased (January 26, 1953). The mine shaft under the Site was filled and abandoned in July 1994.

Two other mines, National No. 1 and National No. 2, reportedly are connected to National No. 3 (A. Graziani, 1993). National No. 3 is also reportedly connected to a mine owned by the Henderson Coal Company, located south and east of National No. 3. Water level measurements obtained from Shaft No. 3 during this study indicated that up to 200 feet of water may be present in the shaft.

4.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The Site is located in the Pittsburgh Plateaus Section of the Appalachian Plateaus Province (Socolow, 1962). The local area is characterized by a dissected plateau whose remnant surface is present at an elevation of approximately 1,300 to 1,350 feet MSL (USGS, 1979).

The Site is located in an area mapped as the Waynesburg formation of the Dunkard Group and the Monongahela formation (Wagner et. al., 1975). These formations are cyclic sequences of sandstone, shale, limestone, and coal. The Waynesburg coal occurs at the base of the Waynesburg, and the Pittsburgh coal occurs at the base of the Monongahela. These formations are nearly flat-lying as shown in outcrops in the Site vicinity. The Site lies on the western side of the axis of the Pittsburgh-Huntington Basin and the underlying bedrock dips gently east, toward the axis (Wagner et. al., 1974).

As described by Wagner et. al. (1975), groundwater occurs primarily in fractures in the limestones, and in intragranular pore spaces within the sandstones. The shales are described as rather impermeable, with groundwater present only in fracture or joint systems. Reported well yields are generally low because of tight, scarce fractures which do not transmit significant quantities of water.

4.3 LOCAL GEOLOGY AND HYDROGEOLOGY

Ten acres, previously developed with buildings, tank farms, and parking, were razed in 1993 and 1994. Site elevations vary from approximately 1,270 feet MSL in the north-central portion sloping to 1,110 feet MSL in the southern portion of the Site. Approximately 27 acres of the original Site topography have been obscured by activities including grading and disposal of mine tailings and the construction of the landfill in 1980. Figure 4-1 shows current Site topography.

The soil beneath the disturbed portions of the Site consists predominantly of fill overlying a clayey weathered shale. The overburden ranges from approximately 1.5 feet thick at MW-101 to approximately 40 feet thick at MW-107. The thickness of fill is variable across the Site. The fill generally increases in thickness toward the southwest and is thickest across the western portions of the Site. Toward the northern end of the Area 1, a layer of oily fill is present in a low area in the clay. The oily fill appears to be located on top of the clay and weathered shale which acts as a barrier to downward migration of any spilled organic liquids. No fill was encountered at the base of the hill toward the east.

The weathered shale underlying the fill and native soils exhibits nearly horizontal bedding planes and shaley partings when dry. When wet, these partings are not visible and the weathered shale resembles massive clay. Cross-section orientations are presented on Figure 4-1. Cross-sections A-A', B-B', and C-C' are presented in Figures 4-2, 4-3, and 4-4 respectively.

Bedrock encountered in borings and monitoring wells at the Site was primarily weathered shale and limestone (mapped as the Waynesburg and/or Monongahela Formations [Wagner et, al., 1975]). The shale, as encountered in soil borings, is light to dark gray, and brown and gray, with nearly horizontal bedding plane partings. Weathering ranges from slight to extreme, and in several locations, the shale has been weathered to clay.

Bedrock surface topography (Figure 4-5) exhibits a local high near MW-101, forming an almost north-south ridge dipping steeply to the east and west, and less steep to the south. To the east, the surface topography roughly follows the bedrock surface, to the west, the bedrock flank has been filled with mining tailings.

Groundwater is present at depths ranging from the surface to deeper than 75 feet bgs in MW-107. Near-surface groundwater appears to occur in several shallow (less than 5 feet bgs) perched zones at the Site. The surface of the first encountered continuous water-bearing zone generally follows the surface topography. Groundwater appears to flow predominantly to the east and southeast (Figure 4-6). Groundwater elevation measurements are present in Table 4-1.

The influence of the thick cover of mine tailings and reworked topography is evidenced in the flattening hydraulic gradient in the vicinity of the former buildings. The hydraulic gradient across the Site ranges from 0.04 feet/feet to 0.1 feet/feet. Perched water flowing in this area is potentially influenced by the coarse gravel used to install the railroad bed. The former railroad bed may be acting as a zone of higher hydraulic conductivity and a preferred pathway. Analytical data from Phase II also suggest a north-south component of groundwater flow in the area.

The hydraulic conductivity of the weathered clay and bedrock beneath the Site range from $2x10^{-5}$ to $6x10^{-4}$ centimeters per second (cm/sec) and based on an estimated aquifer thickness of 20 feet, transmissivity ranges from $2x10^{-1}$ to $9x10^{-3}$ centimeters squared per second (cm^2/sec). Using an estimated effective porosity of 0.25, groundwater velocity across the Site ranges from 2.4 feet/year to 243 feet/year. Using the mean of the calculated hydraulic conductivity of $2x10^{-4}$ cm/sec, the average groundwater velocity is approximately 80 feet/year. Hydraulic conductivity data and calculations are presented in Appendix D.

Topographic maps of the mine area, dated 1927, show a drainage swale running south from the western side of the Site. Groundwater appears to discharge at the base of the relict drainage swale near the southern end of the property.

Surface run-off and shallow groundwater at the Site appear to drain east into unnamed tributary of Brush Run. This tributary begins as an intermittent stream in a marshy area in the north east corner of the site and flows south just outside of the eastern property boundary. Approximately 1000 feet south of the marshy area the intermittent stream enters a culvert. Downstream of the culvert the tributary is a perennial stream. The nature of the discharges to the tributary inside this culvert are unknown but may include groundwater or some underground line from the east or the west. There is no record of such a line from the Site.

Brush Run flows south into the Chartiers Creek and then north to the Ohio River. Drainage from north of the Site enters the Ohio River via Millers Creek and Chartiers Creek.

5.0 CONTAMINATION ASSESSMENT

The following subsections present a description of the distribution of Site-related contaminants in soils, groundwater, and surface water at the Site. For discussion purposes, the background concentration of VOCs in soils is assumed to be less than detection limits. Groundwater data are compared to Pennsylvania Maximum Contaminant Levels (MCLs) from the June 1993 *Applicable or Relevant and Appropriate Requirements for Cleanup Response and Remedial Actions in Pennsylvania* (Table 5-1). The analytical results are presented in Appendix E of this report.

5.1 CHARACTERIZATION OF RELEASES

The type, volume, composition, and nature of released substances at the Site are not known; there are no recorded releases. Current site conditions and historical information suggest two potential categories of unrecorded releases at the Site corresponding with two areas of the investigation: Area 1, accidental releases associated with the chemical reclamation operations (early 1950s to 1968); and Area 2, releases resulting from waste disposal in the black water lagoon (1923 to 1979).

Releases from the chemical reclamation areas most likely occurred near the abandoned railroad siding and former chemical storage and "cracking" or distillation tower. No records concerning the chemical reclamation operations are available. Chemicals, predominantly solvents, were off-loaded from railcars into holding tanks for eventual distillation in the stills and cracking tower. Although there are no records of major releases or spills, day-to-day operations likely resulted in many minor spills and releases. Available data suggest the affected area is approximately 2 acres.

Releases into the environment at the black water lagoon likely resulted from the direct disposal of materials into the lagoon. Apparently, the lagoon was originally used for disposal of coal wash water. In 1980, the lagoon was excavated, backfilled with borrow material, and paved as part of Penn Environmental's closure activities.

5.2 DISTRIBUTION OF CHEMICALS IN SITE SOILS

The data presented on Site soils was collected during the Phase II Site Investigation and is summarized here for completeness. The analytical results of the Phase II soil sampling are presented in Table 5-2.

The Phase II soil sampling and analytical program was designed to characterize the source and distribution of VOCs in Site soils and to locate clean soils for future Site closure activities. Only extended-run gas chromatography (GC) field laboratory analyses (Stage 2 data), and off-site laboratory data (Stage 3 data), are discussed in this subsection. The accelerated data on total halogenated hydrocarbons (Stage 1 data) used in the field for selecting boring locations, are also presented in Table 5-2.

For discussion purposes, VOCs have been divided into two major classes: chlorinated solvents and BTEXS. Vinyl chloride is generally grouped with the chlorinated solvents because it can be a degradation product of tetrachloroethene (PCE), trichloroethene (TCE), and dichloroethenes (DCE). However, vinyl chloride will be discussed separately from chlorinated solvents in this report because of its higher mobility and toxicity compared to other chlorinated solvents.

5.2.1 Area 1 Soils

The highest concentrations of chlorinated solvents, BTEXS, and the only occurrence of chlorobenzene were detected in soils from Area 1 (see Figure 2-4). Six borings (SB-N02 through SB-N05, SB-N07, and SB-N17) intercepted a 0.5- to 2-foot-thick layer of oily fill between zero and 4 feet bgs (Figure 5-1). The horizontal continuity of this thin layer is unknown; however, it appears to underlie the area along the former railroad track spur between borings SB-N02 and SB-N05 and extends southeast toward borings SB-N07 and SB-N17.

The oil-stained layer is characterized as a coarse sand to gravel layer with PID readings ranging from 1.7 to 2,800 parts per million (ppm) of VOCs. The highest concentrations of VOCs in borings intercepting this layer occur between zero and 4 feet bgs (Figures 5-2 through 5-5) which approximately corresponds to the depth range of the oily layer.

In soil samples analyzed for VOCs, BTEXS compounds were more widespread and present at higher concentrations than other VOCs. The distribution of the highest VOC concentrations follows the distribution of the oily layer: along the former railroad spur between SB-N02 and SB-N05, and extending southeast toward borings SB-N07 and SB-N17 (see Figures 5-2 through 5-5).

Lower concentrations (i.e., less than 100 μg/kg) of VOCs were detected in borings east and north of the highest concentrations, along the easternmost former railroad spur. Vinyl chloride was detected in a single sample from Area 1 (Figure 5-6). Analysis of soil from boring SB-N05 detected 1,700 μg/kg of vinyl chloride at depth of 2 feet.

5.2.2 Area 2 Soils

Sixteen of the 19 borings completed in Area 2 during Phase II yielded samples containing halogenated compounds at concentrations greater than detection limits. A total of 23 soil samples from 18 borings underwent extended-run GC analysis.

Area 2 soil samples contained chlorinated solvents and BTEXS, with the maximum concentrations of both groups within the same order of magnitude, 10^5 μg/kg, but with no apparent pattern to the occurrence or co-occurrence of either group of VOCs. In general, Area 2 contamination is more horizontally and vertically diffuse and discontinuous than that reported in Area 1. Contaminant distribution varies widely in adjacent borings in this area.

The highest concentrations of VOCs in this area were detected in soils from borings SB-01, SB-S04, and SB-S07, completed in the former location of the black water lagoon. Concentrations greater than 1,000 μg/kg of BTEXS were also detected in borings SB-S10 and SB-S11, east of the former black water lagoon (Figures 5-2, 5-3, 5-7, and 5-8). Concentrations of VOCs are attenuated to the south of Area 2, in Area 3, and borings SB-S16, SB-S17, and SB-S15.

In the former lagoon area, in borings SB-S01 through SB-S08, VOCs were detected between 5 and 35 feet bgs. This corresponds to the depth of the bottom of the former black water lagoon. Significant concentrations of VOCs were more persistent with depth in Area 2 than in Area 1, occurring at depths to 52 feet bgs in some borings (see Figures 5-2, 5-3, 5-7, and 5-8). The deepest occurrences (greater than 35 feet bgs) of detectable concentrations of VOCs occurred in borings SB-S16, SB-S17, SB-S19, and SB-20, downgradient and to the south and west of the former black water lagoon.

East of the former lagoon, in borings SB-S10, SB-S11, SB-S12, and SB-S14, VOCs were detected between zero and 20 feet bgs.

Vinyl chloride was more widespread in soil samples from Area 2, occurring in soils from five borings (see Figure 5-6). The highest concentrations were detected in soils from borings in the former black water lagoon area (SB-01, SB-S05, SB-S07, and SB-S08). Boring SB-S17, south of the former lagoon, also contained detectable vinyl chloride.

5.2.3 Area 3 Soils

Seventeen samples were collected from 16 borings in Area 3 during Phase II. A total of 10 soil samples from Area 3 were analyzed by accelerated-run GC. Two soil samples from two borings (SB-X05 and SB-X08 [2 feet bgs]) underwent extended-run GC analysis. No samples from Area 3 underwent Stage 3 off-site laboratory confirmatory analyses.

Trace levels, less than 25 μg/kg, of chlorinated solvents were detected in only three soil samples from this area. A single sample from SB-X08 contained 10,993 μg/kg of total BTEXS. No vinyl chloride was detected in soil samples from Area 3.

5.3 DISTRIBUTION OF CHEMICALS IN GROUNDWATER

The groundwater analytical results suggest that although Site-related compounds are migrating via groundwater, there are no defined plumes emanating from either source Areas 1 and 2. This is a result of both the radial flow of groundwater from the site and the effects of secondary porosity in bedrock flow. For purposes of discussion, groundwater analytical results will be grouped by location, migration direction, and related analytical results.

Table 5-3 summarizes the groundwater sampling program. Wells installed during site closure activities (MW-1 through MW-6) were sampled during all four rounds of groundwater sampling. Phase II monitoring wells (MW-101 through MW-107) were sampled during Rounds 2, 3, and 4. Phase III monitoring wells (MW-201 through 205) were sampled once during Round 4, the most recent round of sampling. Table 5-4 presents a summary of groundwater analytical results.

Figure 5-9 shows a plan view of the monitoring wells with graphical representation of concentration ranges of BTEXS, ethenes, ethanes, and dichlorobenzenes.

5.3.1 Background

Monitoring wells MW-1, MW-101, and MW-107 are located upgradient of Areas 1 and 2 and provide additional background groundwater quality data. All three wells are located downgradient of the landfill cell. Groundwater analytical data for MW-1, MW-101, and MW-107 from respective groundwater monitoring rounds, indicate that background groundwater quality is generally high. Analyses from the three wells detected low concentrations (less than 25 μg/L) of six VOCs and two SVOCs, with the exception of 73 μg/L of 1,1,1-trichloroethane (1,1,1-TCA) detected during one round of sampling from MW-107. During Round 2, monitoring well MW-107 also reported 5.3 μg/L of TCE, which exceeds the MCL of 5 μg/L.

Monitoring well MW-1 was sampled and analyzed during all four rounds. Results from the Round 2 sampling event reported low concentrations (10 μg/L or less) of two VOCs (carbon tetrachloride and 1,1,1-trichloroethane [1,1,1-TCA]). Mercury was detected at 0.23 μg/L levels during the first sampling event. Mercury was not detected at any other locations, or any other rounds at this location, and there is no history of mercury use at this site. For these reasons, mercury is not considered to be a Site-related chemical.

MW-101 is located downgradient from the landfill and upgradient from Area 1. The results of three groundwater sampling rounds at MW-101 have shown two VOCs (1,1-dichloroethane [1,1-DCA] and 1,1,1-TCA) and one SVOC (bis[2-ethylhexyl] phthalate) at concentrations greater than Sample Quantification Limit (SQL) but less than 10 μg/L.

MW-107 is located downgradient from the landfill cell; it does not appear to intercept groundwater from either Areas 1 or 2. The results of groundwater analyses show that two VOCs (1,1,1-TCA and 1,1-DCA) were detected at concentrations of 5.3 and 73 μg/L, respectively, during the Round 2 sampling event. During the subsequent rounds of sampling, 1,1-DCA and 1,1,2,2-tetrachloroethane were detected at estimated single μg/L concentrations.

5.3.2 East of the Site

Monitoring wells MW-2, MW-102, and MW-201 are located along a line east from MW-2 and Area 1 (see Figure 4-1). Results of the Phase III investigation show evidence of migration and biodegradation of Site contaminants moving off-site and east of Area 1.

Monitoring well MW-2 is located within Area 1 and is expected to reflect groundwater quality in Area 1. Groundwater samples from this well contained the highest concentrations of the Site contaminants detected in groundwater at the Site. Benzene, 1,1-dichloroethene (1,1-DCE), 1,2-DCE, 1,1,1-TCA, and TCE were detected at concentrations exceeding the MCLs (see Table 5-1). Both olfactory and visual evidence of Site-related compounds were observed during the installation of this well.

Monitoring well MW-2 has consistently shown high concentrations (greater than 10,000 μg/L) of three chlorinated solvents: 1,1,1-TCA, 1,1-DCA, and TCE. The concentrations of two of these compounds are sufficiently high to suggest the presence of a liquid solvent phase in contact with groundwater. The water solubility of TCE and 1,1,1-TCA are given as 1,100,000 μg/L and 350,000 μg/L, respectively. The greatest observed concentration of TCE is equal to approximately 4% of solubility and TCA was detected at a maximum concentration of 1,000,000 μg/L. No separate liquid solvent phase has been observed at this well. Less frequently detected are benzene and 1,1-DCE also at concentrations greater than 10,000 μg/L. Several other volatile chlorinated solvents, volatile aromatics and some SVOCs have been detected at lower concentrations.

Monitoring well MW-102 is located downgradient, to the east, of MW-2, approximately 250 feet from MW-2. Groundwater analyses have detected five VOCs and two SVOCs at concentrations exceeding MCLs (see Table 5-4). The five VOCs are: 1,1-DCE; 1,2-DCE; PCE; 1,1,1-TCA, and TCE. 1,1,1-TCA and TCE were also major contaminants detected in MW-2. 1,1-DCE and 1,2-DCE were also detected in both wells but were present in groundwater from MW-102 at higher concentrations. This may be due to anaerobic biodegradation (reductive dechlorination) of TCE to produce DCEs. The presence of 1,1,1-TCA, TCE, 1,1-DCE and 1,2-DCE in MW-102 is most likely the result of migration from groundwater under Area 1 accompanied by anaerobic biological degradation.

Two SVOCs, 1,2-dichlorobenzene and 1,4-dichlorobenzene, have also been detected above MCLs in samples collected from MW-102. Chlorobenzene-based solvents were also detected in soils from Area 1.

102?

MW-201 is located approximately 250 feet east and downgradient of MW-2, and approximately 40 feet outside the site property to the east. Groundwater analyses detected vinyl chloride at an estimated concentration of 9.3 μg/L which exceeds the MCL of 2 μg/L. Vinyl chloride is a product of the anaerobic biodegradation of PCE, TCE, and DCEs. Its presence, along with lower concentrations of 1,1-DCE in MW-201, is consistent with a groundwater flow path from the vicinity of MW-2 to MW-102 to MW-201, in which biological degradation is converting TCE to less chlorinated ethenes.

5.3.3 Abandoned Railroad Bed

The three monitoring wells MW-2, MW-202, and MW-203 are located along the former railroad bed adjacent to Area 1 (see Figure 4-6). MW-106 is located downgradient, to the east, from MW-203. The railroad bed is thought to represent a migration pathway for perched groundwater from Area 1. The results of the Phase III investigation support this conclusion.

The analytical results of groundwater samples collected from MW-2, located within Area 1, are discussed above.

Odors and visual evidence of Site-related compounds were noted in shallow subsurface soils (less that 5 feet bgs) during the installation of both MW-202 and MW-203. These observations are similar to those observed during the installation of monitoring well MW-2 as well as several soil borings excavated along the railroad bed.

Monitoring well MW-202 is located 190 feet north and downgradient of MW-2. The single round of sampling from this well showed concentrations less than 10 μg/L of acetone, naphthalene, and 2-methylnaphthalene. Round 4 groundwater analytical results for MW-203, located 285 feet north and downgradient of MW-202, detected chlorobenzene (130 μg/L), and concentrations less than 5 μg/L of 1,1-DCA and naphthalene. Chlorobenzene has no Pennsylvania MCL, but the sample did exceed USEPA III drinking water protection levels. This is the largest reported concentration of chlorobenzene detected in groundwater at the Site.

MW-106 is located downgradient and east of MW-203, 200 feet east of the abandoned railroad bed. Analytical results from three rounds of groundwater reported a single occurrence of 1,1,1-TCA at 10 μg/L and sporadic occurrences of low concentrations (less than 5 μg/L) of phthalates. The 1,1,1-TCA concentration is well below the MCL of 200 μg/L.

The analytical results from monitoring wells MW-2, MW-202, and MW-203 suggest some migration of site-related contaminants from Area 1 along the abandoned railroad bed. The sporadic occurrences and variable compounds detected most likely reflect the intermittent nature of this migration pathway. Groundwater flow is expected to occur along this pathway only when infiltration is sufficient to cause groundwater flow in the perched zone.

5.3.4 Southeast of the Site

Three monitoring wells, MW-4, MW-6 and MW-104, are located downgradient from both Areas 1 and 2, near the southwestern site-boundary. Analytical results from these wells do no exhibit a clear pattern of contaminant distribution, suggesting groundwater flow primarily via secondary porosity (i.e., bedrock fractures).

In four rounds of sampling, MW-4 has shown intermittent traces (concentrations below the SQLs) of acetone and phthalates. Both compounds are common laboratory contaminants and their occurrence may be an artifact of the sampling and analytical procedures.

Groundwater samples collected from monitoring wells MW-6 and MW-104 show higher and more consistent concentrations of Site-related compounds: MW-6 has shown concentrations of PCE and TCE ranging from 21 to 240 μg/L (exceeding the MCLs of 5 μg/L) through four rounds of sampling; and MW-104 has shown low (below the MCLs) but consistent concentrations of PCE and TCE through three rounds.

All three monitoring wells are located within 225 feet of each other and about 500 feet downgradient from former Site activities. All three wells are screened within the fractured bedrock underlying the Site. Groundwater flow in fractured shales tends to be strongly influenced by the secondary porosity (along bedding and fracture planes) of the formation. Therefore, the fact that MW-4 taps relatively clean groundwater, while the two adjacent groundwater monitoring wells contain site-related compounds, suggests that the wells are recharged by different fracture or bedding systems. Monitoring wells MW-6 and MW-104 intercept fractures that are hydrogeologically connected with the source areas, MW-4 may not.

5.3.5 South of the Site

Monitoring wells MW-204, MW-105, MW-5, MW-3, MW-206, and MW-103 are located in or downgradient from the southern half of the former CE Cast facility.

Monitoring wells MW-204 and MW-105 are located within the former C-E Cast facility area. MW-204 is located near the former blackwater lagoon and MW-105 is located adjacent to the former location of site buildings. Monitoring well MW-204 was installed during the Phase III investigation and was sampled during the fourth groundwater sampling round. Two VOCs, 1,2-DCE, and vinyl chloride, are present in this well at the greatest concentrations observed in Site groundwaters. Analytical results from this monitoring well show PCE, 1,2-DCE, and vinyl chloride at concentrations greater than their respective MCLs. Two other VOCs (1,1,1-TCA and 1,1-DCA) were detected concentrations below their MCLs.

Monitoring well MW-105 was sampled during last three groundwater sampling rounds. Groundwater quality from this well is rather high considering the proximity to Area 2: analysis of these samples detected trace concentrations (less than SQLs) of bis(2-ethylhexyl) phthalate and chlorobenzene during one round of sampling.

The variation in water quality between MW-204 and MW-105 most likely is a result of the groundwater flow along bedrock fractures and bedding plans, similar to MW-4, MW-6, and MW-104, where MW-105 appears to tap a fracture system with relatively good water quality and MW-204 appears to receive groundwater containing Site contaminants for Area 2.

Monitoring well MW-3 is located closest to the formerly active area of the Site. During four rounds of sampling, vinyl chloride has been detected consistently at concentrations ranging from 9.9 to 23 μg/L, exceeding the MCL of 2 μg/L. 1,2-DCE was also detected with some frequency in concentrations ranging from 33 to 65 μg/L. Acetone, bis(2-ethylhexyl) phthalate, and 1,1-DCA were detected sporadically at concentrations less than the SQLs. These results showing slightly lower concentrations of some of the same contaminants detected in MW-204 are consistent with groundwater migration from Area 2.

Three monitoring wells, MW-5, MW-103 and MW-205, are located along the southern perimeter of the site to monitor groundwater quality leaving the site. Groundwater analyses from these wells indicate that site contaminants are not migrating off-site to the south via groundwater. All three wells show only intermittent, low concentrations (20 μg/L or less) of phthalates, benzene, and acetone. The exception is MW-5, which has reported consistent, low concentrations of chlorobenzene (estimated 2.2 to 8 μg/L) and one detection of trace TCE (less than the SQL). In general, these wells confirm that site contaminants are not leaving the site via groundwater from the southern portion of the site.

5.4 DISTRIBUTION OF CHEMICALS IN SURFACE WATER

Phase III surface water samples were collected from two locations between the sampling locations from the Phase II investigation (Figure 5-11). The results are presented in Table 5-5. Based on field analysis of the surface water samples during Phase II, VOCs were expected to be discharging to the drainage ditch adjacent to the former oil-water separator and running along the abandoned railroad bed into a marsh that forms the head of the unnamed tributary to Brush Run. Analysis of surface water from the unnamed tributary indicated that chemical concentrations were attenuated either along the ditch or in the marsh.

The two surface water samples collected during the Phase III Site Characterization Field Program, SW-201 and SW-202, were collected along the ditch, upgradient of the marsh. SW-201 was collected from the northern portion of the Site at a small intermittent unnamed tributary recharged by both groundwater and stormwater from the Site, beginning by the former railroad bed and flowing north into the marsh. The samples contained trace concentrations (less than the SQLs) of bis(2-ethylhexyl) phthalate and di-n-butyl phthalate (SW-201) and acetone (SW-202). This suggests that VOC concentrations are attenuated in the ditch before surface water reaches the marsh north of the Site.

5.5 DISTRIBUTION OF CHEMICALS IN SEDIMENTS

Four sediment samples were collected from 0 to 6 inches and 12 to 18 inches bgs at two locations, SD-201 and SD-202, from the unnamed tributary that flows along the eastern site boundary (see Figure 3-1). With the exception of two BTEXS compounds, no Site contaminants were detected in any sediment samples (see Table 5-5).

The most common compounds detected in sediment samples were PAHs. Low (below SQLs) estimated concentrations of PAHs were detected in three of the four sediment samples. Di-n-butyl phthalate and bis(2-ethylhexyl) phthalate were also detected at concentrations below the SQLs in two samples each.

Five VOCs were also detected at estimated concentrations below the SQLs: 2-butanone, acetone, methylene chloride, toluene, and xylenes. The VOCs 2-butanone, acetone, and methylene chloride are common lab contaminants. Toluene and xylene, detected in the most downgradient sample is problematic. These compounds were detected in significant concentrations in soils at Area 1. However, toluene and xylenes were not detected in any surface water samples or in the SD-201, collected in between the Site and SD-202, suggesting that the VOCs were not transported via surface water.

5.6 IMPACTED SOIL AND GROUNDWATER VOLUME ESTIMATES

The volume estimates of impacted soil and groundwater were calculated based on available analytical results.

5.6.1 Soil

The volume estimate calculations for impacted soil are presented in Appendix F. The estimated volume of impacted soil in Area 1 is 10,600 cubic yards. This amount is based on average depth of detectable concentrations of Site contaminants of 6 feet.

The estimated volume of soil impacted by hydrocarbons in Area 2 is 20,000 cubic yards. For these calculations, it was assumed that the impacted soil was between 17 and 27 feet bgs.

5.6.2 Groundwater

Figure 5-11 presents interpretive extent of impacted groundwater based on assumptions in this section. The estimated volume of impacted groundwater at Area 1 is 4 million gallons. For this estimate, it was assumed that:

- the average thickness of the impacted groundwater layer is 10 feet
- the porosity of impacted groundwater layer is 0.35 (Fetter, 1980)
- the western edge of the impacted area is halfway between MW-2 and MW-101
- the eastern edge of the impacted groundwater area is the property line
- the northern edge of the impacted area is halfway between MW-106 and a transect through MW-102 and MW-2
- the southern edge of the impacted area is halfway between MW-104 and a transect through MW-102 and MW-2
- MW-104 and MW-106 are not impacted by site-related chemicals

The volume estimate for impacted groundwater at Area 2 is 4 million gallons, based on the following assumptions:

- the average thickness of the impacted groundwater layer is 10 feet
- the porosity of the impacted groundwater layer is 0.35
- the leading edge of impacted groundwater is halfway between MW-3 and MW-103
- the eastern edge of the impacted area is halfway between MW-5 and the transect through MW-3 and MW-103
- the western edge of the impacted area is halfway between MW-107 and the transect through MW-3 and MW-103

- the northern edge of the impacted area is along the transect from MW-107 to MW-4

6.0 MIGRATION AND EXPOSURE PATHWAYS

Section 6.0 has been prepared to identify migration pathways and the location of exposure points, and to estimate potential exposure point concentrations, if applicable.

6.1 CHARACTERIZATION OF MIGRATION PATHWAYS

Based on analytical results and the geologic and hydrogeologic data obtained during this investigation, two migration pathways were identified. The major pathway is through groundwater, and the secondary pathway is through surface water receiving groundwater recharge and/or runoff and preferential pathways or zones of lower hydraulic conductivity such as the former railroad bed.

VOCs are present in groundwater downgradient from Areas 1 and 2. These compounds can and have moved as a result of groundwater flow. Site contaminants detected in monitoring well MW-201 indicate that contamination has moved off-site via groundwater east of Area 1. Analysis of groundwater from the perimeter wells to the south and north indicate that contamination has not reached the property boundaries in the north, southeast, south, and southwest. Most contaminant migration via groundwater appears to be confined within the Site boundaries.

Surface water flow was identified in the Phase II as a potential contaminant migration pathway. Surface water and sediment analyses conducted during the Phase III investigation indicate that contaminants reaching the drainage ditch from Area 1 are attenuated before reaching the marsh area in the northern portion of the site, and are therefore unlikely to be moving off-site in the unnamed tributary to Brush Run. However, groundwater moving off-site to the east could potentially discharge to this unnamed tributary, bringing with it the low concentrations of Site-related contaminants detected in MW-201.

An additional potential migration pathway is mine water flow through the flooded mine workings. Because the interconnection of the mine workings with other mines is unknown, no exposure point characterization was possible for this medium.

6.2 CHARACTERIZATION OF EXPOSURE POINTS

Potential exposure points for the groundwater migration pathway would be drinking water wells downgradient of the Site and the unnamed tributary to Brush Run. Drinking water for residents in the area is supplied by the Pennsylvania American Water Co., and contact with groundwater via domestic water supply is unlikely. However, the potential discharge of contaminated groundwater to the tributary represents a potential exposure point for hunters, recreational vehicle users, and wildlife that may contact the stream. Evidence of such recreational use was observed during the site investigations.

For the on-site-surface water migration pathway, shallow groundwater from Area 1 discharges to the drainage ditch in the vicinity of the former oil/water separator. Water is present only intermittently, and exposure is considered to be limited to animals drinking from the ditch on-site after a rainfall event, or during high water.

Soil at the source areas is an additional exposure point not related to a migration pathway. Soil samples collected from depths of zero to 2 feet bgs in Area 1 contained elevated concentrations of VOCs. Based on available data, excavation in this area would expose workers to contaminated soils.

6.3 ESTIMATES OF EXPOSURE POINT CONCENTRATIONS

Because there are no known exposure points for groundwater, no estimates of exposure point concentrations have been made. Assuming that MW-201 represents the contaminant concentrations that could be discharging to the unnamed tributary to Brush Run, the concentrations of site-related contaminants are relatively low, even without adjustments for dilution and/or volatilization. The concentrations of methylene chloride (5.7 μg/L) and 1,1,1-TCA (43 μg/L) are well below the Fish and Aquatic Life Criteria for Continuous Concentrations, 2368 and 605 μg/L, respectively. Vinyl chloride was reported in groundwater from MW-201 at an estimated 9.3 μg/L, exceeding the MCL of 2 μg/L. Dilution and volatilization would be expected to reduce that concentration to a level below the MCL.

During Phase II, surface water runoff samples were collected during a storm event. These samples represent the worst-case conditions for on-site surface water. 1,1,1-TCA was detected at concentrations of 170 and 210 μg/L, and vinyl chloride was detected at 2 μg/L, using field analytical procedures. Low levels of BTEXS were also present.

Concentrations of chlorinated solvents and BTEXS in surface soils in Area 1 (i.e., 0 to 2 feet bgs) range from below detection to 14,000 μg/kg and 2,600,000 μg/kg, respectively. During site remediation, excavation workers could be exposed to soils containing chlorinated solvents and BTEXS up to these concentrations. However, based on the wide variability of the data and volatilization of VOCs in the top 6 inches of soil, potential exposures to casual trespassers are minimal at the Site.

7.0 CONCLUSIONS

The data obtained during the investigations and closure activities were evaluated with respect to the implementation of potential remedial measures that meet the goals of this investigation. These goals are to:

- prevent migration of contaminants to exposure points, and
- increase potential future use of the Site by meeting PADER requirements for soils and groundwater.

Based on this evaluation, the following findings and conclusions have been developed for the Site.

7.1 SOILS

The nature and distribution of contaminants detected in site soils can be linked to past site activities. The solvent and BTEXS contamination detected in Area 1 appears to be the result of chemical reclamation activities conducted at the site between 1953 and 1980, based on the type of chemicals encountered and the proximity to the former distillation equipment location. Area 2 contamination appears to be remnant contamination from the former blackwater lagoon. The blackwater lagoon was located in Area 2 from 1923 until it was dewatered, excavated, backfilled, and capped under the 1980 Consent Order.

The discontinuous distribution of Site-related chemicals in Area 2 soil may be a remnant of the lagoon closure activities. According to previous reports, an unknown quantity of sludge was excavated from the blackwater lagoon. Significant concentrations of chemicals have been found at relatively deeper levels than those in Area 1. Closure excavation may have failed to remove all the contaminated soils in this area, and/or contaminated groundwater beneath the excavated soils may have re-contaminated the clean fill.

7.1.1 Interpretation of Results

Potential receptors for soil contamination are limited to Site trespassers. Exposure to Site soils could be limited through control of Site access and/or Site closure activities that involve filling and grading. However, contaminated soils in Area 1 appear to be a source of groundwater contamination migrating off-site. In order to minimize migration of Site contaminants as well as remove the potential exposure to contaminated soils, soil remediation is planned for Area 1 soils.

Based on the history of Area 2 and the results of Phase II and III investigations, Area 2 does not appear to be a significant continuing source of groundwater contamination. Sediments from the original black water lagoon were excavated during closure. The diffuse and discontinuous distribution of contaminants in this area suggests that the contaminants detected in soils in Area 2 may be the result of contaminated groundwater left at this area after excavation. This is supported by the lower concentrations of contaminants detected in the Area 2 soils and the observed presence of contaminants in the fill soils used to backfill the lagoon after excavation. Based on these findings it appears that soil contamination in Area 2 may be the result of contamination moving from groundwater to soils and, therefore, the soils in this area do not represent a significant source area.

7.1.2 Recommendations

On-site low-temperature thermal desorption is currently planned for Area 1 soils, to remove the source of groundwater contamination. Appendix G, the Remedial Technology Evaluation, provides a more detailed discussion of remedial alternative selection. Soils with contaminant concentrations exceeding PADER 2 criteria for groundwater protection will be excavated, treated, and returned to the Site. After soil remediation, the Site will be graded to promote proper drainage.

Until the removal of liquid and impacted sediment from the black water lagoon in 1980, Area 2 was very likely a major source of groundwater contamination. Once the bulk of contaminants were removed, the transport of contaminants from the soil matrix to groundwater was greatly reduced. It is possible that the contaminants detected in the soil matrix during Phase II may have re-sorbed from impacted groundwater.

Because the major source of groundwater was removed in 1980, ABB-ES proposes to re-seal the concrete cap atop Area 2 and divert drainage around the area to minimize infiltration. These steps should reduce contaminant migration via groundwater and mitigate the potential for Site-related chemicals to migrate off-site.

No additional investigations are proposed prior to soil remediation.

7.2 GROUNDWATER

As discussed above, both Area 1 and Area 2 soils appear to be acting as a source of groundwater contamination. Site-related chemicals from Area 1 are migrating off-site via groundwater on the eastern side of the property and may be discharging to a small stream running along the eastern site boundary. In the southern and northwestern portions of the Site, contaminant migration via groundwater appears to be confined within the Site boundaries.

The sporadic occurrence and distribution of site-related contaminants in adjacent monitoring wells in several areas of the Site (particularly around monitoring wells MW-4, MW-6, and MW-104 and in Area 2 near MW-105 and MW-204) suggests groundwater flow in some areas may be primarily through bedrock fractures or bedding planes. Groundwater plume mapping in bedrock aquifers is extremely difficult. Site-related contaminants can move preferentially along fractures great distances from the source area. Fracture trace analysis can be used to identify areas for investigation; however, this is not a useful technique in an area that has been as heavily reworked as this Site. Mapping is further complicated by the unknown impact of the abandoned mine on bedrock groundwater flow.

7.2.1 Interpretation of Results

There are no confirmed receptors for the groundwater migration pathway. All area residences are served by the city water system. As discussed in Section 6.1, contaminated groundwater moving off-site to the east may be discharging to the unnamed tributary to Brush Run that flows along the eastern Site boundary. Hunters, recreational vehicle drivers, and others walking in the woods in this area could potentially come in contact with this water. All surface water sampling conducted to date has been upgradient of the likely area of contaminated groundwater discharge. Assuming dilution and volatilization, it is unlikely that groundwater discharge to this stream would pose a risk to human health or the environment.

7.2.2 Recommendations

Soil remediation and Site closure are expected to reduce the migration of Site-related contaminants in groundwater by removing the source from Area 1 and reducing infiltration through Area 2. However, future action with respect to groundwater remains a possibility. Site conditions limit the potential type of remediations to be considered. Groundwater migration through bedrock fractures on the Site severely limits the effectiveness of pump and treat alternatives. Effective groundwater extraction in bedrock aquifers is almost impossible, because it is difficult to locate extraction wells to intercept fractures containing impacted groundwater.

To better assess the potential exposure represented by possible discharge of contaminated groundwater to surface water in the vicinity of former monitoring well MW-102, ABB-ES proposes collection of two surface water samples from the unnamed tributary to Brush Creek in this area. One surface water sample would be collected from the tributary directly downgradient of impacted groundwater in monitoring wells MW-2 and MW-102 (see Figure 5-11). The second sample would be collected upstream from the area that may be impacted from groundwater recharge from Area 1. The two samples would be analyzed for VOCs. This analysis should provide the necessary information to evaluate the potential risk of exposure due to groundwater discharge to surface water.

For the remainder of the Site, ABB-ES recommends biannual sampling of perimeter monitoring wells MW-106, MW-102, MW-104, MW-5, MW-103, and MW-205. The results of these analyses will allow tracking and evaluation of the impact of soil remediation and Site closure on the migration of Site-related contaminants via groundwater.

7.3 SURFACE WATER AND SEDIMENTS

Phase III investigations have confirmed that contaminant concentrations in surface water flowing along the abandoned railway on-site are fully attenuated before leaving the site (see Section 5.4). The potential exposure to trespassers (hunters and recreational vehicle drivers) will be effectively addressed by the Site remediation and closure. Soil remediation in Area 1 will remove the source of contamination and the final Site grading will ensure that Site drainage does not contact any areas of contamination.

GLOSSARY OF ACRONYMS AND ABBREVIATIONS

ABB-ES	ABB Environmental Services, Inc.
bgs	below ground surface
BTEXS	benzene, toluene, ethylbenzene, m,p-xylene, and o-xylene/styrene
cm/sec	centimeters per second
cm^2/sec	centimeters squared per second
1,1-DCA	1,1-dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DOT	U.S. Department of Transportation
GC	gas chromatography
MCL	Maximum Contaminant Level
MSL	mean sea level
NPDES	National Pollutant Discharge Elimination System
PADER	Pennsylvania Department of Environmental Resources
PAH	polycyclic aromatic hydrocarbon
PCE	tetrachloroethene
PHMC	Prospect Hill Management Corporation
PID	photoionization detector
ppm	parts per million
SVOC	semivolatile organic compound
Site	former C-E Cast facility
SQL	Sample Quantification Limit
1,1,1-TCA	1,1,1-trichloroethane
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
μg/L	micrograms per liter
μg/kg	micrograms per kilograms
USEPA	U.S. Environmental Protection Agency

VOC	volatile organic compound

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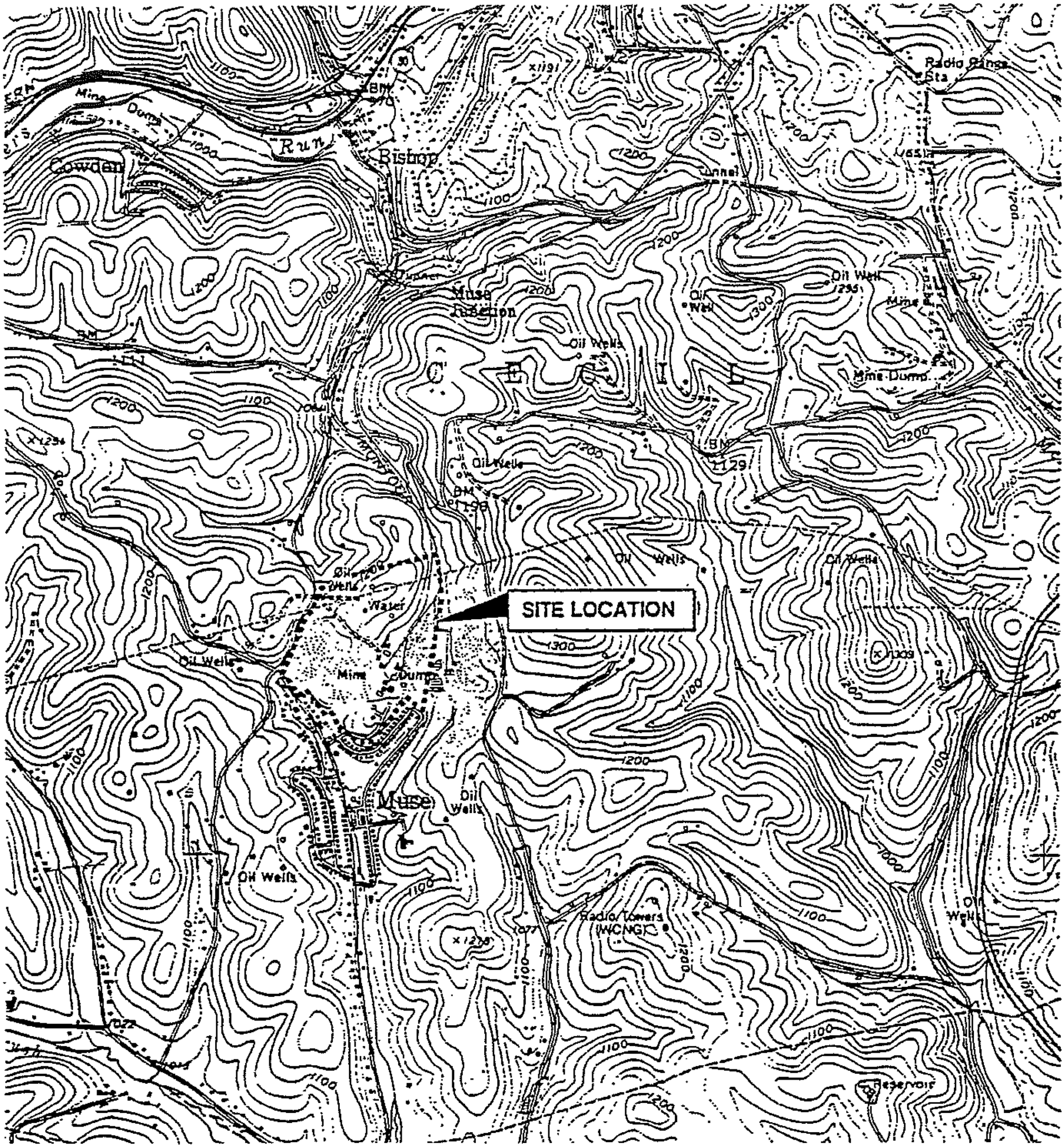
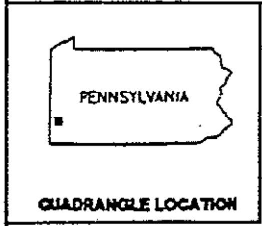
FIGURES



SOURCE: USGS QUADRANGLE 7.5-MINUTE SERIES, CANONSBURG, PA., DATED 1960, PHOTOREVISED 1979.



QUADRANGLE LOCATION

SCALE IN FEET

0 2,000 4,000

FIGURE 2-1
SITE LOCATION MAP
CE-CAST
MUSE, PENNSYLVANIA

ABB Environmental Services, Inc.

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