PCB Mass Loading
Amtrak Refueling Yard
SIRB ID: DE-0266
Wilmington, Delaware

BrightFields, Inc.

Historic Data

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July 30, 2007

Mr. Wilmer Reyes
Department of Natural Resources and Environmental Control
Division of Air and Waste Management
391 Lukens Drive
New Castle, DE 19720-2774

Subject: **Draft Phase II RI/FFS Report**
AMTRAK Former Fueling Facility (DE 266), Wilmington, Delaware

Dear Mr. Reyes:

Enclosed are three hard copies and one CD-ROM of the Draft Phase II Remedial Investigation (RI)/Focused Feasibility Study (FFS) Report for the AMTRAK Former Fueling Facility, Wilmington, Delaware (DE-266). The FFS is presented as Section 13.0 of the attached report. As requested in DNREC's August 10, 2006 letter to SECOR, the five-year remedy evaluation report for the diesel fuel remedial program is presented as Appendix X of the attached report. As described in the report, over 15,200 gallons of product have been recovered.

Should you have any questions or comments associated with the enclosed report, please call me at (484) 875-3075.

Sincerely,
SECOR International Incorporated

Steve Baggett

Steve Baggett, PG
Principal Hydrogeologist

cc: Craig Caldwell, Charles Lin, Michael Stern, Esq., Ben Stonelake, Esq., Paul Yaniga, Kerry Hanlon, Frank Aceto, Project File

VOLUME 1

DRAFT PHASE II REMEDIAL INVESTIGATION AND FOCUSED FEASIBILITY STUDY REPORT AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE

DE- 266

JULY 2007

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7/26/07

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EXECUTIVE SUMMARY

This Draft Phase II Remedial Investigation/Focused Feasibility Study (RI/FFS) Report examines the nature and extent of fuel oil and PCB contamination at the Former Fueling Facility (Site) which is a portion of AMTRAK's Wilmington Yard. This report also evaluates alternative remedies to enhance existing remedial measures at the Site. Fuel oil and PCB contamination at the Site is already contained and controlled by natural conditions and existing remedial measures. It is contained vertically above a thick layer of dense, blue-gray clay at depths of approximately 7-15' below ground surface and measuring approximately 10 feet thick. It is contained laterally by a system of drainage ditches, dams and water retention ponds that collect oil and sediment that would otherwise discharge to the Brandywine Creek. This drainage system also collects run off water and sediment from off-site commercial and industrial sources. Further, tidal water from the Delaware River, Christina River and Brandywine Creek periodically back-flush from the Brandywine Creek with a frequency of up to twice each day through defective tide gates.

The drainage system ultimately discharges through an Outfall (006) that is regulated by an NPDES permit before mixing with other drainage from other off-site sources and subsequently discharges to the Brandywine Creek. Extensive sampling required by this permit has only detected PCBs in this discharge on 1 occasion in more than 20 years. No sampling results have exceeded the 3 ug/L effluent limitation specified in EPA's TSCA regulations for discharges to navigable waters.

Integrated remedial measures and activities over the past several decades have already contained and controlled runoff of oil, surface water and sediment, removed over 15,200 gallons of separate phase hydrocarbons (SPHs) from the water table under the Site, reduced petroleum hydrocarbon levels in upland surface soils, and reduced the PCBs in storm water runoff from a portion of the Site by 94%. The erosion controls used to achieve this result received an award from the Water Resources Association of the Delaware River Basin for reducing PCB discharges to Outfall 004. This system includes the best management practices (BMP's) for controlling erosion of contaminated soils. It includes a system of caps using geotextile fabric, soil and vegetation, ballast, other stone and other features to minimize storm water runoff, minimize the velocity of unavoidable runoff and thereby minimize the erosion of surface soils and sediments. Oil-stained drainages to the Eastern Drainage Ditch have been cleaned and substantial improvement of water quality and vegetation along the Western Drainage Ditch has already been achieved. Extensive ecological testing demonstrates that the diversity and abundance of species in the Eastern Drainage Ditch are comparable to or better than the reference locations evaluated in this study and other ponds in the region.

Phase II remedial investigations were performed to further characterize drainage features associated with the Former Fueling Facility as well as portions of the Brandywine Creek. The Draft (Phase I) Remedial Investigation Report documented the occurrence of petroleum hydrocarbons and PCBs in sediment and PCBs in fish tissue collected in the Eastern Drainage Ditch and the confluence area. In comments to the Draft Phase I Report, DNREC indicated that they considered additional remedial investigation work beyond the boundaries of the previous remedial investigation necessary. As a result, sediment samples were collected from the Brandywine Creek as well as other drainage ditches in the immediate vicinity of the site. Comprehensive sediment sampling was performed in the site drainage features. Soil samples were collected in the Former Fueling Facility and other areas which drain to site drainage ditches in order to characterize potential erodible soils.

A site-specific human health risk assessment (HHRA) was previously performed and included in the Draft Phase I RI Report. The Phase I RI focused on site soils and evaluated the following exposure scenarios: 1) youth (ages 12 to 18) trespasser exposure to on-site and 2) adult trespasser to on-site soils. Risks for these scenarios were found to be within acceptable target risk levels. The risk to on-site worker scenarios were not evaluated because DNREC previously calculated these risks and found them to be within acceptable ranges. Furthermore, fueling operations have ceased in the Former Fueling Facility.

The Phase II HHRA (included in this report) utilized existing representative soil data as well as data collected after the Phase I remedial investigation, including the results of Phase II remedial investigations, In addition, the Phase II HHRA includes on-site worker (construction and commercial workers) scenarios as requested by DNREC in comments to the Phase I RI Report.

In the Phase II HHRA, risks were calculated for exposure to site-wide soils and soils in the former roundhouse area. These two areas were considered because higher PCB concentrations were reported in former roundhouse area soils than in other areas and the former roundhouse is surrounded by fencing with no operations occurring within the fenced area. Exposure scenarios included: 1) youth trespassers to soils; 2) adult trespassers to soils; 3) commercial workers to soils; and 4) construction workers to soils. Risk analyses determined that the reasonable maximum exposure (RME) concentrations of constituents of concern did not exceed DNREC or USEPA target risk levels for all exposure scenarios for site-wide and former roundhouse area soils.

Phase II RI ecological field sampling was performed to further characterize the ecosystem within the AMTRAK ditches and assess the potential effects of constituents of concern on that ecosystem. Macroinvertebrate, fish, and turtle sampling was performed seasonally in spring, summer, and fall over a two year period to examine seasonal variations. Sampling was performed in the AMTRAK ditches and Conectiv Impoundment at approximately the same stations as in the Phase I RI. Sampling was also performed in the City Ditch and the lower portion of Shellpot Creek to provide additional data for comparison with the AMTRAK ditches and further evaluate variation in biological communities within and between sampling locations.

The Phase II ecological sampling supported the conclusions of the Phase I ecological assessment and further demonstrated that a functional aquatic ecosystem exists within the AMTRAK ditches, despite the presence of petroleum hydrocarbons, PCBs, and various metals in sediments. The ecological communities in the AMTRAK ditches are similar to, or are of higher quality than those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area.

Young-of-the-year and multiple age classes of a number of species of fish were observed in the AMTRAK ditches. This shows that fish are successfully reproducing in the AMTRAK ditches, and are surviving/growing over multiple years. The proportion of fish from the AMTRAK ditches that evidenced disease or abnormalities was similar to, or less than, that at the other sampling locations.

The apparent absence of effects of PCBs on the fish community in the AMTRAK ditches is consistent with recent studies that have indicated that exposure to PCB body burdens exceeding levels observed in fish from the AMTRAK ditches do not result in detectable effects on fish populations in their natural environments.

The FFS evaluates numerous alternative remedies that could achieve further reductions in the toxicity, mobility or quantity of fuel oil and PCB contamination at the Site. It recommends that the existing remedial measures be continued and that they be supplemented with additional measures to further reduce discharges of oil and PCBs from Outfall 006 through the use of best management practices. These measures would collect or otherwise treat all mobile separate-phase (liquid phase) hydrocarbon (LPH) on the water table, expand the successful, award-winning erosion control measures beyond the Outfall 004 drainage areas to other areas of the Site and enhance the sediment collection and water treatment capabilities of the drainage system to further reduce the discharge of PCBs from Outfall 006.

Remedial alternatives were evaluated for: 1) Site sediments and adjacent bank soils containing PCB concentrations greater than 50 mg/kg; 2) site-wide soils which may potentially be washed into site drainage features in storm water runoff; 3) former roundhouse area soils which may also be washed into site drainage features, and 4) separate phase hydrocarbons on the water table/groundwater. The recommended remedial alternatives include measures that have been proven to be effective at the site.

The recommended remedial alternatives consist of the following:

- Sediments and bank soils with PCB concentrations greater than 50 mg/kg – re-routing of the Eastern Drainage Ditch; stabilization and encapsulation of Western Drainage Ditch and drainage ditch north of the Eastern Drainage Ditch sediments; construction of sedimentation basins draining to constructed wetlands (lower Eastern Drainage Ditch and confluence area) as a sediment control BMP; and capping bank soils with PCB concentrations greater than 50 mg/kg.

- Site-wide soils – storm water and erosion control BMPs including the installation of bio-retention cap/strips, drainage swales, geotextile/stone surface cover, porous paving, and upgrade of vegetation cover.

- Roundhouse area soils – cover with geotextile and a one foot thick earthen cap. The cap would be vegetated.

- Liquid Phase Hydrocarbons on the Water Table Surface/Groundwater – continuation of the ongoing diesel fuel recovery program with the addition of perimeter interceptor/recovery trenches adjacent to the Eastern and Western Drainage Ditches. Once remedial action objectives are met for liquid phase hydrocarbons, monitored natural attenuation for dissolved hydrocarbons would be implemented.

Other components of the overall site remedy would include the proper closure of an abandoned sewer that is connected to the former lift station and incorporation of the CETC building (if constructed) including construction of a vapor barrier to prevent vapor intrusion. It is also assumed that the tide gate at Brandywine Creek would be fixed and maintained by the appropriate government agency.

1.0 INTRODUCTION

SECOR International Incorporated (SECOR) has been contracted by National Railroad Passenger Corporation (AMTRAK) and American Premier Underwriters, Inc. (APU) to perform Phase II remedial investigation activities and complete a focused feasibility study (FFS) for the Former Fueling Facility portion of the AMTRAK Wilmington Yard located along Vandever Avenue in Wilmington, Delaware (**Figure 1-1**). This Phase II remedial investigation (RI) and FFS was conducted under the Delaware Voluntary Cleanup Program (VCP) enacted under 7 Del. C. Chapter 91: Delaware Hazardous Substance Cleanup Act (HSCA). The scope of the Phase II RI was provided in Revised Phase II Remedial Investigation and Focused Feasibility Study Work Plan (Phase II RI/FFS Work Plan) prepared by SECOR and dated August 28, 2003. The Phase II RI/FFS Work Plan incorporated the modifications requested in the August 12, 2003 correspondence from Delaware Department of Natural Resources and Environmental Control (DNREC) which approved the Work Plan modifications outlined in SECOR's January 28, 2003 correspondence to DNREC.

The scope of the Phase II remedial investigations was developed to further characterize sediments in the Eastern Drainage Ditch, the Western Drainage Ditch and the confluence area of the Former Fueling Facility and portions of the Brandywine Creek as described in the Phase II RI/FFS Work Plan. The Phase II RI/FFS Work Plan also described the scope of work for a FFS in order to evaluate remedial alternatives for site drainage features. A (Phase I) RI was previously performed at the site. The (Phase I) RI was documented in Draft Remedial Investigation Report - AMTRAK Former Fueling Facility, Vandever Avenue, Wilmington, Delaware (Draft Phase I RI Report) prepared by the IT Corporation and dated May 28, 1999. The Phase I RI was performed to determine the extent of subsurface diesel fuel occurrence in the Former Fueling Facility and included the sampling and analyses of sediments and fish tissue in the Eastern Drainage Ditch and confluence area. DNREC provided comments to the Draft RI Report in a letter to AMTRAK dated July 21, 2001.

Data collected during the (Phase I) RI, other previous site investigations and interim remedial measures (the scope was provided to DNREC in a September 9, 1998 correspondence) were used to proactively develop an appropriate remedial program for the removal of liquid-phase diesel fuel from beneath the Former Fueling Facility. The diesel fuel remedy was described in Diesel Fuel Remedial Work Plan – AMTRAK Former Fueling Facility, Vandever Avenue, Wilmington, Delaware (Diesel Fuel Remedial Work Plan) prepared by the IT Corporation and dated March 2000. DNREC approved the Diesel Fuel Remedial Work Plan as a component to the overall site remedy in a letter to IT Corporation dated June 22, 2000. Construction of the diesel fuel remedy was initiated in September

2000 and the trench recovery system was operational in December 2000. Through December 2006, approximately 15, 200 gallons of product have been recovered.

During a September 2004 meeting, DNREC requested an interim data deliverable prior to the submittal of the Draft RI/FFS Report. On behalf of AMTRAK and American Premier Underwriters (APU), SECOR submitted a data package to the DNREC dated March 2006. That data package contained sampling results from the Phase II remedial investigations as well as an update of the project status.

Based on the results of data collected from site drainage ditch bank soil and sediment sampling (results presented in the March 6, 2006 Phase II RI Data Package), additional sample collection activities were proposed. These activities were described in Proposed Supplemental Phase II Remedial Investigations (Supplemental Phase II RI Work Plan) dated May 30, 2006. The proposed supplemental Phase II remedial investigation activities included the investigation of a former/abandoned (reportedly closed) sewer, in addition to other investigative activities such as the further characterization of site soils. The adjustment of the RI/FFS Report submittal date to the end of the 2nd Quarter in 2007 (June 30, 2007) was requested in order to allow for the additional data collection.

Although DNREC had already provided verbal authorization to implement the activities outlined in the Supplemental Phase II RI Work Plan; they compiled a comment letter dated August 10, 2006. The letter included DNREC's concurrence that the adjustment of the RI/FFS submittal date was appropriate. In follow-up to DNREC's letter, a letter responding to DNREC's comments was submitted to DNREC on October 31, 2006. As requested by DNREC in their letter, a Phase II RI/FFS Progress Report was submitted to DNREC on January 26, 2007. This progress report included a status of project activities and a summary of supplemental Phase II RI validated data through December 2006.

A Pollution Minimization Plan (PMPs) (dated September 28, 2005) for the AMTRAK Wilmington Yard was prepared in accordance with the Delaware River Basin Commission (DRBC) PMP Rule 4.30.9. The PMP was developed and implemented to reduce the discharge of PCBs from the facility.

1.1 Purpose

This Report provides the results of additional remedial investigation activities focused on the characterization of drainage features at the Former Fueling Facility as well as the tidal reaches of the Brandywine Creek. The Draft Phase I RI Report documented the occurrence of petroleum hydrocarbons and polychlorinated biphenols (PCBs) in sediment samples and PCBs in fish tissue samples collected in the Eastern Drainage Ditch and the confluence area. In comments to the Draft Phase I RI Report, DNREC indicated that they considered additional remedial investigation work beyond the boundaries of the previous remedial investigation necessary (**Figure 1-2** displays the approximate extent of Phase I RI activities). As a result, in addition to sample collection within area of the (Phase I) RI, Phase II remedial investigations included the collection and analysis of sediment samples in the Brandywine Creek as well as other drainage ditches in the immediate vicinity of the Former Fueling Facility. Soil samples were collected on the general former roundhouse area and on the AMTRAK property to the east of the Eastern Drainage Ditch in order to characterize potential erodible soils.

Interim remedial measures (IRM) activities and the implementation of the Diesel Fuel Remedial Work Plan were performed to identify and recover liquid-phase diesel fuel, reduce the potential for its migration on the water table surface to the Eastern and Western Drainage Ditches and characterize the diesel fuel for the presence of polychlorinated biphenols (PCBs). DNREC comments to the Draft Phase I RI Report indicated that a Feasibility Study should be performed to determine appropriate remedial options for sediments in the drainage ditches. In order to evaluate potential remedial options for the drainage ditches, additional remedial investigation activities were performed to characterize the lateral and vertical extent of PCBs and petroleum hydrocarbons in sediment in the drainage ditches. Additional ecological investigations were also performed in the Former Fueling Facility and in reference areas in order to address DNREC's comments to the ecological investigations described in the Draft Phase I RI Report. Data collected from the Phase II remedial investigations were considered in the FFS for the sediments in the site drainage ditches (refer to Section 13.0 of this Report).

The Draft Phase I RI Report included a human health risk assessment focusing on site soils using realistic exposure scenarios. The exposure scenarios evaluated reported risk estimates within the United States Environmental Protection Agency's (USEPA) target risk levels. The baseline human health risk assessment has been revised. The revised human health risk assessment also includes the on-site worker exposure scenarios (including short term construction worker scenario) as requested by DNREC.

1.2 Site Description

The AMTRAK Wilmington Shops consist of the Maintenance Facility and Former Fueling Facility. The Former Fueling Facility encompasses approximately 20 acres (refer to **Figures 1-2** and **1-3**). The Former Fueling Facility is located south of the former roundhouse, bounded to the east by the unnamed surface water drainage feature (referred to as the Eastern Drainage Ditch), and to the west by a drainage ditch (referred to as the Western Drainage Ditch), which separates the AMTRAK Wilmington Shops from the former Atlas Sanitation property. Both of the drainage ditches flow to the south and empty into a confluence area. The Former Fueling Facility is bounded to the south by the confluence of the two surface water features and the 12th Street Dam. The Former Fueling Facility is situated in an industrial area of southeast Wilmington. The site is zoned General Industrial (M-2) by the City of Wilmington. Located immediately east of the Eastern Drainage Ditch is an undeveloped, heavily vegetated area owned by AMTRAK and then an access road (referred to as Railcar Avenue). On the east side of the access road is the former CONRAIL Edgemoor Yards, now owned and operated by Norfolk Southern (NS), a tank car cleaning company, an asphalt plant, and a cement plant. The Western Drainage Ditch separates the Former Fueling Facility from a tract of land formerly operated by Atlas Sanitation which is now a materials recycling facility. The area across 12th Street to the south of the study area is also industrialized and is referred to as the Brandywine Industrial Complex. As will be described in Section 4.0, PCB concentrations of up to 1,970 mg/kg have been detected in soils in an area where electric transformers were located on the Brandywine Industrial complex.

1.3 Site History

The AMTRAK Wilmington Shops were constructed in 1903 and were used essentially for the maintenance, fueling, and service of locomotives and passenger cars. Ownership and operation of the facility was conveyed by Penn Central Transportation Company, debtor, to Consolidated Rail Corporation (CONRAIL), effective April 1, 1976. CONRAIL subsequently conveyed ownership and operation of the facility to AMTRAK, also effective April 1, 1976.

The Former Fueling Facility was used primarily to service locomotives with coal and later diesel fuel, lubricating oil and sand. Fueling operations ceased in this area in November 1995 and were transferred to a newly constructed facility north of the former roundhouse. Other operations historically performed in the Former Fueling Facility included the refilling of caboose cabin heaters with kerosene and supplying steam engines with water, sand, and coal. The area is currently used to store passenger railcars, locomotives, maintenance of way equipment, and other equipment, and will continue to be used for that purpose in the future.

Diesel fuel was historically stored in a 250,000-gallon, above-ground storage tank (AST), with an attached plate indicating it was built in 1954. The 250,000-gallon AST supplied fuel to the fuel pumps located in the fueling area via a four inch diameter underground pipe. The 250,000 gallon AST was removed in February 1996. In 1989, AMTRAK personnel performed a dye test of the pipe from the 250,000 gallon AST and the piping to the former fueling area. According to AMTRAK personnel, no visual leakage from the tank or the piping was observed in nearby surface water bodies. A product storage and conveyance plan, prepared for the Draft Phase I RI Report, which displays the location of historical site features related to diesel fuel conveyance and fueling in the Former Fueling Area, is included in **Appendix A**.

During April 1999, IT Corporation performed exploratory trenching adjacent to the Western Drainage Ditch in order to identify potential preferential product migration pathway(s) to the Western Drainage Ditch (as part of implementing the Interim Remedial Measures Plan dated September 8, 1998). Several previously unknown pipes and related equipment were encountered. A description of these features was provided in the Diesel Fuel Oil Remedy System Installation and Progress Report prepared by IT Corporation and dated November, 2001. Features that were encountered and suspected of being potential pathways were removed or sealed.

Other prominent features in the Former Fueling Facility include the service building and an abandoned coal tower.

1.4 Report Organization

This Report has been developed in accordance with the HSCA guidelines and is divided into twelve primary sections. These sections are described as follows:

Section 1.0 – Provides a general introductory and background information on the site and the purpose of the Phase II remedial investigation.

Section 2.0 – Summarizes the findings from previous site investigations, provides a description of the site characterization based on the findings of the Draft Phase I RI Report, and summarizes the results of environmental sample analyses conducted subsequent to the submittal of the Draft Phase I RI Report.

Section 3.0 – Provides a discussion of interim remedial activities performed at the site including the status of diesel fuel recovery operations and summary of the Outfall 004 drainage area erosion control and sediment reduction measures.

Section 4.0 – Provides a discussion of the characterization of the regional setting pertaining to PCBs in the tidal reaches of Brandywine Creek.

Section 5.0 – Describes the scope and methods of the on-site Phase II remedial investigation activities completed including the sampling of sediment, soils, and surface water.

Section 6.0 – Describes the scope and methods of the off-site Phase II investigation activities.

Section 7.0 – Presents the results of the on-site environmental sampling performed during Phase II remedial investigations.

Section 8.0 – Presents the results of the off-site environmental sampling performed during Phase II remedial investigations.

Section 9.0 – Details the site conceptual model based on the physical characterization of the site and the results of environmental sampling.

Section 10.0 – Presents the revised human health risk assessment methods and results.

Section 11.0 – Describes the scope and investigative methods for the Phase II ecological assessment. Also presents the results of the Phase II ecological risk assessment.

Section 12.0 – Provides a summary of the results of Phase II RI activities.

Section 13.0 – Presents the Focused Feasibility Study.

Section 14.0 – Provides a list of the references cited in this Report.

2.0 PREVIOUS INVESTIGATIONS

Several environmental investigations were previously performed that included the Former Fueling Facility portion of the AMTRAK Wilmington Yard and were identified in the Draft Phase I RI Report. A brief summary of these investigations is provided below. Also included is a summary of the findings presented in the Draft Phase I RI Report. Subsequent to the completion of these Phase I remedial investigations, sediment samples were collected in the Western Drainage Ditch (north of Dam C), surface soil samples were collected prior to implementation of the Outfall 004 area sediment reduction and erosion control measures, and soil investigations were performed at two locations where building construction was proposed. The results of these investigations were previously provided to DNREC (in Progress Reports) and are summarized below.

Environmental activities performed and reports generated prior to the Phase I remedial investigation are summarized as follows.

- Assessment of PCBs at the Wilmington Maintenance Facility was prepared by Woodward-Clyde Consultants and dated January 30, 1981. Forty-one (41) soil samples were collected for PCBs in backfilled soils along roadways and mainline tracks, and in marshes and puddles throughout the yard. Thirty-five (35) additional samples were collected from split-spoon samples at 18 well locations along the perimeter and throughout the yard. Sediment, surface water, groundwater, sewer water and sewer sediment samples were also collected.

- Analyses of Soil Samples from AMTRAK was prepared by Radiation Management Corporation and dated July 1982. Sixty-four (64) samples were collected from one-and two-foot soil cores from areas bordering Brandywine Creek, its tributary, and on-site drainage areas for analyses of PCBs and oil and grease. Forty-nine (49) of these samples were collected along drainage areas adjacent to the Former Fueling Facility.

- Radiation Management also conducted soil sampling in 1983 and 1984. Three hundred and four (304) samples were collected at depths from six to 12 inches along the perimeter of the AMTRAK Wilmington Shops, in the Maintenance Facility, and around the locomotive shop.

- During 1984 and 1985 approximately 10,000 cubic yards of PCB impacted soils were removed from "hot spots" in and around the Maintenance Facility. The cleanup area included: in and around the locomotive shop; oil and drum staging area; the mainline track area; and the track area south of the locomotive shop. The Former Fueling Facility was not remediated because sampling reported only low levels of PCBs.

- Preliminary Assessment of the Wilmington AMTRAK Rail Yard - Maintenance Facility was prepared by NUS Corporation and dated February 23, 1989. This report summarized previously collected data and no new data were collected.

- Tank Closure Record - Wilmington Maintenance Facility was prepared by Joseph T. Hardy Sons, Inc. and dated May 20, 1991. This report documents the removal of two 8,000-gallon buried tanks in the Former Fueling Facility and one 5,000-gallon kerosene UST from north of the roundhouse.

- Preliminary Assessment - AMTRAK Wilmington Refueling Facility was prepared by DNREC and dated February, 1993. This assessment reviewed existing data to determine the need for further investigations. No new data were collected during this assessment.

- Inspection Report - AMTRAK Wilmington Refueling Facility was prepared by DNREC and dated December, 1994. This investigation included the collection and analyses of three surface soil (at depths of 0 to 1 foot) samples (two were collected on-site and one in a nearby community park), seven surface water samples and seven sediment samples (co-located with the water samples). Subsequently, two on-site surface soil samples and seven sediment samples were collected because the initial samples were not analyzed within the required holding times. All samples were submitted for Target Compound List (TCL) and Target Analyte List (TAL) analyses. No groundwater samples were collected during the investigation.

- Toxicological Evaluation Report was prepared by DNREC and dated December 29, 1994. The report was based on the results of DNREC's facility investigations. The evaluation reported the cancer risk calculated for an on-site worker from surface soils (the most likely potential exposure route) was within the range of 1.0E-04 to 1.0E-06 (reported by DNREC as the acceptable cancer risk range normally used by USEPA Region III). A detailed discussion of exposure assumptions and risk calculations is presented in the referenced report. However, several of the scenarios modeled assumed future residential land use which is highly unlikely. Analyses presented in this report were used to scope the Phase I RI human health risk analyses performed by IT Corporation.

- Results of Maintenance Yard Soil and Groundwater Investigation prepared by Smith Environmental (dated May, 1995) documented the results of a subsurface investigation of the Former Fueling Facility. The investigation included: the advancement of 12 soil borings which were installed and converted to two-inch diameter PVC monitoring wells (MW-1 through MW-12); collection of 19 soil samples from the borings for chemical analyses (all samples were analyzed for total petroleum hydrocarbons (TPH) and one sample per boring was analyzed for PCBs and select metals); groundwater samples were collected from 5 monitoring wells (for analyses of petroleum diesel range organics, TCL base/neutral semivolatile compounds, total PCBs and select dissolved metals (lead, aluminum, iron and zinc)); and analyses of product samples from three wells for PCBs.

2.1 Phase I Remedial Investigation

The purpose of the Phase I remedial investigation was to determine the extent of subsurface diesel fuel occurrence in the Former Fueling Facility and to provide a data base for the development and selection of appropriate remedial alternatives for the removal of this liquid-phase diesel fuel.

Remedial investigations were initiated in 1998 and included the installation test pits, soil borings and monitoring wells; aquifer and product baildown testing; and a characterization of PCB occurrence in product. The site data and consideration of realistic exposure scenarios were then used to estimate the risk to human health associated with the potential chemicals of concern. An ecological assessment was also performed to characterize biological communities, identify and quantify potential chemicals of concern, and to assess the effects of potential chemicals of concern. Sediment and fish tissue samples were also collected from site drainage features. Site maps from the Draft Phase I RI Report presenting data collected during the (Phase I) remedial investigation are included in **Appendix A**.

2.1.1 Geology and Hydrogeology

The site is located within the Atlantic Coastal Plain Physiographic Province and mapped as being underlain by unconsolidated sediments of the Columbia Formation (Quaternary Age). These fluvial sediments generally consist of gravelly, coarse-to medium-grained sands with interbedded silts and clays (Woodruff and Thompson, 1975). The thickness of the Columbia Formation is generally less than 10 feet in the vicinity of the site (refer to **Figure 2-1**).

The Wilmington Complex (Precambrian Age) subcrops beneath the Columbia Formation along the northwestern portion of the site. The Wilmington Complex represents the crystalline basement rocks of the northern Delaware area and consists of norite, hypersthene-quartz-amdesome gneiss, and noritic anorthosite in the vicinity of the site (Woodruff and Thompson, 1975). The upper portions of these basement rocks are commonly weathered resulting in a zone of regolith reported to be from 20 to 50 feet thick just north of the study area (Christopher and Woodruff, 1982).

Twelve monitoring wells (designated MW-1 through MW-12) were installed in the Former Fueling Facility by Smith Environmental (May 1995). During the Phase I remedial investigation eight additional monitoring wells were installed (MW-6A, MW8A, MW-10A, MW-13, MW-14, MW-16, and MW-17). MW-6A, MW-8A, and MW-10A were installed as replacement wells for wells that had believed to have been destroyed, although MW-8 was subsequently uncovered. During January 2004, SECOR installed replacement monitoring wells MW-1A and MW-3A. Monitoring well locations are depicted on **Figure 2-2** and monitoring well construction specifications are summarized on **Table 2-1**. Monitoring well logs are included in **Appendix B.**

The subsurface materials encountered during site investigations consisted of a varying thickness of cinder/ash fill above fine-to coarse-grained sand material. Dense gray clay was encountered beneath the Eastern and Western Drainage Ditches as well as in monitoring wells (MW-6A, MW-17 and MW-10A) and test pits on the eastern portion of the Former Fueling Facility.

Six geotechnical borings were advanced during 2004 in the northern portion of the Former Fueling Facility as part of the development of a design for a proposed building. Drilling refusal (implied to be competent bedrock) was encountered at approximately 55 feet below ground surface (bgs). At a depth interval of approximately 15 to 25 feet bgs, gray silty clay with peat/clayey peat with gray silty clay was encountered on each boring. From below this clayey zone to drilling refusal, the unconsolidated materials were predominantly fine and medium sands. Logs for these geotechnical borings are also included in **Appendix B**. **Figure 2-3** presents generalized hydrogeologic profiles across the site.

The excavation of test pits during and subsequent to the Phase I RI indicated localized zones of coarse fill consisting of brick, concrete fragments and angular rock fragments. These zones appear to be potential preferential pathways for water and liquid phase product.

Depth-to-water and product measurement data recorded in site monitoring wells indicated that groundwater occurs under unconfined conditions and was encountered at depths ranging from approximately 1.5 feet (MW-10) to 10 feet (MW-3) below ground surface across the site. Groundwater elevation data collected on December 30, 1998 (refer to **Appendix A**) indicates a north-south trending groundwater divide bisects the Former Fueling Facility with groundwater movement towards the surface water features (Eastern and Western Drainage Ditches). The results of recent depth-to-water and product measurement events are described in Section 3.0.

Slug tests were performed in four site monitoring wells to estimate the hydraulic conductivity of saturated subsurface materials. Hydraulic conductivity values were estimated to range from 0.066 feet/day (MW-14) to 1.83 feet/day (MW-17). Of the wells tested, hydraulic conductivity values were generally higher on the eastern portion of the site (MW-2 and MW-17) as compared to wells on the western portion of the site (MW-8A and MW-14).

As was described in the Draft Phase I RI Report, the site and surrounding area is supplied with potable water from the City of Wilmington. The City uses two intakes from the Brandywine Creek. These intakes are at least two miles upstream of the site. Two other public water purveyors were identified within four miles of the site, Wilmington Suburban Water Company (WSWC) and the Artesian Water Company (AWC). WSWC uses surface water from streams more than four miles from the site and the nearest AWC well is approximately four miles south of the site. In addition, the site is located in a non-critical water resource area as defined by DNREC (personal communication, 1998).

2.1.2 Surface Water Hydrology

The area between the Eastern and Western Drainage Ditches is relatively flat with a slight grade from the center of the Former Fueling Facility towards the directions of these features. The Eastern Drainage Ditch originates to the east of the Maintenance Facility and also receives drainage from ditches draining from the NS Yard, the cement and asphalt plant operations and the tank car cleaning operations, on adjacent properties. There is a drainage ditch to the north of the Eastern Drainage Ditch which flows mostly along the western portion of NS property and connects to Shellpot Creek. The northern portion of this ditch flows to Shellpot Creek while the southern portion flows into the Eastern Drainage Ditch. The approximate direction of the drainage divide is presented on **Figure 2-4**.

The Western Drainage Ditch also receives drainage from the former Atlas Sanitation property. In recent years, a significant volume of debris has been placed on this property. Water storage in this debris may provide baseflow to the Western Drainage Ditch. Water in both ditches drain to the south and empty into a confluence area at the southernmost boundary of the study area. This confluence area (which also receives street runoff from the NS Yard, the cement and asphalt plant operations, and the tank car cleaning operation on adjacent properties) drains through a dam (12th Street Dam) which then drains through two pipes under 12th Street and into the Brandywine Creek located approximately 250 feet downstream. Below the 12th Street Dam, flow to the Brandywine Creek is also provided by a City of Wilmington drainage ditch. The surface expression of this ditch (it is believed to originate in underground storm water culverts) begins to the west of the Former Atlas Sanitation property, it flows roughly between the Former Atlas Sanitation property and the Gander Hill prison, and joins drainage from the site below the 12th Street Dam and then flows under 12 Street to the Brandywine Creek. Flood gates/valves are located where the pipes under 12th Street discharge to Brandywine Creek. However, these gates do not appear to functioning properly based on the tidal fluctuations observed in the vicinity of the 12th Street Dam.

The Brandywine Creek flows into the Christina River (approximately 3,500 feet downstream) which empties into the Delaware River approximately 1.6 miles east of the site. The drainage area for the site drainage ditches is approximately 120 acres. This area includes water drainage from the western portion of the Maintenance Facility adjacent to the NS Yard, the former Atlas Sanitation Company landfill, a cement plant, a tank car cleaning company and an asphalt plant. As a result, these areas may contribute constituents of concern to site drainage features. A review of the historical development of site drainage features was presented in the Draft Phase I RI Report.

Earthen dams and weirs were constructed on the Eastern and Western Drainage Ditches to control oil seepage from the Former Fueling Facility (refer to **Figure 1-2**). Dam B was constructed in the Eastern Drainage Ditch, Dam C was constructed in the Western Drainage Ditch and the 12th Street Dam was constructed downstream of the confluence of the two drainage ditches. An additional earthen dam was historically reported in the Western Drainage Ditch downgradient of Dam C although it is no longer present. Woodward-Clyde Consultants performed an investigation of the Wilmington Maintenance Facility that included PCB analysis of sediment samples as well as other media samples. Based on the results of the investigations, Woodward-Clyde (1981) recommended that ponded areas associated with the site dams serve as sediment traps in order to reduce sediment transport.

IT Corporation performed maintenance activities on Dam B and the 12th Street Dam during November 1999. Maintenance activities were also performed by IT Corporation at Dam C during September 2001. The maintenance activities were performed to improve the overall integrity of the dams as well as to increase the effectiveness of these dams as sediment traps. At each location, piping with a downward 90° elbow was set on the upstream side of the dams in order to allow drainage through the dam to occur while facilitating the skimming of product with sorbent booms. At the 12th Street Dam, steel sheet piling was placed at the upstream and downstream (because of tidal influences) sides of the dam. At Dam B, the sheet piling was placed at the upstream side of the dam. At Dam C sheet piling was set at the upstream and downstream sides to increase the overall structural stability of the dam. At each location, the sheet piling was cut in order to allow the replacement pipes to extend through the sheet piling. The area around the pipes was then sealed with concrete, within the dams as well as at the upstream and downstream faces of the dam. Since at each location, the upstream face of the dams consist of steel sheet piling with a downward 90° elbow in the piping, they are effective in preventing the movement of floating product through the dams and function as effective sediment traps. Surface water drainage from these dams is maintained and monitored by AMTRAK by implementing the requirements of a NPDES permit.

As described in the Diesel Fuel Remedial Work Plan, surface water data collected by AMTRAK as part of the NPDES monitoring program at the facility is evaluated on an ongoing basis to verify that groundwater discharge does not have an adverse effect on surface water quality in the ditches. A new NPDES permit (DE0050962) became effective May 1, 2006. Three sampling locations adjacent to or downgradient of the former fueling area are identified in the current NPDES permit will be monitored in accordance with the permit. These locations are described as follows (refer to **Figure 1-2** for sampling locations):

- Outfall 001 – in the Eastern Drainage Ditch at Dam B.
- Outfall 005 – in the Western Drainage Ditch at Dam C.
- Outfall 006 – located downstream of the site in the pond area at the confluence of the Eastern and Western Drainage Ditches. The sampling location is the downstream side of the 12th Street Dam.

Other monitored outfalls at the AMTRAK Wilmington Shops include Outfall 002 (formerly referred to as Outfall 002A) which is located north of the Maintenance Facility and Outfall 007 which discharges to the Eastern Drainage Ditch north of the Former Fueling Facility (neither of these outfalls receives storm water runoff from the Former Fueling Facility). Outfall 003 located in the Eastern Drainage Ditch just north of Outfall 001, and Outfall 004 is located in the northwestern portion of the Former Fueling Facility are not monitored under the current permit (and were not monitored under the previous permit). **Figure 2-4** presents the location and approximate on-site drainage area for each outfall.

Outfall 006 receives flow from the Eastern and Western Drainage Ditches (refer to **Figure 2-5**). The Eastern Drainage Ditch receives storm water from properties east of the AMTRAK facility including the NS Yard, the cement and asphalt facilities, and a tank car cleaning operation. The Western

Drainage Ditch receives direct surface water runoff from the adjacent Atlas Sanitation property which is on the western side of the Western Drainage Ditch. The location of Outfall 006 is tidal and periodically water flows from the City of Wilmington drainage ditch upgradient through Outfall 006 during high tide conditions.

2.1.3 Results of Phase I Remedial Investigations Environmental Sampling

The following is a summary of soil, groundwater and product data presented in the Draft Phase I RI Report. Sediment and fish tissue samples collected and data collected during previous site investigations are also summarized in the Draft Phase I RI Report. Laboratory data from the analysis of soil, groundwater, sediment and fish tissue are displayed graphically in **Appendix A**.

The evaluation of soils included the excavation of test pits and the advancement of soil borings. Since no soil samples were collected from the test pits for quantitative chemical analyses, the discussion below pertains to the analytical results from soil boring samples. Eight soil borings (MW-6A, MW-8A, MW-10A, MW-14, MW-15, MW-16 and MW-17) were advanced during the Phase I remedial investigation. TPH-DRO concentrations in surface soils ranged from 270 mg/kg (MW-14) to 36,000 mg/kg (MW-15). TPH-DRO concentrations in subsurface samples ranged from 840 mg/kg [MW-14 (2' - 4')] to 56,000 mg/kg [MW-15 (2' - 4')].

Groundwater samples were collected on July 1, 1998 from all wells that did not contain measurable liquid phase hydrocarbons (LPH). Groundwater samples were collected from monitoring wells MW-1, MW-2, MW-3, MW-4, MW-8A, MW-11, MW-12, MW-13 and MW-14. TPH-DRO concentrations ranged from 0.22 mg/l (MW-12) to 45 mg/l (MW-8A). In general, wells away from the former fueling area (MW-1, MW-2, MW-3, MW-11, MW-12, and MW-13) reported lower TPH-DRO concentrations (0.22 mg/l to 6.3 mg/l) while wells closer to the former fueling area (MW-4, MW-8A and MW-14) reported higher TPH-DRO concentrations (19 mg/l to 45 mg/l).

Liquid level data collected during monthly gauging events were used to evaluate the lateral extent of LPH occurrence as wells as seasonal variations in apparent LPH thickness. Apparent product thickness data collected during the December 30, 1998 gauging event are presented in **Appendix A** (additional liquid level data will be discussed in Section 3.0). Laboratory analyses of product (oil) samples were performed for composition and physical characteristics (MW-5, MW-10A, and MW-16 only). Product samples collected from MW-5, MW-10A, and MW-16 were characterized as #2 Fuel Oil.

Product samples were also collected from monitoring wells, standpipes, the Western Drainage Ditch and a sump located at the base of the sand tower for PCB content. PCB content in product samples collected ranged from below detection levels (sand tower sump) to 72.3 mg/kg (in the Western Drainage Ditch at Dam C). All PCBs detected in product were PCB aroclor 1260. In general, with exception of the sump (at the base of the sand tower) product sample, lower PCB concentrations were measured in product samples collected adjacent to the Eastern Drainage Ditch at MW-6A, MW-7, MW-17, MW-10A, and TP-1, where PCB concentrations ranged from 0.65 mg/kg to 3.4 mg/kg. No PCBs were detected in the samples of product recovered from Sump #1 collected on December 22, 1998. Additional analyses of product samples for PCBs is described in Section 3.0 as part of the on-going diesel fuel remedial operations.

2.1.4 Baseline Risk Assessment

A human health risk assessment for the Former Fueling Facility was completed by IT Corporation (refer to the Draft Phase I RI Report) focusing on site soils. The human health risk assessment presented in the Draft Phase I RI Report was performed using applicable exposure scenarios. The site is zoned industrial and will continue in the reasonably foreseeable future to be used as a rail yard. Therefore, residential exposure scenarios were not appropriate. Since potable water in the vicinity of the site is supplied by the City of Wilmington and there are no occupied buildings (inhalation scenarios) in the Former Fueling Facility, exposure to groundwater was not evaluated. In addition, observations by site personnel indicate no trespassers have been seen in the site drainage features and any trespassers observed in the upland areas are immediately removed by site personnel. Therefore, surface water exposure scenarios were also not evaluated.

Because the estimated exposure and risk to an on-site worker from surface soils was previously calculated by DNREC and found to be within acceptable target risk levels and fueling operations have ceased in the area (lessening potential worker exposure), an on-site worker was not further evaluated in the Phase I RI assessment for exposure to soil. As a result, exposure scenarios evaluated during the human health risk assessment described in the Draft Phase I RI Report consist of:

- Youth (ages 12 to 18) trespasser to on-site soils.
- Adult trespasser to on-site soils.

The data set considered for the estimation of human health risk included information collected during the RI. Soil analyses for petroleum hydrocarbons, metals and PCBs reported in Inspection Report - AMTRAK Wilmington Refueling Facility, prepared by DNREC (dated December, 1994) and Results of Maintenance Yard Soil and Groundwater Investigation prepared by Smith Environmental (dated May, 1995) were also considered.

Using the information generated during the exposure assessment and the toxicity assessment, the theoretical upper-bound carcinogenic and non-carcinogenic risks to human health were estimated. The estimated risks are summarized as follows:

- the estimated upper-bound cancer and non-cancer risks for a youth (ages 12 to 18) trespasser exposure to on-site soils are 3×10^{-7} and 0.02, respectively; and

- the estimated upper-bound cancer and non-cancer risks for an adult trespasser exposure to site soils are 1×10^{-6} and 0.02, respectively.

These risk estimates are all within USEPA's target risk levels of 1×10^{-4} to 1×10^{-6} for cancer and a hazard index of 1.0. Since the human health risk assessment was performed in 1998, additional site fencing has been installed and AMTRAK police security enhanced, further restricting site access by trespassers (which would result in lower target risk estimates than those reported).

A human health risk assessment was also performed as part of the Phase II remedial investigations. The Phase II human health risk assessment was performed to: 1) also include site worker exposure scenarios as requested by DNREC, and 2) to consider additional data collected subsequent to the Phase I RI.

An ecological assessment was also presented in the Draft Phase I RI report. The revised human health risk assessment is presented in Section 10.0. The ecological assessment focused on the site drainage features. The Phase I and Phase II RI ecological assessments are discussed in Section 11.0.

2.2 Site Characterization Activities Subsequent to the Phase I Remedial Investigation

Additional site characterization activities were performed after the submittal of the Draft Phase I RI Report. These activities include sediment sample collection in the Western Drainage Ditch (north of Dam C), surface soil sampling in the Outfall 004 drainage area, and two soil investigations at proposed building locations. The results of these investigations have been previously provided to DNREC in Diesel Fuel Remedy Progress Reports and are summarized below. Site characterization activities performed as part of the diesel fuel recovery operations are discussed in Section 3.0.

2.2.1 Western Drainage Ditch Sediment Sample Collection

In order to assess conditions in the Western Drainage Ditch, sediment samples were collected by IT Corporation from the Western Drainage Ditch north (upgradient) of Dam C during May 2001. Three samples of material in the ditch were collected from each of three locations (designated WD-1, WD-2 and WD-3) using a hand-driven coring device. At each location samples were collected at depths of 0 to 0.5 feet, 1.5 to 2.0 feet and 3.5 to 4.0 feet below the top of sediments. Each sample was analyzed for petroleum hydrocarbons (C10 through C40) and PCBs. A site plan indicating the sampling locations and tabulated analytical results are presented in **Appendix C**.

As described in the Progress Report dated November 2001, at sampling locations WD-1 and WD-2, dense blue/gray clay was encountered at approximately 3.5 feet below the bottom of the surface of the material in the ditch. At sampling location WD-3, dense blue/gray clay was encountered at approximately 3 feet below the surface. At all three locations, the material above the blue/gray clay was dark silty material rich in decaying organic debris.

As indicated in **Appendix C**, the highest petroleum hydrocarbon and PCB concentrations (ranging from 76,000 to 150,000 mg/kg and 21.0 to 45.0 mg/kg, respectively) were measured in the sample collected at a depth of 0 to 0.5 feet below the surface of the saturated sediment material at each location. The lowest petroleum hydrocarbon and PCB concentrations (ranging from 850 to 8,800 mg/kg and 0.1 to 2.5 mg/kg, respectively) were reported in the deepest sample (collected at a depth of 3.5 to 4.0 feet below the surface of saturated material and in the clay) at each location. The data also indicates that the saturated material above the clay consisted of 66.5% to 78.8% water.

2.2.2 Outfall 004 Drainage Area Surface Soil Sample Collection

As will be described in Section 3.0, erosion control and sediment reduction measures were implemented in the Outfall 004 drainage area. Prior to implementing these controls, surface soil samples were collected. The Outfall 004 drainage area was divided into six subdrainage areas (designated areas 1 through 6) based on topography and observation of surface water drainage during storm water. Surface soils samples were collected using the procedures described in the Draft Phase II RI Work Plan. As described in the Draft Phase II RI Work Plan, the intent of the surface soil sampling program was to evaluate the potentially erodible soils.

Surface soil samples were collected in Area 3 and Area 4 on June 23, 2003. One discrete soil sample was collected from Area 3 (location designated A3DIS1) and Area 4 (location designated as A4DIS1), sample designation A4DIS2 is a duplicate sample of A4DIS1. One composite sample was also analyzed from Area 3 (sample designation A301) and Area 4 (sample designation A401). Sample A301 is a composite of 14 soil aliquots collected at locations of 100-foot grid spacing. Sample A401 is a composite of 12 soil aliquots collected at locations of 50-foot grid spacing. Soil aliquots were collected at a depth of 0 to 3".

Surface soil samples were collected on March 12, 2004 from Outfall 004 area sub-drainage areas 1, 2, 5 and 6. One discrete surface soil sample was collected from each of the areas. Composite samples were also collected from each area using 50 foot or 100 foot grid spacings. Composite soil samples from Area 1, 2, 5, and 6 were compiled from 12, 9, 8, and 11 soil aliquots, respectively, collected at designated grid spacing. Soil aliquots were collected at a depth of 0 to 3". Each discrete sample and each composite was analyzed for PCB using EPA Method 8082, grain-size using ASTM Method D-422, and petroleum hydrocarbons using EPH/VPH methodology as described in the Draft Phase II RI/FS Work Plan. The composite samples from each area were composited in the laboratory using an equal weight from each discrete soil aliquots.

Sample locations and surface soil sample results are summarized in **Appendix D**. As indicated, the total PCB concentration for the discrete (A3DIS1) and composite (A301) samples from Area 3 were 15 mg/kg (aroclor 1260) and 31 mg/kg (aroclor 1260), respectively. The PCB concentrations for the discrete (A4DIS1) and composite (A401) samples from Area 4 were 5.1 mg/kg (aroclor 1260) and 17 mg/kg (aroclor 1260), respectively. These areas were subsequently covered with geotextile and 6 inches of top soil and then vegetated as part of implementation of the Outfall 004 erosion control and sediment reduction measures (refer to Section 3.0).

The results for sub-drainage areas 1, 2, 5 and 6 are also presented in **Appendix D**. As indicated, the total PCB concentrations for the discrete samples ranged from 3.5 mg/kg (Area 5) to 39 mg/kg (Area 1). The total PCB concentrations in the composite samples ranged from 3.6 mg/kg (Area 5) to 39 mg/kg (Area 2).

2.2.3 Proposed CNOC Building (Former Roundhouse Area) Investigation

During October 2004, 15 borings (SB-1 through SB-15) were advanced in the former roundhouse area where construction of a new CNOC building was considered. Construction of this building has been ruled out. Soil borings were advanced using a GeoProbe™ device to an average depth of six feet below ground surface (bgs). Five surface soil samples (SS-1 through SS-5) were also collected. Based on the analytical results from these soil borings, nine additional borings (designated SB-24 through SB-32) were advanced during January 2005. The total depths of these supplemental borings ranged from 3.5 to 12 feet bgs. Soil boring locations are depicted in **Appendix E**.

Discrete soil sample analysis included PCBs by USEPA Method 8082 and petroleum hydrocarbons using EPH/VPH methodology. Composite soil samples analyses included priority pollutant list (PPL) metals using USEPA Method 6010b/7000a and Toxicity Characteristic Leachate Procedures (TCLP) volatile organic compounds, semi-volatile organic compounds, pesticide/herbicides and metals. Tabulated laboratory results are included in **Appendix E**. Total PCB concentrations in soil samples collected between 0 to 2 feet bgs ranged from below detection limits to 1,400 mg/kg (SB-11, 0.25 to 1 feet bgs). Total PCB concentrations in subsurface soils (samples collected at depths greater than 2 feet bgs) ranged from below detection limits to 1,100 mg/kg (SB-11, 2 to 3 feet bgs). The petroleum hydrocarbon results and results for the composite sample analyses are included in **Appendix E**. Separate-phase hydrocarbons were not apparent in any soil boring.

2.2.4 Proposed MOW Building Investigation

During October 2004, eight soil borings (SB-16 through SB-23) were advanced in the general area of considered for a new MOW building (northeastern portion of the Former Fueling Facility). The construction of the MOW building has been ruled out and the area is currently being considered for the construction of a new CETC building. Soil borings were advanced using a GeoProbe™ device to an average depth of six feet bgs. Due to a change in the proposed location of MOW building six additional borings (SB-32 to SB-38) were installed during February 2005. The average depth of these soil borings was also 6 feet bgs. Soil boring locations are depicted in **Appendix F**.

Discrete soil sample analyses included PCBs by USEPA Method 8082 and petroleum hydrocarbon using EPH/VPH methodology. Composite sample analyses included priority pollutant list (PPL) metals using USEPA Method 6010a/7000a and TCLP volatile organic compounds, semi-volatile organic compounds, pesticide/herbicides, and metals.

Tabulated laboratory results are included in **Appendix F**. Total PCB concentrations in surface soil samples (sample; collected between 0 to 2 feet bgs) ranged from detection limits to 41.5 mg/kg (SB-18, 0 to 0.25 feet bgs). Total PCB concentrations in subsurface samples (samples collected at depths greater than 2 feet bgs) ranged from below detection limits to 2.1 mg/kg (SB-18, 4 to 5 feet bgs).

The petroleum hydrocarbon results and the results for the composite sample analyses are included in **Appendix F**.

3.0 INTERIM REMEDIAL MEASURES

In response to the quantification of PCBs in product at the Former Fueling Facility, interim remedial measures (IRM) were implemented during 1998 to further characterize PCBs in product, initiate product recovery, and further control/contain the surface occurrence of product in the Eastern and Western Drainage Ditches. Other activities were previously performed in order to prevent the release and control the movement of product in the vicinity of the Former Fueling Facility including: the installation of the dams and sorbent booms in the Eastern and Western Drainage Ditches; the upgrade of the dams; the transfer of fueling operations to a newly constructed facility north of the former roundhouse, and removal of ASTs. During 2000, the product recovery system described in the Diesel Fuel Remedial Work Plan was installed. During 2003, erosion control and sediment reduction measures were implemented in the Outfall 004 drainage area in order to reduce PCBs in storm water runoff from the site. Additional erosion control and sedimentation reduction measures were installed during 2005. Interim measures are described below.

3.1 Interim Remedial Measures Plan (September 9, 1998)

Based on field observations and data collected during the Phase I remedial investigation, interim remedial measures (IRM) were implemented in September 1998. The scope of the interim remedial measures was provided to DNREC in Interim Remedial Measures Plan (IRM Plan) prepared by IT Corporation dated September 9, 1998. Interim remedial measures performed included:

- Gauging and manual recovery of product from site monitoring wells and standpipes.
- Installation of two 30-inch diameter product recovery sumps; automated product skimming equipment was installed in the sump determined to yield the most product (Sump #1).
- Installation of in-well collection devices in three select monitoring wells.
- Removal of oil and surface debris (oil-soaked leaves, etc.) from the Western Drainage Ditch.
- Replacement of existing sorbent booms and placement and maintenance of additional booms in the site drainage features.
- Field reconnaissance and exploratory excavations for preferred pathways of product seepage to either Eastern or Western Drainage Ditches, such as piping runs.

These IRM activities were documented in the Draft Phase I RI Report and in the Diesel Fuel Remedial Work Plan.

3.2 Diesel Fuel Oil Remedial Program

AMTRAK and APU proactively developed the Diesel Fuel Remedial Work Plan to increase diesel fuel recovery and reduce the mobility of the diesel fuel. The oil recovery system described in the Diesel Fuel Remedial Work Plan was installed during the period September to December 2000. The system was installed to address liquid phase diesel-fuel occurrence in the Former Fueling Facility. Slight modifications were made to the proposed system presented in the Diesel Fuel Remedial Work Plan, as a result of conditions encountered during installation.

Components of the on-going diesel fuel remedial program include:

- Installation and operation of an oil recovery system,
- Bioremediation of surface soils in the vicinity of the Eastern Drainage Ditch,
- Test trenching and closure/removal of preferential pathways,
- Review of NPDES surface water sampling results,
- Groundwater monitoring, and
- Continuation of the sorbent boom maintenance program.

These components are described below.

3.2.1 Oil Recovery System Installation and Operation

Construction of the oil recovery system began on September 5, 2000. The system was installed and equipment shakedown completed by December 1, 2000. The operation and maintenance of the system began in December 2000. The layout of the oil recovery system is presented on **Figure 3-1**. The installation and operation of the system from December 2000 through October 2001 were detailed in Diesel Fuel Oil Remedy System Installation and Semi-Annual Progress Report (Progress Report) dated November 2001. The system installation and operation are summarized below.

The installation of the oil recovery system included the following:

- Installation of approximately 1200 feet of recovery trenches approximately 9 feet deep. Four trenches were installed for active product skimming.

- A total of five 30-inch diameter recovery wells (RW-1, 2, 3, 4 and 5) and nine 8-inch diameter standpipes (SP-1 through 9) were installed within the active product skimming trenches. Oil recovery pumps are placed at five recovery well locations. Oil is routed from these to the 1,000 gallon above-ground storage tank.

- All subsurface piping encountered during recovery trench installation were capped and/or sealed on both sides of the trench.

- All recovery wells, standpipe and trench locations were surveyed and a new base map prepared.

- A total of 11 oil collection and monitoring sumps were installed in the vicinity of the Eastern and Western Drainage Ditches. The sumps consist of 12-inch diameter PVC well screen placed to depths from 5 to 7 feet, backfilled with pea gravel and covered with site fill material.

- As indicated on **Figure 3-1**, the lateral extent of the pea gravel at each location varies and is dependent on the extent oil of observed in the subsurface during excavation.

- Six sumps were installed in the vicinity of the Eastern Drainage Ditch (ED-1 through ED-6). As indicated on **Figure 3-1**, ED-3 and ED-4 were installed in a "passive" recovery trench approximately 100 feet in length.

- Five sumps were installed in the vicinity of the Western Drainage Ditch (WD-A, WD-B, WD-D, WD-E and WD-F).

- The inspection pit was filled with pea gravel and backfilled. Holes were drilled into the concrete of the pit before backfilling to allow oil collection. Two 8-inch diameter recovery sumps were installed to a depth of approximately 2 feet below the bottom of the inspection pit. The pea gravel was covered with geofabric and crush-and-run was placed above the geofabric.

In response to the measurement of approximately 0.3 to 0.35 feet of oil on the water surface at sump WD-B, a product skimming system was installed. Since electrical service was not available in the vicinity of sump WD-B, a compressed gas powered product skimming system was installed. This product skimming system utilizes a pump intake that floats on the water surface. The system is operated by a battery-powered timer which activates the pump. The timer is set to activate the pump at a selected number of intervals and duration of each interval (determined based on the oil recovery rate). When the pump is activated, compressed nitrogen gas is used to evacuate oil collecting in the pump intake. The recovered oil is routed to a 100 gallon double-walled recovery tank adjacent to the recovery location. The recovery tank is equipped with an overfill shutoff probe that will deactivate the system when the tank is full. This system is relocated to other wells/sumps based on observed apparent product thicknesses. Routine operation and maintenance of the oil recovery system is performed to service the recovery equipment as well as to perform other tasks including manually recovering oil, collecting depth to liquids measurements and inspecting the sorbent booms in the drainage features. The effectiveness of the system is monitored through recording oil recovery volumes, depth to liquids measurements, groundwater sampling and analysis, and tracking the results of surface water sampling associated with the NPDES permit for the site.

In order to increase oil recovery from the active oil-skimming recovery trenches, a system was installed to remove water accumulated in the trenches, route the water through granular activated carbon and drain the treated water to the ground surface in the immediate track area. This removal of the water accumulated in the trenches is being performed in similar fashion to what was implemented in the fall of 2000 during trench construction. This procedure was reviewed with DNREC via telephone conversation on June 19, 2000 and relayed via correspondence to DNREC on June 14, 2001 (request for authorization to remove water) and June 19, 2001 (confirmation of authorization to remove water). Although the water is treated with GAC, some iron staining has been observed in the track area due to naturally occurring iron and the anaerobic conditions occurring in the subsurface. Water pumps installed in RW-1 and RW-3 on July 25, 2001 were operated manually until the water level floats, storage tank and controls were in place. Water pumps were subsequently placed in operation in all recovery wells.

Since the evacuated water is routed through granular activated carbon and discharged to ground surface in the track area, operation of the dewatering system is assessed on a weekly basis. Water pumping is adjusted so that the evacuated water drains in the track area. The water pumping system is deactivated when periodic water pumping does not provide for efficient oil recovery, when standing water from precipitation is observed in the track area, or if the ground is frozen limiting infiltration into the ground surface.

Product has been recovered through operation of the oil recovery pumps in the recovery trenches, manual product bailing, and the compressed gas (nitrogen) powered oil recovery pumps. Oil recovery volumes for these methods through December 2006 are summarized below.

Figure 3-2 depicts the total liquid product recovery from the initiation of the IRM through December 2006. As indicated, the total oil recovery volume is approximately 15,209 gallons. The total recovered volume includes the following:

- Approximately 574 gallons of oil recovered during oil recovery trench construction and approximately 12,207 gallons of oil recovery for the Filter Scavenger product recovery pumps installed in Sump #1, RW-1, RW-2, RW-3, RW-4 and RW-5 (refer to **Figure 3-3**),
- Approximately 1,263 gallons from the manual recovery program (refer to **Figure 3-4**), and
- Approximately 718 gallons from the compressed nitrogen gas system (refer to **Figure 3-5**).

Oil samples are collected from the 1,000 gallon oil recovery AST prior disposal of the product. Recovered oil is removed from the recovery ASTs and transported to a TSCA authorized facility) for thermal destruction.

As a result of the detection of product in test pit standpipes installed during 2005 (refer to Section 3.2.2), an additional recovery trench was installed during April 2007. This trench was placed between test pit standpipes TP-101 and TP-106 (the southernmost standpipes in the trench area in which product was detected and TP-102 (product has not been detected) in order to prevent the southerly movement of product. This recovery trench is approximately 70 feet long and extends in a general east-west direction to the south of the previously existing recovery trench system (refer to **Figure 3-1**). The trench construction was similar to that of the existing trenches (approximately nine feet deep, and three feet wide filled with pea gravel), although the trench was excavated to a depth of 12 feet in the vicinity of the recovery well (RW-6). RW-6 is a 30-inch diameter PVC recovery well with 10 feet of 40 slot well screen and two feet of PVC (0.627 inch thickness) riser (solid) pipe. Two standpipes (SP-10 and SP-11) were installed in order to monitor the depth to liquids in the western portion of the trench. A 16-inch diameter steel pipe was excavated at a depth of approximately 4 feet bgs, trending in a north-south direction (perpendicular to this trench) between SP-10 and SP-11 (refer to **Figure 3-1**). Excavation was performed below this pipe to a depth of nine feet bgs and the excavation was backfilled with pea gravel so the trench was continuous. Product recovery and water pumps were placed in RW-6. Water and product conveyance conduits were connected to existing liquids management systems.

3.2.2 Liquid Level Gauging Results

Liquid level measurements are recorded from wells, standpipes and sumps on a quarterly basis. Monitoring well construction specifications are summarized on **Table 2-1**.

As described in the Progress Reported (dated October 2005), 15 test pits (designated TP-101 through TP-115) were installed in the Former Fueling Facility to a depth of approximately eight feet below ground surface (bgs) during July 2005. The test pits were installed primarily in the southern portion of the recovery trench area in order to evaluate oil occurrence on the water table. During January 2007, an additional 20 test (designated TP-116 through TP-135) pits were installed along the eastern portion of the Fueling Facility. Excavated materials were stockpiled adjacent to each pit location and then placed back in each test pit at the approximate depth that they were excavated from, to the extent practical.

After each test pit was examined, a standpipe was placed in order to evaluate the presence of product on the water table. Test pit standpipe locations are depicted on **Figure 3-1**. The test pit standpipes were constructed on 4-inch diameter PVC well screen (0.020 slot) and solid riser pipe. The depth of the test pit standpipes installed during July 2005 (TP-101 through TP-115) ranged from 6.5 feet to 9.0 feet below ground surface (bgs). The depth of the test pit standpipes installed during January 2007 ranged from 6 to 8 feet bgs. The depth of the test pit standpipes installed during January 2007 ranged from 6 to 8 feet bgs. Materials encountered in these test pits generally consisted of:

- 0 to 1 feet bgs – angular gravel in matrix of black silt, with slag fragments (fill and ballast).
- 1 feet to 3.5 feet bgs – black cinders, and fill material, few cobbles
- 3.5 feet to maximum depth of excavation (up to 9 feet bgs) – brownish tan medium grained sand, few rounded cobbles.
- In test pits in the vicinity of the Eastern Drainage Ditch, gray clay was encountered at depths ranging from 4 to 6 feet bgs.

The description presented above was generally consistent across the area of test pit excavation with the exception of TP-110 and TP-125. TP-110 was located adjacent to the northern stained surface soil area in the vicinity of the Eastern Drainage Ditch. At this location, fill material consisting of brick, timber, and large angular bolder up to 1 to 2 feet in diameter was encountered. Water entered the excavation from the west wall at a rate estimated to be several gallons a minute at a depth of approximately 4 feet bgs. This test pit could only be extended to a depth of 6.5 feet bgs because the side walls collapsed. TP-125 also encountered coarse fill material including bricks and other materials at a depth of the 4 feet bgs. Lesser amounts of coarse fill materials were encountered in other test pits. Liquid level data collected from site-wide gauging events performed on September 13, 2006; December 1, 2006; and March 21, 2007 is presented in **Appendix G** (prior quarterly liquid level data was included in previous progress reports). Liquid level data from the site-wide and other gauging events were used to develop hydrographs for select wells in order to evaluate seasonal water table elevation and oil thickness. Hydrographs for recovery wells RW-1 and RW-3 and monitoring wells MW-7 and MW-16 are included in **Appendix G**.

Hydrographs for MW-7 and MW-16 display the seasonal fluctuations of the water table at the site for the period 1998 through March 21, 2007. The water table elevation is typically lowest during the late summer through fall.

The hydrograph from RW-1 is effected by the extraction of water from the trenches during the reporting period (water was not pumped from RW-3 since approximately 2003). Comparison of the hydrographs for RW-1 and RW-3 to **Figure 3-3** (cumulative oil recovery for the trench system) confirms that increased oil recovery occurs when the water levels in the trenches are low.

Product has not been detected in monitoring wells MW-1 (and MW-1A), MW-2, MW-3 (and MW-3A), MW-4, MW-8A, MW-11, MW-12, and MW-13 since liquid level gauging began. Since oil was detected in MW-14 for the first time on June 25, 2003, more frequent (weekly) liquid level measurements were collected during the reporting period. A hydrograph for MW-14 is also included in **Appendix G**. Product has not been detected in MW-14 since October 16, 2004 (when an apparent product thickness of 0.01 feet was reported).

As described previously, 15 test pit standpipes (designated TP-101 through TP-115) were installed during July 2005 in order to evaluate product occurrence in the vicinity of the recovery trenches. These test pit standpipe locations are depicted on **Figure 3-1**. Hydrographs were prepared for TP-105, TP-106 and TP-114 in order to depict the change in apparent product thickness with changing water elevation (refer to **Appendix G**). As indicated on these hydrographs, the greatest apparent product thicknesses in these standpipes were reported during September 2005 when the water table elevation was the lowest since the new standpipes were installed. Product has not been detected in TP-102.

Figure 3-6 presents the apparent product thickness measurements recorded on March 21, 2007. **Figure 3-6** includes all monitoring wells and test pit standpipes. The detection of product in newly installed standpipes will be considered in the FFS Report.

In order to evaluate the change in apparent product thickness in site wells and standpipes, apparent product thickness maps were prepared for the July 1, 1998, October 15, 1999, February 2, 2001, and June 24, 2004 gauging events were presented in a previous Progress Report (dated September 2004). Since the apparent product thickness in the wells is affected by the elevation of the water table, the selection of these events allows for the comparison of apparent product thickness over time when the water table was at a similar elevation.

As described in a previous Progress Report (dated April 2005), comparison of data for these gauging events indicated a significant reduction in the apparent thickness is depicted in all wells/standpipes in which greater than 1.0 feet of apparent product thickness was measured on June 1, 1998. As mentioned, product has not been detected in monitoring wells MW-1 (and MW-1A), MW-2, MW-3 (and MW-3A), MW-4. MW-8A, MW-11, MW-12 and MW-13 since liquid level gauging began. However, as described previously, product was detected in new test pit standpipes installed during 2005 and 2007. As described in the Draft (Phase I) RI Report, product bail-down tests were performed during 1998. These tests indicated that the "apparent" product thickness was 3 to 15 times greater than the "true" product thickness estimated for the wells tested.

3.2.3 Groundwater Monitoring

The diesel fuel remedial program includes the monitoring of groundwater in order to verify that the natural attenuation of dissolved constituents is occurring. During each sampling event groundwater samples were collected from all wells in which product was not detected.

Groundwater samples were analyzed for total petroleum hydrocarbons-diesel range organics (TPH-DRO) by modified EPA Method 8015B by Lancaster Laboratories of Lancaster, Pennsylvania. Laboratory analyses were also performed for iron and manganese (dissolved and total), nitrate, nitrite, sulfate, alkalinity, free carbon dioxide, and methane. During well purging, field measurements of temperature, pH, specific conductance, Eh, and dissolved oxygen were recorded.

Appendix G presents historic groundwater chemistry data for wells sampled since the initiation of the groundwater monitoring program (April 2001). The data indicates that MW-8 and MW-8A (both located west of the former fueling area and near the Western Drainage Ditch where product has been detected in sumps along the ditch) consistently reported the highest TPH-DRO concentrations. In general, the wells located at a greater distance from the former fueling area reported lower TPH-DRO concentrations than the wells closer to the former fueling area. Because of the heterogeneous nature of the subsurface materials at the site, the water chemistry at each well location will reflect local subsurface conditions. The groundwater generally has a low redox potential (less than 0 mV) and low dissolved oxygen content (less than 1.0 mg/l in the majority of the wells sampled (discussion of anaerobic biodegradation is provided below).

As first discussed in the Progress Report dated April 2004, review of the historic groundwater monitoring data indicates that natural attenuation of dissolved hydrocarbons is occurring in most of the site wells that do not contain free product. The data suggests that the groundwater system is limited by the availability of electron acceptors for aerobic biodegradation (primarily oxygen and nitrates) as evidenced by the elevated concentrations of dissolved iron and manganese (characteristic of anaerobic biodegradation). Naturally occurring diesel fuel-utilizing bacteria are more efficient under aerobic conditions. The elevated concentrations of these dissolved metals indicate that nitrates and dissolved oxygen are generally not available in the groundwater. The data suggests that subsurface conditions alternate from anaerobic to aerobic degradation between rainfall events that release dissolved oxygen to the groundwater when considering dissolved oxygen, nitrates and oxidation-reduction potential (ORP) as primary indicators of natural attenuation processes (the depth to groundwater is shallow at the site). This is characteristic of a groundwater system where natural attenuation of hydrocarbons is occurring with mixed kinetics. Percolating rainfall provides dissolved oxygen and nitrates into the groundwater to enhance aerobic reduction naturally due to the shallow water table. When oxygen and nitrates are consumed, the system converts to using iron and manganese in the soil as electron acceptors. Considering the presence of hydrocarbons in the subsurface at the site, this process is likely to continue for some time during operation of the remedial system as product is removed.

Because of the mass of hydrocarbons in the subsurface, a significant decrease in TPH-DRO concentrations in groundwater has not been detected in the vicinity of the former fueling area. Although natural attenuation is occurring, the availability of oxygen in the subsurface is limited because it is consumed at a rate faster than it is recharged to the system through percolating rainfall. As separate-phase product is recovered and dissolved petroleum hydrocarbons are degraded, dissolved TPH-DRO concentrations will decrease. Based on the rate of natural attenuation observed, annual groundwater monitoring is proposed (rather than quarterly monitoring). The monitoring performed during 2001 through June 2006 can be used to assess seasonal changes in groundwater chemistry. However, as noted groundwater chemistry appears to change in response to precipitation events to (providing oxygen to the system) to a greater extent than seasonal fluctuations.

3.2.4 Product Sample Analyses

On October 24, 2001, oil samples were collected from recovery wells and standpipes installed in the recovery trench system for PCB analyses. These results are summarized on **Table 3-1**. As indicated, PCB concentrations (all aroclor 1260) in oil samples ranged from 2.8 mg/kg (Sump #1) to 69.0 mg/kg (SP-6). In general, the highest PCB concentrations were detected in the western (RW-5) and southern (SP-6 and SP-9) portion of the area covered by the recovery trenches.

On September 13, 2005, oil samples were collected from test pit standpipes TP-101, TP-105, TP-106, TP-114, and TP-115 for PCB aroclor analyses. The results are summarized on **Table 3-2**. As indicated, total PCB concentrations ranged from below detection limits (TP-101) to 299 mg/kg (TP-106). PCB Aroclors 1254 and 1260 were detected in test pit standpipes TP-105 and TP-106. Only PCB aroclor 1260 was detected in test pits standpipes TP-114 and TP-115 located to the east of the recovery trench containing RW-1 and RW-4. As described in Section 3.2.1, an additional recovery trench was installed in April 2007 to prevent the southerly movement of product from the area of TP-101 and TP-106.

3.2.5 NPDES Monitoring Program

As described in Section 2.0, surface water data collected by AMTRAK as part of the NPDES monitoring program at the facility is evaluated on an ongoing basis to verify that groundwater discharge does not have an adverse effect on surface water quality in the ditches. A new NPDES permit (DE0050962) became effective May 1, 2006. As previously mentioned, three sampling locations adjacent to or downgradient of the former fueling area (Outfall 001, 005 and 006) are identified in the current NPDES permit are monitored in accordance with the permit.

Prior to the implementation of the new NPDES permit, the only detection of PCBs (detection limit of 0.5 ug/l) in locations receiving run-off from the former fueling area (Outfalls 001, 005, and 006) occurred during January 2006. During January 2006, total PCB aroclors were reported at a concentration of 0.710 ug/l at Outfall 006. AMTRAK contacted DNREC and provided written notification regarding the exceedence on February 28, 2006 (the same day that AMTRAK received the analytical results). As a result of the detection of PCBs, the outfall was also sampled during February, March and April 2006. PCBs were not detected in any of these subsequent sampling events. Oil and grease was reported at a concentration of 17 mg/l in Outfall 005 (above the permit standard of 15 mg/l) during January 2006, but was below the permit standard in February 2006 and subsequent sampling events.

The monitoring requirements of the new NPDES permit vary by outfall locations and are included in **Appendix G**. Parameters for analysis under the permit include oil and grease, pH, TCE, surfactants, PCB congeners, total nitrogen, total phosphorus, and enterococci. The new permit also requires annual PCB congener analyses from Outfall 006 and Outfall 002, and biannual analyses at Outfall 007. As described in Section 2.0, Outfall 006 receives flow from the Eastern and Western Drainage Ditches. The Eastern Drainage Ditch receives storm water from properties east of the AMTRAK facility including the NS Yard, the cement and asphalt facilities, and a tank car cleaning operation. The Western Drainage Ditch receives direct surface water runoff from the adjacent Atlas Sanitation property which is on the western side of the Western Drainage Ditch. The location of Outfall 006 is tidal and periodically water flows from the City of Wilmington drainage ditch upgradient through Outfall 006 during high tide conditions.

3.2.6 Stained Surface Soil Remediation

The diesel fuel remedial program includes addressing hydrocarbon-stained surface soils adjacent to the Eastern Drainage Ditch through bioremediation. These soils occur in three general areas adjacent to the Eastern Drainage Ditch; immediately north of the former 250,000 gallon AST location (northern area), immediately south of the former 250,000 gallon AST location (middle area), and to the southwest of Sump ED-1 (southern area) (refer to **Figure 3-1**).

As described in the Diesel Fuel Remedial Work Plan, diesel fuel components biodegrade most efficiently under aerobic (oxygen-rich) conditions. Under aerobic conditions, indigenous microorganisms utilize inorganic nutrients and oxygen to convert hydrocarbons into cell mass, carbon dioxide and water. In the areas of the stained surface soils, inorganic nutrients such as nitrogen, phosphorous and potassium have been previously added by tilling a fertilizer into the soils, weather permitting.

All three areas were periodically visibly inspected during the reporting period to determine if the soils were dry enough to allow tilling. Based on visual observations, a greater proportion of each area is covered by vegetation than in the past.

A comparison of petroleum hydrocarbon sample results between samples collected in each of the three areas during June 2005 and November 2001 was provided in the May 2006 progress report and is discussed in Section 7.1. In general, C9-C-18 aliphatic hydrocarbons, C19-C-36 aliphatic hydrocarbons, and C11 and C22 aromatic hydrocarbons, reported lower concentrations in 2005 than in 2001 (these are heavier molecular weight hydrocarbons and generally take longer to biodegrade than lighter molecular weight hydrocarbons). Analytical data for this area will be discussed in Section 7.2.2.

3.3 Outfall 004 Erosion Control and Sediment Reduction Measures

Outfall 004 is located in the northwest portion of the Former Fueling Facility (refer to **Figure 1-2**). It receives surface water drainage from the southwest portion of the Maintenance Facility (where there are no active industrial operations) and the northwest portion of the Former Fueling Facility (refer to **Figure 2-4)**. Surface water samples were collected from Outfall 004 during 2000 and 2001 at the request of the Delaware River Basin Commission (DRBC) for the analysis of PCB congeners (Method 1668A). The results of three wet weather sampling events were provided to DRBC in correspondence dated July 13, 2001 from IT Corporation. Based on the results of these sampling events, a Sediment Reduction Plan was developed and implemented. The goal considered in preparing the Sediment Reduction Plan was to provide readily accessible, practical storm water controls to reduce sediment transport from areas that drain to Outfall 004 and improve the surface drainage of the rail track areas in the vicinity of Outfall 004. The plan was focused on minimizing surface disturbances and maximizing the existing drainage swales/pipes and overall “flat” grade of the drainage areas and track structures. As described below, the measures implemented included the installation of bioretention caps, stone/fabric filter berms, grading of certain areas, placing fabric/stone stabilized construction entrances and stone check dams.

The drainage area for Outfall 004 is approximately 11 acres. The Outfall 004 drainage area has been divided into six sub-drainage areas (designated Areas 1 through 6) for preparing design documents for the control measures and sample (soil and surface water) collection (refer to **Appendix H**). These areas represent approximately 9 acres of the total Outfall 004 drainage area. The remainder of the Outfall 004 drainage area consists mostly of paved roadways and track. The following is a description of the controls installed in each sub-drainage area. Design drawings are included in **Appendix H**. The controls were inspected by a person certified by DNREC for erosion and sedimentation control measures installation (“blue card”). When stone/fabric filter berms were installed, the berm height could not be constructed higher than existing adjacent rail track elevation.

Area 1 consists of approximately 2.4 acres and is a chain-link fenced area at the former location of the roundhouse. Surface improvements to drainage and sediment control measures consist of reinforced silt fencing, stone filter berms, and a stone driveway. High quality, filter fabric material was attached to existing chain-link fencing along the southern and western perimeters of the area. The filter fabric material was embedded in the ground approximately eight inches below grade and extends to approximately 16 inches above-grade. Stone/fabric filter berms were installed across the gated southern access to the area and along the northwestern perimeter of the area. The stone/fabric filter berms were installed by first preparing the subgrade. Then a stone berm approximately one-foot high was installed. A non-woven, needle-punched geotextile material was then placed over the stone berm. The geotextile material was embedded in the ground approximately six inches below grade on the upgradient side. The geotextile material was then covered with 12 to 14 inches of crushed stone. A gravel driveway was installed extending into the area from the southern entrance. This driveway is approximately 2,000 sq. ft. and was constructed by placing geotextile material on the existing grade and covering the geotextile material with at least six inches of crushed stone.

Area 2 consists of approximately 1.6 acres and is located west of the fenced area of the former roundhouse and east of the paved road leading to the maintenance shop. Two tracks run through this relatively low-lying area. The eastern part (between the fence on the east and the tracks to the west) is used for miscellaneous materials storage. Surface improvements to drainage consisted of constructing stone/fabric filter berms and two fabric/stone covered areas. Stone/fabric filter berms were installed at select locations along the tracks and along the paved road. A fabric/stone covering was placed in the southern portion of the area between the two tracks and between the eastern track and the Area 1 perimeter fence. The fabric/stone covering was constructed similarly to the driveway described for Area 1. The total area of covered with fabric/stone is approximately 0.3 acres.

Area 3 consists of approximately 2.8 acres and is a triangular shaped area generally located contiguous to the main line track, bounded by the main entrance road (between Outfall 004 and the south side of Area 3), the main line (north side), and the road perpendicular to the main line leading to the maintenance shop (east side). Surface improvements to drainage consisted of slope stabilization/relocation, improvements to drainage swales, clearing the existing culvert, stone/filter berms for the entrance, a new perimeter road, installation of a bio-retention cap, and management of exposed soils along a slope. Two stabilized construction entrances (in the southern and northeastern portion of the area), a perimeter road (approximately 10 feet wide generally adjacent to the main line track), and a parking area (in the eastern portion of the area) were constructed similarly to the driveway described for Area 1. Stone/fabric filter berms were installed around the sides of the entrances and along the down slope side of the new perimeter road. The stone/fabric filter berms were constructed similarly to those described for Area 1. The culvert beneath Vandever Avenue was cleared of sediment. The previously-exposed soil slopes, on the eastern and southern sides of the area, were stabilized by re-grading the slopes and the swales at the base of the slopes. A geotextile material was then placed on the slopes and the swales and embedded into the ground at both ends. The geotextile on the slopes was then covered with the approximately six inches of stone. The geotextile in the swales was then covered with approximately nine inches of stone. Stone check dams were also placed across the swales at select locations. A bio-retention cap was placed over the upland portion of Area 3. The bio-retention cap was constructed using a geotextile filter fabric, topsoil, and grass in addition to the other surface controls described for this area. Filter fabric was placed over an area of approximately 1.7 acres to stabilize the existing soil. Topsoil was then placed and spread with low-pressure equipment to a minimum depth of 6 inches. Finally, grass was planted using a seed mix consisting of approximately 55% hard fescue, 35% creeping fescue, 10% rye at a rate of 100 pounds per acre. The seeded areas were covered with straw matting (rated for regular duty) that was secured with staples at the manufacturer's recommended spacing.

Area 4 consists of approximately 1 acre, contains the Outfall 004 inlet structure, and is bounded by railroad tracks on the west, south, and east sides, and by the main entrance road on the north side. Surface improvements made to drainage consist of erosion and sedimentation protection around the outfall structure, drainage swale repair, installing stone filter berms, and stabilizing the outlet structure. A stabilized construction entrance was installed to allow access into the northwestern portion of the area. A stone/fabric filter berm was installed along the northern and eastern perimeters of the area. The swale to outfall structure from the culvert (from under the paved road) was regarded to improve drainage. The swale was lined with filter fabric and stone (minimum depth nine inches) and a stone/fabric filter berm was constructed along the both sides of the swale. A stone check dam was also installed across the swale. A bio-retention cap was placed over most of the area outside of the reconstructed swale. The extent of the bio-retention cap is approximately 0.6 acres and was constructed as described for Area 3. The discharge end of the culvert from Outfall 004 to the Eastern Drainage Ditch was stabilized using riprap and concrete.

Area 5 consists of approximately 0.75 acres and is east of the area containing Outfall 004 and is bounded between two sets of railroad tracks on the east, south, and west sides, and by the main entrance road to the north. Surface improvements to drainage consisted of constructing stone filter berms. Stone/fabric filter berms were placed along the northern, western, and southern perimeters of the area.

Area 6 consists of approximately 0.6 acres and is located east of Area 5 and south of Area 1 (the fenced former roundhouse area) and is bounded between two sets of railroad tracks on the east, south, and west sides, and by the main entrance road to the north. The eastern part (between the fence on the east and the tracks to the west) is used for miscellaneous materials storage. Surface improvements to drainage consisted of constructing stone/fabric filter berms, and fabric/stone covered areas. Stone/fabric filter berms were placed along the northern and western perimeters of the area. A fabric/stone covering was placed in the northeastern portion of the area adjacent to the paved roadway. The fabric/stone covering consisted of approximately 0.06 acres and was constructed similarly to the driveway described for Area 1.

The effectiveness of the sedimentation control measures implemented during July and August 2003 was evaluated by collecting storm water samples. The results of storm water samples collected after the implementation of the controls were compared to results of samples collected before implementation of the controls. On December 17, 2003 wet weather samples were collected at Outfall 004 (sample designations OF4 and duplicate sample OF4-1).

Sample collection and compositing were consistent with the techniques used in the (DRBC) wet-weather 2000 and 2001 sampling program. Conditions for sample collection were that the sampling be initiated on a "rising hydrograph” and that the storm event be greater than 0.1 inches in magnitude and have a duration of at least one hour. Approximately 0.65 inches of rain was reported at the New Castle County Airport on December 17, 2003 (precipitation data from the Porter Reservoir was not available on this date).

Three grab samples were collected per hour at least 15 minutes apart. The samples were composited on a flow-weighted basis. During each event, the storm water discharge rate was measured using the “V” notch weir installed at Outfall 004. This flow data was used as the basis for sample compositing at each location.

Storm water samples collected on December 17, 2003 were analyzed for Total Suspended Solids (TSS) and PCB congeners (Method 1668A) by Severn Trent Laboratories (STL) located in Knoxville, Tennessee. The total PCB concentration for samples OF4 and OF4-1 collected on December 17, 2003 were 1,370,822 pg/l (1.37 ug/l) and 994,566 pg/l (0.99 ug/l), respectively.

Wet weather samples were also collected at Outfall 004 (sample ID OF4 and duplicate sample OF4-1) on April 12, 2004. Samples were collected using the sampling criteria described above. These samples were also analyzed for PCB congeners (Method 1668A) and TSS. The total PCB concentration for samples OF4 and OF4-1 were 1,285,549 pg/l (1.286 ug/l) and 1,246,547 pg/l (1.247 ug/l), respectively. **Table H-1** (**Appendix H**) presents a comparison of PCB congener data collected from Outfall 004 since November 2000. Note that the total PCB results for the November 2000, December 2000, and March 2001 were for 81 congeners (the 2003 and 2004 results are for all 209 congeners). As indicated, a 94% reduction in PCB concentrations has been documented since the implementation of sediment control measures.

TSS data collected at Outfall 004 on November 19, 2003, December 17, 2003, and April 12, 2004 (after implementation of Outfall 004 sediment controls) and data from five sampling events from November 14, 2000 to June 18, 2003 (before implementation of Outfall 004 sediment controls) were compared (refer to **Table H-2; Appendix H**). The average TSS concentration for the five sampling events prior to implementation of Outfall 004 sediment control was 143.5 mg/l (range in concentration of 45 mg/l to 343 mg/l) and the average TSS concentration for the three sampling events after implementation of Outfall 004 sediment controls was 21.5 mg/l (the TSS on the three events were 42.7, 6 mg/l, and 16 mg/l) which is an 85% reduction in the average TSS concentrations.

Additional sediment control measures or Best Management Practices (BMPs) were implemented in certain areas that drain to Outfall 004 during April and May 2005. These improvements included the installation of additional stone/filter berms, stone/fabric drainage swale, stone/fabric coverings, and road-side coverings (asphalt, stone/fabric). A description of these measures and design drawings were provided to DNREC in a submittal dated November 12, 2004 (this correspondence is included in **Appendix H**). These activities were approved by DNREC (SIRB) in a letter to SECOR dated December 16, 2004 (included in **Appendix H**). Sediment and storm water plan approval was provided by DNREC Division of Soil and Water Conservation in correspondence to AMTRAK dated December 8, 2004 (also included in **Appendix H**). Before and after construction photographs of sediment control measures are included in **Appendix H.**

4.0 REGIONAL ENVIRONMENTAL SETTING

As will be described in Section 6.0 off-site investigations focused on PCBs in sediments were performed during Phase II remedial investigation activities. As will be described below, several sites were identified along the tidal reach of Brandywine Creek at which PCBs were detected. PCBs from sites along this portion of the Brandywine Creek may be re-suspended or re-deposited by tidal actions. This discussion is presented in order to consider the results of the Phase II RI off-site activities in the context of the regional environmental setting. The information provided below includes data provided in the Phase II RI/FS Work Plan as well as supplemental review of DNREC files.

This characterization of the regional setting includes a review of available data for sediment quality in the tidal reach of the Brandywine Creek. As has been described, the Former Fueling Facility is situated in an industrial area of southeast Wilmington that has been affected by anthropogenic activities for the past 250 years. The watershed drainage area for the site drainage ditches is approximately 120 acres. This area includes water drainage from the western portion of the Maintenance Facility adjacent to the NS Yard, the former Atlas Sanitation Company landfill, a cement plant, a tank car cleaning company and an asphalt plant. As a result, these areas may contribute constituents of concern to site drainage features.

The Former Fueling Facility is bound to the south by the confluence of the Eastern and Western Drainage Ditches. This confluence area drains through a dam (12th Street Dam) which then drains into the Brandywine Creek located approximately 250 feet downstream. Below the 12th Street Dam, additional flow to the Brandywine Creek is supplied by a City of Wilmington drainage ditch. The surface expression of this ditch (it is believed to originate in underground storm water culverts) begins to the west of the Former Atlas Sanitation property where it drains (roughly between the Former Atlas Sanitation property and the Gander Hill prison) until it joins below the 12th Street Dam and then drains to the Brandywine Creek. The Brandywine Creek flows into the Christina River (approximately 3,500 feet downstream) which empties into the Delaware River approximately 1.6 miles east of the site. The City of Wilmington drainage ditch, Brandywine Creek, Christina River, and Delaware River receive drainage from industrial areas that may contribute constituents of concern.

Numerous environmental studies have been performed to discern the presence, distribution and potential environmental impact and to determine potential upland source areas that may be impacting the Brandywine Creek drainage basin. Environmental investigations have been performed at specific former industrial properties along the Brandywine Creek. The following are select environmental studies performed at properties located adjacent to tidal reach of the Brandywine Creek.

12th Street Dump Site (DE-294)
Atlas Sanitation (DE-280)
Diamond State Salvage (DE-281)
Electric Hose and Rubber Site (DE-174)
7th Street Drum Site

Figure 4-1 (first presented in the Phase II/FFS Work Plan) depicts the locations of these sites in relation to the Former Fueling Facility. Available DNREC and USEPA files for these facilities were reviewed under the Freedom of Information Act (FOIA). The Diamond State Foundry/Pullman Palace Car Works (DE-1144) is believed to be at the location of the Electric Hose and Rubber site (the site map provided in the DNREC (September 2000) is not clear).

Data obtained from the DNREC file review for the sites identified above and data reported by DNREC (1995) for PCBs in sediments in the Brandywine Creek are presented on **Figure 4-1.** Available data from the mouth of the Brandywine Creek (at the Christina River) upstream to the Market Street bridge (the extent of the tidal reach of the Brandywine) is included. Data presented on **Figure 4-1** includes the results of laboratory analyses as well as field immunoassay surveys. **Figure 4-1** was previously presented in the Phase II RI/FFS Work Plan. A search of DNREC files for PCB data in sediments in Brandywine Creek was performed in 2007, however no additional sediment data was found.

As indicated on **Figure 4-1**, PCBs were detected throughout the tidal reach of Brandywine Creek. PCB concentrations ranged from below detection levels to 470 ug/kg (immediately downstream of the Diamond State Salvage site). The northern-most (most upstream) sample reported a PCB concentration of 143.6 ug/kg. This sample was collected immediately downstream of the Market Street bridge. The observed distribution of PCB in sediments throughout the tidal reaches of the Brandywine Creek is consistent with multiple potential sources and the reworking of sediments as a result of changing tidal conditions. In addition, sediments from the Christina River and Delaware River may be transported up the tidal reach of the Brandywine Creek during tidal exchanges. This suggests the potential for sources of PCBs such as historic industrial facilities, land disposal of PCB materials and wastewater treatment plants outside of the Brandywine Creek drainage basin to have contributed to the observed distribution of PCBs.

The Final Brownfield Preliminary Assessment II for the Diamond State Foundry/Pullman Palace Car Works (DNREC, September 2000) reported a soil sample containing 670 mg/kg PCB aroclor 1254 and 1,300 mg/kg PCB aroclor 1260 in a soil sample associated with the location of transformers. DNREC (September 2000) concluded that surface soils in transformer areas "show extremely high levels of lead and/or PCBs." Remedial action and additional investigations were recommended for these areas.

During an inspection conducted on March 21, 2003, the following observations were made concerning an area where electric transformers and other equipment are located (off-site from the Former Fueling Facility, not on AMTRAK property). The location of the area is across 12^{th} Street, south of the Former Fueling Facility study area and between the southern most location of AMTRAK property and the Brandywine Creek. This area is industrialized and referenced as the Brandywine Industrial Complex. This complex includes the Former Electric Hose and Rubber site. As indicated above, PCBs have historically been reported at concentrations of up to 1,970 mg/kg for the area where electric transformers and other equipment are located on the Brandywine Industrial Complex. On March 21, 2003, Frank Aceto of SECOR and Paul Yaniga of WISE observed that storm water accumulation from a recent precipitation event was actively being pumped from the ground surface at the electric transformer area on to 12^{th} Street and allowed to discharge into a nearby storm water catch basin structure. The storm water catch basin is presumed to discharge to the adjacent Brandywine Creek. The observations and photos of this event were sent to DNREC on April 25, 2003.

5.0 ON-SITE PHASE II REMEDIAL INVESTIGATION ACTIVITIES

This section describes the Phase II remedial investigation activities performed in the vicinity of the Former Fueling Facility. The scope and methods of the investigation were presented in the Phase II RI/FFS Work Plan. The Phase II RI/FFS Work Plan included a Sampling and Analyses Plan which provided quality assurance/quality control (QA/QC) requirements developed in accordance with HSCA protocols. As has been discussed, based on the results of initial Phase II RI data collection, supplemental activities were proposed in the Supplemental Phase II RI Work Plan. Investigations performed in accordance with the Phase II RI/FFS Work Plan and the Supplemental Phase II Work Plan are described below.

5.1 Investigative Approach

The focus of the Phase II remedial investigations was to further characterize sediments in the site drainage features in order to provide a database to evaluate potential remedial alternatives. Sediment samples were collected in the Eastern Drainage Ditch, Western Drainage Ditch and the confluence area to assess the distribution and vertical extent of PCBs and petroleum hydrocarbons in sediments. Sediment samples were previously collected from Western Drainage Ditch upgradient of Dam C (refer to Section 2.0) and no further sampling was performed in this section of the ditch. Surface soil samples were collected from upland areas in order to characterize potentially erodible soils which may be washed to site drainage features during storm events. Surface water samples will be collected in different areas of the Former Fueling Facility under dry weather and storm conditions. Investigations were also performed in an abandoned storm water sewer.

5.2 Sediments

Sediment was characterized within the Eastern Drainage Ditch, Western Drainage Ditch, (downgradient of Dam C) and the drainage ditch confluence area during Phase II remedial investigations. This data will be used to assess potential remedial alternatives for the site ditches.

5.2.1 Eastern Drainage Ditch

In order to characterize sediment in the Eastern Drainage Ditch, 14 transect locations were established spaced approximately 100 feet apart. As described below, sediment samples were collected along each transect for laboratory analyses. Transect locations are depicted on **Figure 5-1**. Samples were collected along 14 transects (designated EDT-1 through EDT-14) between April and July 2005.

Sediment samples were collected at either two, three or four locations along each transect depending on the channel width.

At each transect location; samples were collected for laboratory analyses to evaluate the vertical sediment profile. Representative samples were retained for analyses from (1) a depth 0 to 3 inches (designated the “A” interval on **Figure 5-1**), (2) a depth of 3 inches to the top of the underlying clay substrate, (designated the “B” on **Figure 5-1)**, and (3) from the top the clay to one foot into the clay (designated the “C” interval on **Figure 5-1**). The “A” interval was analyzed to represent the potentially bioavailable/erodible layer. The “B” interval sample was analyzed to represent the bulk of sediment material at each location. The clay substrate (“C” interval) was analyzed to evaluate the material beneath sediment. Along each transect, sediment samples from the “A” and “B” intervals were collected and composited. One composite sample for each of the “A” and “B” intervals along each transect was analyzed. In addition, one discrete sample along each transect was collected from “C” interval.

As described in the March 2006 data package, in order to vertically profile the “B” interval, samples were collected over three-feet depth horizons. After the “A” interval sample was collected using a stainless steel hand auger, a temporary two-inch diameter PVC pipe with a Tyvek® cover on the bottom of the pipe, was pushed into the sediment to a depth of approximately 3 inches. A stainless steel hand auger was then inserted into the PVC pipe to collect composite sediment sample over the 3” to 3’ 3” depth interval. Similarly, a PVC pipe was then installed to a depth of 3’ 3” and then a sample was collected from the depth interval of 3’ 3” to 6’ 3” (or to the top of clay substrate where the sediment thickness was less than 6’ 3”). Where the sediment thickness was greater than 6’ 3”, an additional “B” interval sample was collected from a depth of 6’ 3” to the top of the clay substrate. In order to collect representative samples from the “C” interval (clay substrate), the PVC pipe with the Tyvek® cover on the bottom was pushed through the overlying sediments to the top of the clay, a sediment sample was then collected by inserting the stainless steel hand auger through the PCB and collecting a sample from the upper 1-foot interval of the clay horizon. The sampling procedures described above were implemented in order to obtain representative sediment samples of the target depth interval.

In addition, sediment samples were collected from the middle of the ditch from the northern extent of the open water area of the Eastern Drainage Ditch to the drainage divide (between the Brandywine River and Shellpot Creek) at approximately 100-foot intervals. The sampling locations within this segment of the ditch are presented on **Figure 5-2** (designated sampling NED-1 through NED-15). At each sediment sample location, a sample from the “A”, “B”, and “C” intervals were collected (if possible) for laboratory analyses. At some locations samples from all intervals could not be collected because either the sediment profile above the clay was thin or the hand auger could not penetrate through gravel or cobbles.

Samples were preserved appropriately and transported to the analyzing laboratory according to quality assurance procedures described in the Phase II RI/FFS Work Plan. A chain-of-custody form was completed and conveyed with the samples throughout the shipping process. Quality assurance/quality control (QA/QC) samples were also submitted for laboratory analyses in accordance with the requirements summarized in the Phase II RI/FFS Work Plan.

Each sediment sample retained for laboratory analyses for each interval along each transect was analyzed for PCB aroclors by USEPA method 8082 and petroleum hydrocarbons (TPH-DRO) by USEPA Method 8015. Composite samples from the 0 to 3 inch in depth interval ("A" interval) were analyzed for total organic carbon (TOC) and grain-size. PCB congener analysis were performed on approximately 10% of the samples. PCB congener analyses were performed according to "USEPA Method 1668, Revision A: Chlorinated Biphenol Congeners in Water, Soil, Sediment and Tissue by HRGC/HRMS", USEPA No. 821-R-00-002, December 1999 (Method 1668A) for all 209 congeners. Field measurements at each sediment sampling location included depth to water, depth to sediment, thickness of sediment, and depth to clay substrate.

5.2.2 Western Drainage Ditch (Dam C to Confluence Area)

During the period April through August 2005, sediment samples were collected from the Western Drainage Ditch from Dam C to the drainage ditch confluence area. Sediment samples were collected along transects spaced approximately 100 feet apart. Transect locations are depicted on **Figure 5-1**. Samples were collected along eight transects (designated WDT-1 through WDT-8). Since the Western Drainage Ditch is only on the order of 15 to 30 feet wide in this reach, sediment samples were collected from the middle of the ditch at each transect.

Samples were retained for laboratory analyses from the "A", "B" and "C" intervals at each location. Discrete samples were collected at each location for laboratory analyses from the "A" and "C" intervals. Sediment samples within the "B" interval were collected at three-foot increments and composited to obtain a sample representing each three-foot "B" interval at each sampling location. The sample collection and laboratory analyses procedures were similar to those discussed for the Eastern Drainage Ditch (refer to Section 5.2.1).

5.2.3 Drainage Ditch Confluence Area

During April 2005, sediment samples were collected from the confluence area of the Eastern and Western Drainage Ditches at the south end of the facility. Sediment samples were collected along 3 transects (designated CAT-1 through CAT-3). Samples were retained for laboratory analyses from the "A", "B", and "C" intervals at each location. Sediment samples were collected at three sampling locations along each transect. A composite sample from each transect representing the "A" interval and "B" (3" to 3' 3") interval were retained for laboratory analyses. One discrete sample from the "C" interval along each transect was retained for laboratory analyses. Sample collection and laboratory analyses procedures will be similar to those described for the Eastern Drainage Ditch (refer to Section 5.2.1).

5.3 Soil Sample Collection

Soil samples were collected adjacent to site ditches in conjunction with the sediment sampling described above. Samples were also collected in the three general areas of hydrocarbon stained surface soils adjacent to the Eastern Drainage Ditch and surface soil samples were collected across the site in order to characterize potentially erodible soils.

5.3.1 Drainage Ditch Bank Soil Samples

As proposed in the Phase II RI/FFS Work Plan, soil samples were collected along the eastern and western banks of the Eastern Drainage Ditch, the Western Drainage Ditch (downgradient of Dam C) and the drainage ditch Confluence Area. The bank soil samples were collected at the location of sediment sampling transects (refer to **Figure 5-1**). Sampling locations were between the seasonal high and low water level on each side of the drainage feature. The bank soil surface samples were collected at a depth of 0 to 6 inches below grade using a stainless steel hand auger. The hand auger was decontaminated between sampling locations. To the extent practical, the hand auger boring continued to the depth of the clay layer visually for visual inspection of the materials above the clay layer.

During June and July 2005, bank surface (at depth of 0 to 6") soil samples were collected at each end of the 14 transects across the Eastern Drainage Ditch (samples are designated EDT-1E through EDT-14E and EDT-1W through EDT-14W). Bank surface soil samples were collected to the east and west of the eight sediment sampling locations in the Western Drainage Ditch during May and June 2005. These soil samples were designated WDT-1E through WDT-8E and WDT-1W through WDT-8W. Bank surface soil samples were collected at each end of the three transects across the Confluence Area during May 2005. These soil samples are designated CAT-1E through CAT-3E and CAT-1W through CAT-3W.

Each bank surface soil sample was analyzed for PCB aroclors using USEPA Method 8082 and total petroleum hydrocarbons (TPH/DRO) using USEPA Method 8015. Approximately 25% of the soil samples were also analyzed using Massachusetts EPH/VPH methodology which provides results for specific carbon-range groups for aromatic and aliphatic hydrocarbons. Approximately 10% of the samples were also analyzed for PCB congeners using Method 1668A.

As proposed in the Supplemental Phase II RI Work Plan and the Phase II RI/FFS Progress Report, additional bank soil samples were collected to further characterize soils to delineate the lateral extent of the "B" interval sediments at locations were elevated PCB concentrations were reported in site sediments.

During 2006, additional hand auger soil borings were installed approximately 20 feet laterally (in an outward direction, away from the Eastern Drainage Ditch) from the previous bank soil sampling locations at the ends of transect/bank soil sampling locations. At each soil boring location, a soil sample was collected from the upper 6-inches of soil ("A" horizon), and a soil sample was collected at every 3 foot interval (in the "B" horizon) to the top of the clay substrate. These "B" interval soil samples were composited over each 3 foot interval. Soil borings were advanced to the top of clay substrate or to hand auger refusal, whichever was encountered first. Each supplemental bank soil sample was analyzed for PCB aroclors and TPH/DRO. **Figures 5-3** and **5-4** presents the bank soil sampling locations. As indicated on **Figure 5-4**, additional bank soil borings were installed in the vicinity of EDT-4W and EDT-14E in order to provide additional delineation.

Supplemental bank soil borings were installed approximately 20 feet north and south of bank surface soil sampling locations EDT-4W, EDT-14W, and EDT-14E which reported elevated PCB concentrations (refer to **Figure 5-4**).

Supplemental bank soil borings were advanced at each end of transect CAT-1 (Confluence Area) and transect WDT-1 (Western Drainage Ditch) refer to **Figure 5-3**.

Soil borings were advanced adjacent to select locations in the drainage ditch north of the Eastern Drainage Ditch (these locations include NED-13, NED-14, and NED-15) in order to further characterize the "B" horizon. No bank soil samples were previously collected in these areas. Soil borings were advanced to the east and west of the ditch at each of these three locations (refer to **Figure 5-3**).

5.3.2 Stained Soil Areas

As described in Section 3.0, in-situ bioremediation of hydrocarbon stained soils has been performed in three areas adjacent to Eastern Drainage Ditch as part of the diesel fuel recovery operations. These areas are displayed on **Figure 5-5**. In each area three discrete soil samples were collected from a depth of 0 to 6 inches on June 8, 2005 below ground surface (designated SSA-1A, B, C, SSA-2A, B, C and SSA-3 A, B, C). The samples were collected using a stainless steel hand auger which was decontaminated between sampling locations. Hand auger boring continued visual inspection of sub surface materials.

Each discrete soil sample was analyzed for PCB aroclors using USEPA Method 8082. Each sample will also be analyzed for petroleum hydrocarbons using Massachusetts EPH/VPH methodology. One sample (SSA-3B) was analyzed for PCB congeners using Method 1668A.

5.3.3 Surface Soils in Upland (Subdrainage) Areas

Surface soil samples were collected across the Former Fueling Facility in order to evaluate the potentially erodible soil. These samples were collected in order to characterize soils which may be washed into the site drainage ditches during precipitation events.

As previously described, the area between the Eastern and Western Drainage Ditches is relatively flat with a slight grade from the center of the Former Fueling Facility towards the directions of the ditches. As a result, there is a surface water divide trending north-south through the Former Fueling Facility which separates surface water drainage from the Eastern and Western Ditches. The Former Fueling Area was divided into 16 subdrainage areas based on observations of site topography and surface water runoff during precipitation events. Surface soil samples were collected from Areas 1 through 6 during the Outfall 004 erosion control and sediment reduction project as previously described (refer to Section 3.0) A 100 foot grid was set up over Areas 7 through 16. At each grid mode, a discrete surface soil sample (at a depth of 0 to 3 inches) was collected between March and May 2005. Upland surface sampling locations are depicted on **Figure 5-6**.

The samples within each area were composited and one composite sample was analyzed for each subdrainage area. In addition, one discrete sample from each subdrainage area was retained for laboratory analyses.

The composite soil samples were analyzed for PCB aroclors (USEPA Method 8082), for petroleum hydrocarbons using Massachusetts EPH/VPH methodology, and grain size. The discrete samples were analyzed for petroleum hydrocarbons (EPH/VPH methodology), PCB aroclors and grain size. Discrete soil samples 10-M, 12-G, 13-B, and 16-M as well as the Area 16 composite sample were analyzed for PCB congeners using Method 1668A.

As proposed in the Supplemental Phase II RI Work Plan and described in the Phase II RI/FFS Progress Report, additional surface soil sampling was performed in the Former Fueling Area and on the AMTRAK property to the east of the Eastern Drainage Ditch.

Four additional subdrainage areas were established in vegetated areas immediately west of the Eastern Drainage Ditch. These areas were designated areas 17, 18, 19 and 20 (refer to **Figure 5-6**).

Eight subdrainage areas were established in the AMTRAK property to the east of the Eastern Drainage Ditch. These areas were designated areas E1 thought E8 (refer to **Figure 5-7**).

These subdrainage areas were established based on field observation of surface water drainage and topography. For each supplemental subdrainage area, a composite sample of the upper three inches of soil was compiled (by the laboratory) from at least six discrete samples spaced across each sub-area. One composite and one discrete surface soil sample was retained from each subdrainage area during the period May through June 2006 for PCB aroclor analyses. As a result of elevated PCB concentrations at discrete surface sample location E-1A, four additional surface soil samples were collected approximately 20 feet to the north, south, east and west (designated E1A-N, EIA-S, E1A-E, and E1A-W) of this location during July 2006. As a result of elevated PCB concentrations at discrete sample location E1A-W, three additional samples were collected approximately 20 feet north, south and east (designated samples E1A-W1, E1A-Ws, and E1A-W3) of this location during September 2006.

5.3.4 Soil Borings on the AMTRAK Property East of the Eastern Drainage Ditch

As proposed in the Supplemental Phase II RI Work Plan, soil borings were advanced on the AMTRAK property to the east of the Eastern Drainage Area. Five hand auger soil borings (designated ESB-1 through ESB-5) during May 2006 (refer to **Figure 5-8**). The soil borings were advanced to the top of clay substrate or hand auger refusal whichever occurred first. Surface (0 to 6 inches) and subsurface samples were retained from each soil boring for the laboratory analyses of PCB aroclors (Method 8082) and TPH/DRO (Method 8015).

5.4 Surface Water Investigations

In order to evaluate the chemistry of surface water in different areas of the site, grab surface water samples were collected at Dam B in the Eastern Drainage Ditch (Outfall 001), the drainage pipe under Railcar Avenue located north of the open area of the Eastern Drainage Ditch (Railcar Avenue Location), at Dam C in the Western Drainage Ditch (Outfall 005), and at the 12th Street Dam in the drainage confluence area (Outfall 006). A surface water sample was also collected at the 12th Street Dam during an incoming tide. Water has been observed moving northward (upstream) through the dam as a result of tidal conditions in Brandywine Creek. The surface water sampling locations are presented on **Figure 5-9**.

Dry weather grab samples were collected from each location on June 24, 2005 after a period of at least 72 hours with no precipitation. A sample was also collected at Outfall 006 on June 24, 2005 during an incoming tide.

Wet weather samples were collected from Outfall 001, Outfall 005, Outfall 006 and the Railroad Avenue location on November 12, 2004. Wet weather grab samples were composited on a flow-weighted basis using techniques described in NPDES Storm Water Sampling Guidance Document dated July 1992 (USEPA, 1992). At each sampling location except Outfall 006, composite samples were prepared from 12 grab samples collected at least 20 minutes apart. At Outfall 006, the composite sample was prepared from 6 grab samples (sampling ceased after tidal reversal was observed). Precipitation on this day was 1.3 inches as measured at the Porter Reservoir located approximately one mile north of the site. Sampling initiated while the water level in the drainage feature was rising as determined by the observation of the nearest staff gauge.

Surface water samples were analyzed for PCB aroclors using USEPA Method 8082, PCB congeners using Method 1668A, and total suspended solids (unfiltered samples only). PCB analyses was performed on filtered and unfiltered samples. Samples were filtered by the laboratory.

During the dry and wet surface water sampling events, flow measurements were recorded at each sampling location. Estimates of flow were measured at each location by recording the height of water in each pipe and measuring surface water velocity in each pipe using a hand-held electronic flow meter. If flow was observed through more than one pipe at a sampling location, the flow through each pipe was added in order to estimate the total flow at each location.

5.5 Former/Abandoned (reportedly closed) Sewer Evaluation

As described in the Supplemental Phase II RI Work Plan, an area where the upwelling of water (with visible iron staining) has continually been observed between the former lift station where an abandoned sewer formerly terminated and the Eastern Drainage Ditch (refer to **Figure 5-10**). Iron staining was also observed in water accumulating in the former lift station (refer to location in **Figure 5-10**). Based on previous discussions with facility personnel, it is believed that the lift station was installed by the late 1960's. The site sewers were routed to the lift station and then the water was pumped to the City of Wilmington POTW. Investigations were performed to characterize water and sediment in this abandoned sewer and to determine if this sewer is a potential source of PCBs to the Eastern Drainage Ditch.

Investigations focusing on this former sewer system were performed during August 2006. Available facility maps were inspected and site reconnaissance was performed in order to identify potential surface water and sediment sampling locations associated with the sewer system. Grab surface water samples were collected from six vaults found in the area of the former roundhouse (Vault-1 through Valult-7), although no sample was collected from Vault 4 (because only a small amount of water was observed in the vault); two manholes including MH-1 (adjacent to the former roundhouse) and MH-2 (south of the former roundhouse); the lift station; and from the water upwelling area. Surface water sampling locations are depicted on **Figure 5-10**. These samples were analyzed for PCB aroclors, TPH/DRO, and total suspended solids.

Grab sediment samples were also collected from the sewer system. Sediment samples were collected from the six vaults identified above as surface water sample locations; from MH-1 and MH-2; from the lift station; and two sediment samples were collected at the location of the water upwelling area. A sediment sample was also collected from a section of a former brick sewer found approximately 40 feet northeast of the former turntable location in the former roundhouse area. These sediment sampling locations are also depicted on **Figure 5-10**. Sediment samples were analyzed for PCB aroclors and TPH/DRO.

In order to determine if there is a connection between the abandoned sewer system, the lift station and the upwelling area, dye testing was performed (under dry weather conditions). Dye introduced into MH-1 was observed at MH-2. During another test, dye was introduced into MH-2 and it was observed in the lift station, the upwelling area, and eventually in the Eastern Drainage Ditch to the east of the upwelling area. Dye was also introduced to Vault 6. However, direct communication with adjacent Vaults 5 and 7 was not confirmed. These locations are indicated on **Figure 5-10**.

5.6 Western Drainage Ditch Vegetative Enhancement Testing

As described in the proposed Supplemental Phase II RI Work Plan dated May 30, 2006, wetland vegetation was placed over an approximately 100 foot section of the Western Drainage Ditch between Dam C and the Confluence Area (refer to **Figure 5-11**). The wetland plantings were installed during August 2006. The plantings were placed in order to evaluate if selective plantings can reduce the iron content in water in the Western Drainage Ditch as well as to evaluate which plants wills grow in the sediment conditions in the Western Drainage Ditch. The plantings should function to locally provide oxygen to the surface water, filtering the surface water to reduce particulate material; uptake dissolved organic compounds and improve overall water quality. Herbaceous plugs of the selected species were placed directly in the sediment at a spacing 2 to 3 foot centers. Based on water depth in the test area, five shallow water (0 to 12 inches) species were placed. These include:

- Broad-leaf cattail (Typha latifolia)
- Green bulrush (Scirpus atrovirens)
- Fox sedge (Carex vulinoidea)
- Lurid sedge (Carex lurida)

Two medium water species (12 to 36 inches) were also planted. These include:

- Arrow arum (Peltandra virginica)
- Pickerelweed (Pontederia cordata)

A wetlands seed mix was proposed to be broadcast within the treatment area in order to assess which species thrive in the conditions in the test area. However, as requested by DNREC, the wetland mix was not used because of concern with the potential introduction of non-native species. Wetland seed mixes can be custom made to include only native species. AMTRAK and APU may propose to use a custom wetland seed mix in the future if determined to be needed.

Surface water quality monitoring was proposed to quantify any reduction of iron in surface water in the vegetative enhancement testing area of the Western Drainage Ditch as a result of the installation of the wetland plants. In their August 10, 2006 letter, DNREC expressed concern that organics were not included in the proposed suite of analytes. As a result, AMTRAK and APU included the analyses of petroleum hydrocarbons using EPH/VPH methodology. Baseline surface water sampling events were performed between July and October 2006 (surface water monitoring locations are depicted on **Figure 5-11**). Performance surface water monitoring of the vegetative enhancement pilot testing will occur after a period of acclamation of the plantings to the site conditions and growing seasons.

6.0 OFF-SITE PHASE II REMEDIAL INVESTIGATION ACTIVITIES

In response to DNREC's comments to the Draft Phase I RI Report, sediment sampling was performed in drainage ditches contiguous to the vicinity of the Former Fueling Facility and in the Brandywine Creek. QA/QC samples were also collected in accordance with the Phase II RI/FFS Work Plan.

6.1 Adjacent Drainage Ditches

Sediment samples were collected from drainage ditches in the vicinity of the Former Fueling Facility in order to evaluate potential impacts from surrounding properties. Drainage ditch sediment sampling locations are depicted on **Figure 6-1**.

As indicated on **Figure 6-1**, sediment samples were collected at five locations (in the approximate center of the ditch) within the City drainage ditch, spaced approximately every 500 feet from the 12^{th} Street Dam to the origin of the ditch during December 2004. These sediment sampling locations are designated CD-1 through CD-5.

Sediment samples were also collected from each of two drainage ditches that enter the Eastern Drainage Ditch from the east (refer to **Figure 6-1**). Sample location DD-1 is the drainage ditch that enters the Eastern Drainage Ditch from the east, approximately 300 feet south of Dam B. This ditch originates in a low-lying vegetated storm water collection area to the east of Railcar Avenue (in the vicinity of an adjacent rail yard and railcar tank cleaning operation). Water is routed under Railcar Avenue through a concrete pipe approximately six feet in diameter. Upon review of the results of sediment sample collected at the DD-1 location on July 11, 2005, DNREC requested additional sediment sampling in this ditch during a telephone conversation with SECOR on March 9, 2007. The additional sampling was requested in order to determine if there was a possible off-site source of the PCBs detected at location DD-1. As a result, on March 23, 2007, sediment samples were collected from an additional sediment sampling location (designated DD1 Sed 2), positioned immediately adjacent to the outlet of the pipe under Railcar Avenue (this is the most upgradient location in this ditch on AMTRAK property). A sediment sample (designated DD Pipe Sed 1) was collected from within the pipe under Railcar Avenue.

A sediment sample was also collected from a location (designated DD-2) in the drainage ditch entering the Eastern Drainage Ditch from the east side immediately east of the railroad bridge over the Eastern Drainage Ditch (refer to **Figure 6-1**).

At each sampling location, a sample of surficial sediment (0-3 inch depth interval) was collected. Sediment samples were also collected at two-foot intervals until refusal or a clay substrate was reached. Sediment samples were collected with a stainless steel hand auger. The sediment samples were analyzed for PCBs (aroclors), TOC, and grain size (except as noted below). Samples DD-1 (0-3”), DD-2 (3”-2’2”) and CD-3 (0-3”) were also analyzed for PCB congeners using Method 1668A. Sediment samples collected on March 23, 2007 were analyzed for PCB aroclors and TPH/DRO.

6.2 Brandywine Creek

Sediment samples were collected from the tidal reaches (south of Market Street) and non-tidal reaches (north of Market Street) of the Brandywine Creek. Sediment samples from the tidal reach of Brandywine Creek may be affected from sources upgradient of the tidal reach and along the tidal reach as well as from sediments from the Christina and Delaware Rivers.

6.2.1 Tidal Reach

Sediment samples were collected from the tidal reach of the Brandywine Creek along transects as well as in potential depositional areas on November 3 and 5, 2004. Sediment sampling locations in the Brandywine Creek are displayed on **Figure 6-2**.

Three surficial sediment (approximately 0-3 inch depth interval) were collected along each of three transects in the tidal Brandywine Creek (transects are designated BCT-1, BCT-2 and BCT-3) in the vicinity of the surface water outfall from beneath 12th Street, adjacent to the Former Fueling Facility. One transect was extended from the drainage outfall beneath 12th Street (BCT-2), one transect was located approximately 500 feet upstream (BCT-1), of BCT-2 and the third transect was located approximately 500 feet downstream (BCT-3) of BCT-2.

Surficial sediment samples were collected at six potential depositional areas (designated BC SED-1 through BC SED-6) distributed throughout the tidal reach of the Brandywine River. These sampling locations are depicted on **Figure 6-2**.

All sediment samples were collected using a Petite Ponar grab sampler. The location of each sample was determined using a geographic positioning system (GPS). The sediment samples were analyzed for PCB aroclors (USEPA Method 8082), TOC, and grain size. Nine of the samples were also analyzed for PCB congeners using Method 1668A. One PCB congener analysis was performed for each of the three transects (BCT-1B, BCT-2B, BCT-3C) and one congener analysis was performed for each of the six potential depositional areas (BC SED 1 through BC SED 6). Water temperature, dissolved oxygen concentration, conductivity, and pH was measured at each sampling station using calibrated field instruments.

Benthic macroinvertebrate samples were collected at each sediment sampling location using the Petite Ponar grab (0.023 m^2 per replicate); five replicates were collected at each station and composited to form one sample. Samples were washed through a 0.5-mm sieve and preserved with 10 percent rose-bengel formalin solution. At the laboratory, specimens were removed from attendant sediment/detritus, identified to the lowest practicable taxonomic level and enumerated.

6.2.2 Non-Tidal Reach

Three sediment sampling locations (BCNT-1, BCNT-2, and BCNT-3) were established in the non-tidal tidal Brandywine Creek, upstream of the Market Street Dam. At each location, one surficial sediment sample (0-3 inch depth interval) was collected using a stainless steel hand auger. Additional samples were collected in approximately 6 to 12 inch intervals until hand auger refusal was encountered. The surficial sediment samples were analyzed for PCBs aroclors (USEPA Method 8082), TOC, and grain size. Sediment samples collected below a depth of three inches were analyzed for TOC and PCB aroclors (USEPA Method 8082) at each one-foot interval. Samples BCNT-1 (0-3") and BCNT-3 (0-3") were also be analyzed for PCB congeners using Method 1668A.

7.0 RESULTS OF SITE ENVIRONMENTAL SAMPLE COLLECTION

The following is a discussion of the results of the Phase II remedial investigations at the Former Fueling Facility. As described in Section 5.0, these activities included: sediment sampling in site drainage ditches; soil sample collection including drainage ditch bank soils, three areas with stained soils, upland surface soils, and soil borings to the east of the Eastern Drainage Ditch; surface water sample collection; evaluation of a former abandoned (reportedly closed) sewer; and surface water monitoring associated with vegetative enhancement testing in the Western Drainage Ditch.

As specified in the Phase II RI/FFS Work Plan, chemical analyses of the environmental media sampled were performed by a DNREC certified laboratory (Lancaster Laboratories, Inc. Lancaster, Pennsylvania). As also noted in Phase II RI/FFS Work Plan, the only exception was the PCB congener analyses (Method 1668A for 209 congeners) which was performed by Severn Trent Laboratories (STL) in Knoxville, Tennessee. The analytical data was validated in accordance with HSCA protocols. The data validation reports and electronic data packages are included in **Appendix I**.

7.1 Sediments

As described in Section 5.2, representative sediment samples were collected from: (1) a depth 0 to 3 inches (designated the “A” interval; (2) a depth of 3 inches to the top of the underlying clay substrate, (designated the “B” interval); and (3) from the top the clay to one foot into the clay (designated the “C” interval). In order to profile the “B” interval with depth, samples were collected over three-foot depth horizons in the “B” interval through the use of temporary PVC casings installed into the sediment at select depth horizons. Site sediment samples were collected from the Eastern Drainage Ditch, the Confluence Area, and the Western Drainage Ditch. The individual PCB congener concentrations and the results for grain size analyses results sediment samples are presented in **Attachment J.**

7.1.1 Drainage Ditch North of the Eastern Drainage Ditch

As described in Section 5.2, sediment samples were collected from the drainage ditch to the north of open water area of the Eastern Drainage Ditch and from open water area of the Eastern Drainage Ditch.

Figure 7-1 displays the 15 sampling locations in the drainage ditch to the north of the Eastern

Drainage Ditch extending from the open water area of the Eastern Drainage Ditch to the approximate drainage divide between the Shellpot Creek and Brandywine Creek. As indicated, locations NED-1 through NED-12 are north of Railcar Avenue and locations NED-13, 14 and 15 are located to the south of Railcar Avenue. Sampling locations were in the middle of the channel. To the north of Railcar Avenue, the drainage ditch channel is well defined with the width of water filled channel ranging from approximately 2 to 40 feet, with the widest reaches immediately north of Railcar Avenue. At sample locations NED-14 and NED-15, the drainage ditch flows through a low lying dense *Phragmites* (common reed) wetland area and the channel is not well defined.

Table 7-1 presents a summary of field measurements recorded during sample collection including water depth, width of open water body, and depth to clay substrate. As indicated on **Table 7-1** the water depth ranged from 0.23 feet to 3.17 feet. The depth to the clay substrate ranges from 3 feet (NED-1) to 10 feet (NED-10). Grain-size data for the surficial sediments at each location is presented in **Appendix J**.

Figure 7-1 and **Table 7-2** present the analytical results for sediments in the drainage ditch to the north of the Eastern Drainage Ditch. Data is presented for the drainage ditch north of the Eastern Drainage Ditch, to the north (NED-1 through NED-12) and south (NED-13, 14, and 15) of Railcar Avenue. As indicated on **Table 7-2**, the total PCB aroclor concentration in "A" interval sediment north of Railcar Avenue ranged from 2.73 mg/kg (NED-8A) to 17 mg/kg (NED-5A) and from 2.9 mg/kg (NED-13A) to 21 mg/kg (NED-15) to the south of Railcar Avenue. As indicated on **Table 7-2**, only PCB aroclor 1260 was detected in "A" interval sediments in locations NED-1 through NED-7A, NED-13A, and NED-15A. PCB aroclors 1254 and 1260 were reported in NED-8A, NED-11A, NED-12A, and NED-14A; while PCB aroclors 1248, 1254 and 1260 were detected in NED-9A.

Total PCB concentrations in "B" horizon sediments north of Railcar Avenue ranged from 2.5 mg/kg (NED-7B (3" to 2'3")) to 36 mg/kg (NED-5B (3"-2'9")) and from 0.35 mg/kg (NED-15B (6'3" to 8'2")) to 210,000 mg/kg (NED-14B (3'3"-5'11")) to the south of Railcar Avenue. Similar to the "A" interval sediments, only PCB aroclor 1260 was detected in "B" interval sediments at locations NED-1 through NED-7, NED-13 and NED-15. PCB aroclor 1254 was detected at NED-8, NED-9, NED-10 and NED-12 in "B" interval sediments. PCB aroclor 1248 was detected in NED-9 in "B" interval sediments.

Total PCB aroclor concentrations for all "C" interval (clay substrate) samples ranged from below the detection limit of 0.028 mg/kg (NED-12C) to 1 mg/kg (NED-14C). As indicated, PCB concentrations in the clay substrate were significantly lower than in the over-lying sediments.

As indicated on **Table 7-2**, TPH-DRO concentrations ranged from: 93 mg/kg (NED-1-A) to 8,100 mg/kg (NED-15A) in the “A” interval, 61 mg/kg (NED-4B (3”-3’3”)) to 210,000 mg/kg (NED-14B (3’3”-5’11”) in the “B” interval; and below detection limits (NED-1C, NED-9C, NED-13C and NED-15C) to 270 mg/kg (NED-14C) in “C” interval sediments.

Samples NED-3B (3”-3’3”), NED-5A, NED-7C, NED-8B (3” to 1’9”) and NED-9A were also analyzed for PCB congeners. Total PCB congener results are summarized on **Table 7-2** and individual congener results are included in **Appendix J**.

7.1.2 Eastern Drainage Ditch

Figure 7-2 displays the locations of 14 transects across the Eastern Drainage Ditch (individual sample locations along each transect are presented on **Figure 5-1**). Transects are designated EDT-1 through EDT-14.

Table 7-3 presents a summary of the field measurements recorded during sample collection. As indicated on **Table 7-3**, the water depth ranged from approximately 0.75 feet (EDT-11) to 2.92 feet (EDT-9). As indicated on **Table 7-3,** the depth to clay substrate ranged from 1.33 feet (EDT-14) to 9 feet (EDT-6).

Figure 7-2 and **Table 7-4** present the analytical data for sediments in the Eastern Drainage Ditch. As indicated on **Table 7-4**, total PCB aroclor concentrations and TPH/DRO concentrations in the “A” interval sediment samples ranged from 16 mg/kg (EDT-8A) to 320 mg/kg (EDT-5A) from 43,000 mg/kg (EDT-8A) to 240,000 mg/kg (EDT-9A), respectively.

Total PCB aroclor TPH/DRO concentrations in the “B” interval sediments ranged from 0.74 mg/kg (EDT-6B (6’3”-9’3”)) to 220 mg/kg (EDT-3B (3” to 3’3”)) and from 5,600 mg/kg (EDT-2B (3’3” to 6’3”)) to 190,00 mg/kg (EDT-11B (3”-3’3”), respectively.

Total PCB aroclor and TPH/DRO concentrations in the “C” interval sediments ranged from below detection limits (EDT-6IC, EDT-7IIC, EDT-9IIC and EDT-10IIC) to 5.90 mg/kg (EDT-1IIC) and below the detection limit of 40 mg/kg (EDT-9IIC) to 57,000 mg/kg (EDT-11IIC) respectively.

Sediment samples EDT-6B (3”-3’3”), EDT-7C, EDT-11B (3”-3’3”) and EDT-12A were also analyzed for PCB congeners. Total PCB congener results are summarized on **Table 7-4** and individual congener results are included in **Appendix J**.

7.1.3 Western Drainage Ditch

Figure 7-3 displays the eight sediment sampling locations in the Western Drainage Ditch below Dam C (designated WDT-1 through WDT-8). Samples were collected from the middle of the ditch. Results of sediment samples collected north of Dam C were described in Section 2.0

Table 7-5 presents a summary of field measurements recorded during sample collection. As indicated the water depth ranged from approximately 0.17 feet (WDT-2) to 1.75 feet (WDT-8). The depth to the clay substrate ranged from 1.75 feet (WDT-6) to 5.0 feet (WDT-8). The width of the water filled channel ranges from approximately 10 to 30 feet along this reach of Western Drainage Ditch.

Figure 7-3 and **Table 7-6** present the analytical results for sediments in the Western Drainage Ditch. As indicated on **Table 7-6**, total PCB aroclor and TPH/DRO concentrations in the "A" interval sediments ranged from 2.4 mg/kg (WDT-2A) to 17 mg/kg (WDT-1A) and 540 mg/kg (WDT-2A) to 34,000 mg/kg (WDT-7A), respectively.

Total aroclor and TPH/DRO concentrations in the "B" interval sediments ranged from 1.3 mg/kg (WDT-1B (3"-3'3") to 94 mg/kg (WDT-1B (3"-3'3"), and from 120 mg/kg (WDT-2B (3"-2'7") to 120,000 mg/kg (WDT-3B (3"-2'9")), respectively.

Total PCB aroclor and TPH/DRO concentrations in the "C" interval ranged from below detection limits (WDT-5C, WDT-6C and WDT-8C to 0.13 mg/kg (WDT-1C) and from 27 mg/kg (WDT-6C) to 2,100 mg/kg (WDT-3C), respectively.

Sediment samples WDT-4A, WDT-4B (3"-3'1"), and WDT-4C were also analyzed for PCB congeners. Total PCB congener results are summarized on **Table 7-6** and individual PCB congener results are presented in **Appendix J**.

7.1.4 Confluence Area

Figure 7-3 displays the locations of three transects across the confluence area (individual sample locations are presented on **Figure 5-1**). Transects are designated CAT-1, CAT-2, and CAT-3.

Table 7-5 presents a summary of field measurements recorded during sample collection. As indicated on **Table 7-5**, the water depth ranged from 0.5 feet (CAT-1) to 2.58 feet (CAT-3). The depth to clay substrate ranged from 1.83 feet (CAT-1) to 4.5 feet (CAT-3).
Table 7-7 presents the analytical results for sediments in the confluence area. The total PCB aroclor

results for the "A" interval were 14 mg/kg (CAT-1A), 12 mg/kg (CAT-2A) and 47 mg/kg (CAT-3A). TPH/DRO results for the "A" interval area 34,000 mg/kg (CAT-1A), 20,000 mg/kg (CAT-2A), and 9,100 mg/kg (CAT-3A).

The total PCB aroclor and TPH/DRO results for "B" interval sediments ranged from 17 mg/kg (CAT-2B (3"-3'3") to 69 mg/kg (CAT-1B (3"-3'3") and from 16,000 mg/kg (CAT-3B (3"-3'3")) to 120,000 mg/kg (CAT-1B (3"-3'3").

Total PCB aroclor concentration in "C" interval sediments were 0.17 mg/kg (CAT-1C), 9.9 mg/kg (CAT-2C), and 0.11 mg/kg (CAT-3C). TPH/DRO concentrations in "C" interval sediments were 270 mg/kg (CAT-1C), 45,000 mg/kg (CAT-2C), and 710 mg/kg (CAT-3C).

In general, during the Phase II remedial investigations, the highest PCB and TPH/DRO concentrations in sediments were detected in the Eastern Drainage Ditch while the lowest concentrations were detected in the Western Drainage Ditch. Also, the dense gray clay substrate was encountered in all site drainage features sampled.

7.2 Soils

As described in Section 5.3, soil sample collection included: drainage ditch bank soils, surface soils in three areas of stained soils adjacent to the Eastern Drainage Ditch, surface soils from subdrainage areas in the Former Fueling Facility and the AMTRAK property to the east of the Eastern Drainage Ditch, and soil borings on the AMTRAK property to the east of the Eastern Drainage Ditch. The results of these investigations are summarized below.

7.2.1 Drainage Ditch Bank Soils

Drainage ditch bank surface soil samples were collected during June and July 2005. Additional soil samples were collected during 2006 and 2007 from supplemental soil borings advanced in an outward direction (from each drainage feature) from the bank surface soil locations.

7.2.1.1 Drainage Ditch Bank Surface Soil – 2005

Figures 7-4 and **7-5** display the location of surface soil (depth of 0 to 6 inches) samples collected on the eastern and western banks of the Eastern Drainage Ditch, Confluence Area, and Western Drainage Ditch, respectively. Samples were collected on the eastern and western ends of transects across each of these drainage features, at a location between the seasonal low and high water level. Soil samples were collected at each end of 14 transects in the Eastern Drainage Ditch (samples are designated EDT-1E (east) through EDT-14E and EDT-1W (west) through 14W), three transects in the Confluence Area (CAT-1E through CAT-3E, and CAT-1W through CAT-3W), and eight transects in the Western Drainage Ditch (WDT-1E through 8E, and WDT-1W through WDT-8W).

Table 7-8 presents the results for the drainage ditch bank surface soil samples collected adjacent to the Eastern Drainage Ditch between April and July 2005. **Figure 7-4** also presents total PCB aroclor concentrations. Total PCB aroclor concentrations ranged from 0.60 mg/kg (EDT-2E) to 77 mg/kg (EDT-4W and EDT-14E). Only PCB aroclor 1260 was detected in these samples. Sample EDT-9E was also analyzed for PCB congeners. As indicated on **Table 7-8**, this sample reported 18 mg/kg total PCB congeners. Complete congener results for this sample is presented in **Appendix K**. TPH/DRO concentrations ranged from 79 mg/kg (EDT-6E) to 150,000 mg/kg (EDT-14E). Samples EDT-5E, EDT-5W, EDT-6E, EDT-8E, EDT-9E, EDT-10W and EDT-12E were also analyzed for petroleum hydrocarbons using EPH/VPH methodology which are summarized on **Table 7-8**.

Table 7-9 presents the results for the drainage ditch bank surface soil samples collected adjacent to the Western Drainage Ditch during May and June 2005. **Figure 7-5** also presents total PCB aroclor concentrations. Total PCB aroclor concentrations ranged from 0.85 mg/kg (EDT-6W) to 26 mg/kg (WDT-1W). With the exception of samples WDT-7E and WDT-7W (also reported PCB aroclor 1254); only PCB aroclor 1260 was detected. Samples WDT-2W and WDT-8E were also analyzed for PCB congeners and reported 3.382 mg/kg and 1.198 mg/kg total PCB congeners, respectively (refer to **Table 7-9**). Complete congener results for these samples are included in **Appendix K**. TPH/DRO concentrations ranged from 110 mg/kg (WDT-3W) to 7,500 (WDT-1W). Samples WDT-2E, WDT-2W, WDT-3E and WDT-8E were also analyzed for petroleum hydrocarbons using EPH/VPH methodology (results are presented on **Table 7-9**).

Table 7-10 presents the results for the drainage ditch bank surface soil samples collected adjacent to the Confluence Area during May 2005. Total PCB aroclor concentrations ranged from 1.2 mg/kg (CAT-3E) to 22 mg/kg (CAT-1E). Only PCB aroclor 1260 was detected. Sample CAT-1W was also analyzed for PCB congeners and reported 18.113 mg/kg total congeners (refer to **Table 7-10**). Complete congener results are presented in **Appendix K**. TPH/DRO concentrations ranged from 0.100 mg/kg (CAT-3E) to 3,700 mg/kg (CAT-1W). Samples CAT-1E and CAT-3W were also analyzed for petroleum hydrocarbon using EPH/VPH methodology (these results are presented on **Table 7-10**).

7.2.1.2 Supplemental Drainage Ditch Bank Soil Borings – 2006 and 2007

Supplemental hand auger soil borings were advanced at locations approximately 20 feet laterally (in an outward direction, away from the drainage ditch) from the previous bank surface soil sampling locations positioned at the ends of each transect/bank soil sampling location. These hand auger borings were advanced to characterize surface soils as well as to delineate the extent of the "B" horizon of the sediments. At each soil boring location, a soil sample was collected from the upper 6-inches of soil ("A" horizon) and a soil sample was collected at every 3 foot interval (in the "B" horizon) to the top of the clay substrate. The "B" horizon soil samples were composited over each 3 foot interval. Hand auger soil borings were advanced to the top of clay substrate or to hand auger refusal, whichever was encountered first. Each soil sample was analyzed for PCB aroclors and TPH/DRO.

Hand auger soil borings were advanced at select locations adjacent to the drainage ditch north of the Eastern Drainage Ditch (NED) in order to further delineate the "B" horizon sediments. These locations include NED-13, NED-14, and NED-15 (refer to **Figure 7-6**). No bank soil samples were previously collected in these areas. Hand auger soil borings were advanced to the east and west of the ditch at each of these three locations. These sample locations are presented on **Figure 7-6**.

The analytical results for these samples are presented on **Figure 7-6** and **Table 7-11**. Adjacent to sediment samples NED-13, NED-14 and NED-15, bank soil boring were advanced outward (away from drainage ditch) until the PCB concentrations at all depth intervals were les than 50 mg/kg. As indicated on **Figure 7-6** and **Table 7-11**, total aroclor PCB concentrations were less than 50 mg/kg in all depth intervals at NED-13E-3, and NED-13W-2; NED-14 E-2 and Ned-14W-2; and NED-15E-2 and NED-15W-1. TPH/DRO concentrations in all soil bank samples in this area ranged from 62 mg/kg (NED-13E-3B (0.5' to 2.5')) to 230,000 mg/kg (NED-14W-1A).

Hand auger soil borings were advanced at each end of the 14 previous transects across the Eastern Drainage Ditch during the period from April through July 2006. Soil borings were also advanced north and south of bank surface soil sampling locations EDT-4W, EDT-14W, and EDT-14E which previously reported elevated PCB concentrations. These sample locations are presented on **Figures 7-7, 7-8,** and **7-8A**. The analytical results for these samples are also presented on **Figures 7-7, 7-8,** and **7-8A**, and **Table 7-12**. Soil samples in all depth intervals reported total aroclor PCB concentrations less than 50 mg/kg with the exception of the areas of EDT-4W and EDT-14E. As a result, additional soil borings were advanced in these two areas between May 2006 and January 2007.

The extent of soils with total PCB aroclor concentrations greater than 50 mg/kg in the area EDT-4W is delineated by soil borings EDT-4W-5, EDT-4W-12, EDT-4W-14, EDT-4W-15, EDT-4W-26, EDT-4W-27, EDT-4W-29 and EDT-5W-1. Total PCB and TPH/DRO concentrations in the EDT-4W area soil borings ranged from below the detection limit of 0.280 mg/kg (EDT-4W-12B (3.5'-6.5') to 3,200 mg/kg (NED-4W-9B) (3.5'-5.0')) and 170 mg/kg (EDT-4W-11A) to 48,000 mg/kg (EDT-4W-17B (3.5' to 7.0'), respectively.

The extent of soil with the total PCB concentrations greater than 50 mg/kg in the area of EDT-14E is delineated by soil borings EDT-14E-3, EDT-14E-5, EDT-14E-6, EDT-14E-7, EDT-14E-8, and EDT-14E-9. Total PCB and TPH/DRO concentration in the EDT-14E area ranged from 3.3 mg/kg (EDT-14E-8B (3.5'-6.5') to 150 mg/kg (EDT-14E-1B (3.5'-6.5') and 120 mg/kg (EDT-14E-6A) to 79,000 mg/kg (EDT-14E-2B (0.5'-3.0'), respectively.

Hand auger soil borings were advanced at each end of transect CAT-1 (Confluence Area) and transect WDT-1 (Western Drainage Ditch) during April and May 2006. These sample locations are presented on **Figure 7-9**. The analytical results for these samples are presented on **Figure 7-9** and **Table 7-13**. As indicated, Total PCB aroclor concentrations ranged from 0.11 mg/kg (CAT-1E-1A) to 38 mg/kg (WDT-1W-1A). TPH/DRO concentrations ranged from below the detection limit of 13 mg/kg (CAT-1E-1A) to 19,000 mg/kg (WDT-1W-1B (0.5-3.5').

Table 7-14 presents the depths of all drainage ditch bank soil borings. Soil borings were advanced to the top of clay substrate or to hand auger refusal. As indicated the depth to clay substrate ranged from 1.5 to 7.5 feet adjacent to the drainage north of the Eastern Drainage Ditch: 0.5 to 10 feet adjacent to Eastern Drainage Ditch; and 0.25 to 6.5 feet adjacent to Western Drainage Ditch and Confluence Area. As indicated, the clay substrate was encountered adjacent to all drainage features. Hand auger soil boring logs are included in **Appendix L**.

7.2.2 Stained Surface Soil Areas

Table 7-15 presents the analytical results for surface soil samples collected in the three stained soil areas adjacent to the Eastern Drainage Ditch. Three samples were collected in each of the three areas. Stained surface soil sampling locations and total PCB aroclor concentrations are presented on **Figure 7-10**. Total PCB aroclor concentrations for the samples collected ranged from 0.67 mg/kg (SSA-2B) to 3.6 mg/kg (SSA-1D). The individual congener concentrations for sample SSA-3B are presented in **Appendix M.**

Table 7-16 compares the petroleum hydrocarbon results from the June 8, 2005 sampling event to the results of one composite sample from each area collected on November 29, 2001 (this data was previously included in the May 2003 Progress Report). As indicated on **Table 7-16**, and discussed in the May 2006 Progress Report (for the reporting period July 2005 through December 2005) all samples collected in June 2005 reported C5-C8 aliphatic hydrocarbons, C9-C12 aliphatic hydrocarbons, and C9-C-10 aromatic hydrocarbon concentrations below detection levels. In general, C9-C-18 aliphatic hydrocarbons, C19-C-36 aliphatic hydrocarbons, and C11 and C22 aromatic hydrocarbons, reported lower concentrations in 2005 than in 2001 (these are heavier molecular weight hydrocarbons and generally take longer to biodegrade than lighter molecular weight hydrocarbons). The data comparison suggests that treatment in the southern area was more effective than in the other two areas.

7.2.3 Upland (Subdrainage Area) Soils

Upland (Subdrainage area) surface soil samples were collected in order to characterize potential erodible soils. Soil samples were collected from the Former Fueling Facility and the AMTRAK property to the east of the Eastern Drainage Ditch.

7.2.3.1 Former Fueling Facility

Table 7-17 presents the analytical results for upland surface soil samples collected in a total of 16 subdrainage areas collected between June 2003 and May 2005. The area of investigation was divided into 16 subdrainage areas based on field observations of storm water run-off during rain events. A sample grid was laid out within each subdrainage area. A surface soil sample (0 to 3 inches) was collected at each grid node. For each subdrainage area, one grab sample and one composite sample (all grab samples within each subdrainage area was composited by the analyzing laboratory) were analyzed. Samples from subdrainage areas 1 through 6 were collected during 2003 and 2004; prior to the installation of Outfall 004 sediment control measures (these measures and sample results were discussed in Semi-Annual Progress Reports). Subdrainage area composite and grab sample locations are depicted on **Figure 7-11**. The individual congener concentrations for discrete samples 10-M, 12-G, 13-B, 15-C and 16-M and the Area 16 composite sample are presented in **Appendix N**. Total PCB congeners concentrations for these samples are summarized on **Table 7-17**. **Table 7-17** also presents the petroleum hydrocarbon results using EPH/VPH methodology for select samples.

In order to characterize surface soils within the immediate Eastern Drainage Ditch drainage area, surface soils were collected from four additional subdrainage areas (Areas 17, 18, 19 and 20) in the vicinity of the Former Fueling Facility (refer to **Figure 7-11**) adjacent to the Eastern Drainage Ditch. One discrete and one composite sample from each area were analyzed for PCB aroclors. The results for these samples are presented on **Table 7-18**.

Tables 17 and **18** as well as **Figure 7-11** indicate that for samples collected in the Former Fueling Facility, total PCB aroclor concentrations in discrete samples ranged from 0.34 mg/kg (Area 13-B) to 39 mg/kg (Area 1–6) and 0.37 mg/kg (Area 16) to 39 mg/kg (Area 2) for composite samples. Area 1 is the location of former round house.

7.2.3.2 AMTRAK Property to the East of the Eastern Drainage Ditch

Surface soils were also characterized on the portion of AMTRAK property to the east of the Eastern Drainage Ditch (refer to **Figure 7-12**) using the strategy used for upland surface soil characterization described in the March 6, 2006 Phase II RI Data Package. Subdrainage areas were established based on field observation of surface water drainage and topography. For each sub-area, a composite surface sample of the upper 3" of soil was compiled (by the laboratory) from at least six discrete samples spaced across each sub-area. One composite and one discrete surface soil sample were collected from each sub-area for PCB aroclor analyses. As a result of elevated PCB concentrations in the discrete sample collected in area E1 (sample Area E1-A located to the east of the Eastern Drainage Ditch), additional discrete surface soil samples were collected approximately 20 feet north, east, west and south (designated as samples E1A-N, E1A-E, E1A-W, and E-1A- S, respectively) of location Area E1-A. Additional discrete surface soil samples were collected to the north, west, and south of discrete sample E1A-W (designated discrete samples E1A-W1, E1A-W2, and E1A-W3).

Surface soil sample results are presented on **Figure 7-12** and **Table 7-19**. As indicated, total PCB aroclor concentrations for discrete samples ranged from 0.370 (Area E-2A) to 110 mg/kg (Area E1A-1) and from 0.83 mg/kg (Area E3A-F) to 10 mg/kg (Area E9A-F).

7.2.4 Soil Borings (AMTRAK Property to the East of the Eastern Drainage Ditch)

Additional soil characterization was performed on the portion of AMTRAK property to the east of the Eastern Drainage Ditch. Five hand auger soil borings (ESB-1 through ESB-5) were spaced across the property (refer to **Figure 7-13**). These borings were advanced to the top of clay substrate or hand auger refusal whichever occurred first. Hand auger refusal was encountered in borings ESB-1, ESB-3, and ESB-4 at depths ranging from 0.5 to 2.5 feet bgs. The clay substrate was encountered in borings ESB-2 and ESB-5 at depths of 4 and 4.5 feet bgs, respectively. Surface and subsurface soil samples were collected for PCB aroclors and TPH/DRO (using the same sample collection strategy as described above).

The analytical data from these soil borings are presented on **Figure 7-13** and **Table 7-20**. As indicated, total PCB aroclor concentrations ranged from below the detection limit of 0.14 mg/kg (ESB-1B (0.5'-4.0'), ESB-1B (0.5'-2.5') and ESB-5-1B (3.5-4.5')) to 1.2 mg/kg (ESB-5-1A (0-0.5')). TPH/DRO concentrations ranged from 23 mg/kg (ESB-2-1A (0.0-0.5')) to 360 mg/kg (ESB-1-1A (0.0'-0.5')).

7.3 Surface Water

As described in Section 5.4, storm water samples were collected on November 12, 2004 at four locations. These locations included the culvert under Railcar Avenue, Outfall 001 (Dam B), Outfall 005 (Dam C) and Outfall 006 (12^{th} Street Dam). Sample locations are presented on **Figure 7-14.** **Table 7-21** and **7-22** present the analytical results for unfiltered and filtered samples, respectively. The individual congener concentrations for each sample are presented in **Appendix O.**

As indicated on **Figure 7-14** and **Table 7-21**, the highest total PCB congener concentrations (unfiltered samples) were detected in the Western Drainage Ditch at Outfall 005 (Dam C) which reported a concentration of 180,525.70 pg/l (0.18 ug/l) and the drainage ditch north of the Eastern Drainage Ditch at Railcar Avenue which reported 164,114.00 pg/l (0.16 ug/l). Total congener concentrations were lower down gradient of the Railcar Avenue sampling location at Outfall 001 (Dam B) which reported a concentration of 60,996.40 pg/l (0.061 ug/l) and at the most down gradient sample location Outfall 006 (12^{th} Street Dam) which reported 121,707.40 ug/l (0.12 ug/l).

Tables 7-23 and **7-24** present the analytical results for unfiltered and filtered dry weather surface water samples, respectively, collected on June 24, 2005 at four locations. These locations included the culvert under Railcar Avenue, Outfall 001 (Dam B), Outfall 005 (Dam C) and Outfall 006 (12^{th} Street Dam). A sample was also collected at Outfall 006 during an incoming tide (water was flowing onto the site through the 12^{th} Street Dam). Sample locations are presented on **Figure 7-14.** The individual congener concentrations for each sample are presented in **Appendix O.**

As indicated on **Figure 7-14** and **Table 7-23**, the highest PCB congener concentrations (unfiltered samples)),in dry weather samples was reported in the drainage ditch to the north of the Eastern Drainage Ditch at Railcar Avenue which reported a concentration of 865,728.61 pg/l (0.87 ug/l). Total PCB congener concentrations were lower at locations down gradient of the Railcar Avenue location, at Outfall 001 (138,864.39 pg/l) and Outfall 006 (108,818.17 pg/l). The total PCB congener

concentration from the Outfall 005 sample reported 38,751.32 (0.039 ug/l) while the duplicate sample reported 98,624.72 (0.099 ug/l). The sample collected from water coming into the AMTRAK property during an incoming tide reported 2,873 pg/l (0.0029 ug/l) total PCB congeners.
Total PCB congener concentrations in filtered and unfiltered samples were compared. For the storm water samples, the unfiltered and filtered (**Table 7-21** and **7-22**, respectively) were similar. However, for the dry weather samples, the filtered results (**Table 7-24**) were significantly less (up to 98% less) than the unfiltered results. SECOR contacted the analyzing laboratory regarding this discrepancy but the laboratory responded that wet weather and dry weather samples were managed and analyzed in the same manner. However, due to the relative low solubility and high tendency to sorb to sediment particles, a significantly lower PCB concentration was expected in the filtered samples as indicated by dry weather sample analyses.

Table 7-25 provides a summary of surface water flow measurements recorded at the surface water sampling locations using the flow measurement technique described in Section 5.4. As indicated, a wide range in the flow rate was measured at Outfall 006. This is attributed to the tidal conditions at this location.

The Eastern Drainage Ditch receives storm water runoff from properties to the east of the Wilmington Shops including an adjacent freight rail yard, a tank car cleaning operation, an asphalt plant, and a cement plant. The Western Drainage Ditch also receives storm water runoff from the scrap yard to the west of the Former Fueling Facility. As has been described, Outfall 006 (12^{th} Street Dam) is a surface water location downstream of Outfall 001 and 005 and the confluence of the Eastern and Western Drainage Ditches. As such, 006 receives storm water from properties to the east and west of the AMTRAK Facility. In addition, tidal conditions exist at Outfall 006. Surface water flow associated with the adjacent City Ditch, drainage from 12^{th} Street and Brandywine Creek periodically backflow through Outfall 006. Therefore, surface water from a significant geographic area outside of the Former Fueling Facility ultimately backflows through Outfall 006 from tidal activity. **Figure 2-5** presents the approximate extent of the Outfall 006 Drainage Area which is estimated to be on the order of 118 acres. The Outfall 006 drainage area encompasses the drainage areas of Outfalls 001, 003, 004, 005, and 007 as well as off-site areas.

As described in Section 3.0, Outfall 006 is located at the 12th Street Dam outlet piping. The 12th Street Dam is constructed with sheet piling on the upstream side. Three corrugated HDPE pipes, with downward extending 90° elbows on the upstream side to allow water flow through the dam while facilitating oil skimming with sorbent booms and reducing sediment transport.
A summary of the total PCB congener concentrations and flow measurements recorded during each of

the three wet weather and dry weather sampling events performed for the Delaware River Basin Commission (DRBC) PCB monitoring program as well as the Phase II RI results are presented on **Table 7-26**. The flow measurements presented for Outfall 006 were recorded hourly over a 12 hour period by measuring flow velocity in the pipes through the dam, and height of water in the pipes. Measurements were performed in this manner in order to measure the net outgoing flux of water through the outfall, due to the tidal conditions. As indicated on **Table 7-26**, during the three wet weather events, net flux of water leaving the site ranged from 0.026 MGD (18 gpm) to 0.467 MGD (324 gpm). The net flux of water leaving the site during the three dry weather events ranged from 0.011 MGD (7.6 gpm) to 0.665 MGD (461 gpm). The average flows for the three wet weather and three dry weather events were 0.214 MGD (149 gpm) and 0.234 MGD (162 gpm), respectively. As indicated, the wet weather average flow was less than the average dry weather flow. This suggests that flow at Outfall 006 is affected by tidal conditions as well as precipitation. It has also been observed that when the stage of the Brandywine River is high, water is not allowed to drain under the 12th Street and water is backed up behind 12th Street.

Because of the tidal conditions, dry weather and wet weather samples collected at Outfall 006 were grab samples (rather than composite samples) collected during an out-going flow. Because of the mixing of water from the back-flushing through the 12th Street Dam, the PCB concentration in the sample will depend on when in the tidal cycle the sample is collected. Dry weather samples collected for the Phase II remedial investigation and the DRBC Program on June 25, 2005 (both analyzed via Method 1668a) reported 108,818.17 pg/l and 12,351.90 pg/l, respectively. Both of these samples were collected when water was discharging from the site, but at different times during the day. One sample was collected in the morning and the other in the afternoon.

These issues will be considered in the development of a program to measure remedial progress in the reduction of PCBs in surface water from the site.

7.4 Former/Abandoned (reportedly closed) Sewer Evaluation

As described in Section 5.5, investigations were performed to characterize water and sediment in a former sewer and to determine if this sewer is a potential source of PCBs to the Eastern Drainage Ditch. Available facility maps were inspected and site reconnaissance was performed in order to identify surface water and sediment sampling locations associated with the sewer system.

Grab surface water samples were collected from: six vaults found in the area of the former roundhouse (Vault-1 through Vault-7, although no sample was collected from Vault 4 because of only a small amount of water was observed in the vault), two manholes including MH-1 (adjacent to the former roundhouse) and MH-2 (south of the former roundhouse); the lift station; and from the water upwelling area. Surface water sampling locations are depicted on **Figure 7-15**. These samples were collected on August 15, 2006 and were analyzed for PCB aroclors, TPH/DRO, and total suspended solids.

The surface water results are summarized on **Figure 7-16** and **Table 7-27**. As indicated, total PCB aroclor concentrations ranged from below detection limits (0.48 ug/l) at upwelling water to 237 ug/l in manhole MW-1. PCB aroclors 1254 and 1260 were detected in the water in the sewer. The non-detectable total PCB concentration at the upwelling area is likely associated with the lack of suspended solids (less than 12 mg/l) at that location.

Grab sediment samples were collected on August 16, 2006. Sediment samples were collected from the six vaults identified above as surface water sample locations, from MH-1 and MH-2, from the lift station and two samples were collected at the location of the water upwelling area. A sediment sample was also collected from a section a former brick sewer found approximately 40 feet northeast of the former turntable location in the former roundhouse area. These sediment sampling locations are depicted on **Figure 7-16**. These samples were analyzed for PCB aroclors and TPH/DRO.

The sediment results are presented on **Figure 7-15** and **Table 7-28**. As indicated on **Table 7-28**, total PCB aroclor concentrations ranged from 16.2 mg/kg (Vault 5) to 290 mg/kg (Lift Station). PCB aroclors 1254 and 1260 were detected in all sampling locations except in the upwelling area Sediment Sample 2 (only aroclor 1260 was detected). TPH/DRO concentrations ranged from 190 mg/kg (upwelling area Sediment Sample 1) to 67,000 mg/kg (Vault 5; the duplicate sample at this location reported 83,000 mg/kg).

As mentioned in Section 5.5, in order to determine if there is a connection between the abandoned sewer system, the lift station and the upwelling area, dye testing was performed (under dry weather conditions). Dye introduced into MH-1 was observed at MH-2. During another test, dye was introduced into MH-2 and it was observed in the lift station, the upwelling area, and eventually in the Eastern Drainage Ditch to the east of the upwelling area. Dye was also introduced to Vault 6. However, direct communication with adjacent Vaults 5 and 7 was not confirmed.

7.5 Western Drainage Ditch Vegetative Enhancement Testing

During 2006, baseline surface water monitoring was performed in the Western Drainage Ditch immediately upgradient and down gradient of the pilot test area. Surface water sampling locations are presented on **Figure 5-11**. Baseline surface water monitoring results are presented on **Table 7-29**. Due to the relatively cold weather conditions (plants had not yet fully emerged after the winter) performance monitoring samples had not been collected through April 2007.

8.0 RESULTS OF OFF-SITE ENVIRONMENTAL SAMPLES COLLECTION

The following is a discussion of the results of Phase II remedial investigations performed in drainage ditches in the site vicinity and in the tidal and non-tidal reaches of the Brandywine Creek. The laboratory data was evaluated in accordance with HSCA protocols. The data validation reports and electronic data packages are included in **Appendix I**.

8.1 Adjacent Drainage Ditches

Sediment samples were collected at five locations (CD-1 through 5) in the City Ditch. At each location, a surficial sediment (approximately 0-3 inch depth interval) sample was collected. Samples were also collected at depth at each location (maximum depth was 24 inches).

Figure 8-1 and **Table 8-1** present the analytical results for sediment samples collected in the City Ditch. As indicated on **Table 8-1**, total PCB aroclor concentrations ranged from 0.247 mg/kg (CD-5 (0-3”)) to 20.46 mg/kg (CD-2 (18”-24”)). PCB aroclors 1248, 1254, and 1260 were detected in all sediment samples. Sample CD-3 (0-3”) was also analyzed for PCB congeners and reported 2.485 mg/kg total PCB congeners (refer to **Table 8-1**). Sample locations are presented on **Figure 8-1.** The individual congener concentrations for sample CD-3 (0-3”) grain size results are presented in **Appendix P.**

Figure 8-1 and **Table 8-2** present the results of sediment samples collected in two drainage ditches on the AMTRAK property to the east of the Eastern Drainage Ditch. As has been described, these ditches receive storm water from properties to the east. Total PCB aroclor concentrations in samples collected at location DD-1 were 8.6 mg/kg (0-0.3”), 19 mg/kg (3”-2’3”), 27 mg/kg (2’3” -4’3”) and 47 mg/kg (4’3”-6’3”). Based on these sample results, DNREC requested that additional samples be collected in this drainage ditch in order to evaluate potential off-site sources. During March 2007, sediment samples were collected from the most upgradient location (DD-1 Sed-2) on AMTRAK property and from sediments (DD-1 Pipe) accumulated in the culvert that routes storm water under Railroad Avenue from the adjacent property. Sample location DD-1 SED 2 reported the following total PCB aroclor concentrations: 9.5 mg/kg (0-3”), 11 mg/kg (3”-2’3”), 16 mg/kg (2’3”-4’3”), and 14 mg/kg (4’3”-5’). The sample collected from within the culvert reported 11 mg/kg total PCB aroclors.

Sediment samples collected from location DD-2 reported total PCB aroclor concentrations of 2 mg/kg (0-3”) and 1.7 mg/kg (3”-2’2”). **Table 8-2** also summarizes the TPH/DRO results.

Samples DD-1 (0-3”), DD-5 (duplicate of DD-1 (0-3”)), and DD-2 (3”-2’2”) were also analyzed for PCB congeners. The total congener results are presented on **Table 8-2** and the individual congener results are presented in **Appendix P**.

8.2. Brandywine Creek

8.2.1 Tidal Reach

Figure 8-2 presents the locations of sediment samples collected in the tidal portion of Brandywine Creek. Samples were collected at six depositional areas (BC-SED-1 through BC-SED-6) and at three locations along each of three transects (BCT- 1A, B, C; BCT-2A, B, C; and BCT-3A, B, C). At each location, a surficial sediment (approximately 0-3 inch depth interval) sample was collected. All samples were analyzed for PCB aroclors. Samples BC-SED1 through BC-SED-6, BCT-1B, BCT-2B, and BCT-3C were also analyzed for PCB congeners.

Figure 8-2 and **Table 8-3** present the sediment sample results. Total PCB aroclor concentrations in the samples from the six depositional areas ranged from below detection limits of 0.022 and 0.023 mg/kg (BC-SED-3, BC-SED-4. BC-SED-5, and BC-SED-6) to 3.6 mg/kg (BC-SED-1). Total PCB congener results for the six samples collected from the depositional areas ranged from 0.0022 mg/kg (BC-SED-4) to 1.05 mg/kg (BC-SED-1). As indicated on **Figure 8-2**, BC-SED-1 is located in a dispositional area near the confluence of Brandywine Creek with the Christina River.

The total PCB aroclor concentration in the nine samples collected along the three transects ranged from below detection limits of 0.022 to 0.041 mg/kg (BCT-3B, BCT-2C, and BC-3A) to 0.114 mg/kg (BCT-3C). Total PCB congener results for samples collected along the three transects ranged from 0.007 to 0.478 mg/kg and are presented on **Table 8-3**. Individual PCB congener results and grain size data are presented in **Appendix P**.

8.2.2 Non-Tidal Reach

Sediment samples were collected at three locations in the non-tidal portion of Brandywine Creek (BCNT-1 through 3). All Brandywine Creek sediment sampling locations are presented on **Figure 6-2**). At each location, a surficial sediment (approximately 0-3 inch depth interval) sample was collected. Samples were also collected at depth at each location (maximum depth was 24 inches). **Table 8-4** presents the results for sediment samples collected in the non-tidal portion of Brandywine Creek. Total PCB aroclor concentrations ranged from below detection limits to 0.0045 or 0.0046 mg/kg (BCNT-1 (0-3”), BCNT-1 (3-8”), and BCNT-3 (0-3”) to 0.10 mg/kg (12-24”). **Figure 8-2** presents the location of sediment samples collected for PCB congener analyses in the non-tidal portion of Brandywine Creek. Total PCB congener concentrations were also reported for BCNT-1 (0-3”) (0.0027 mg/kg) and BCNT-3 (0-3”) (0.0011 mg/kg). PCB congener results are presented in **Appendix P**. PCB aroclors 1248, 1254, and 1260 were detected in non-tidal sediments.

9.0 SITE CONCEPTUAL MODEL

This site conceptual model is presented to characterize source conditions, describe diesel fuel migration pathways, and demonstrate the use of ditches as sediment traps and product containment at the Former Fueling Facility (Site). Data compiled during the Phase I and Phase II remedial investigations, IRM, and diesel fuel oil remedy system installation and operation as well as available literature regarding physical and chemical characteristics, and fate and transport processes of diesel fuel constituents were used in the development of this conceptual model.

The Former Fueling Facility was largely constructed on fill. Localized areas of construction debris such as concrete rubble, bricks, wood, and large angular rock fragments have been encountered in the fill during subsurface investigations. A dense gray clay associated with peat (likely marsh deposits) has been encountered beneath the fill and beneath all site drainage features where sediment samples were collected. The track and fueling areas are generally flat with a slight grade away from the axis of the facility in the direction of the adjacent surface water features.

Fuel oil and PCB contamination at the Former Fueling Facility is contained and controlled. It is contained vertically above a thick layer of dense, blue-gray clay encountered at depths of 7-15' below ground surface and measuring approximately 10 feet thick. It is contained laterally by a system of drainage ditches, dams and water retention ponds that collect oil and sediment that would otherwise discharge to the Brandywine Creek. This drainage system also collects runoff water and sediment from off-site commercial and industrial sources. Further, tidal waters from the Delaware River, Christina River and Brandywine Creek periodically back flush from the Brandywine Creek with a frequency of up to twice each day through defective tide gates.

The drainage system ultimately discharges through an Outfall (006) that is regulated by an NDPES permit, before mixing with other drainage from other off-site sources and subsequently discharges to the Brandywine Creek. Extensive sampling required by this permit has only detected PCBs in this discharge on one occasion in more than 20 years. No sampling results have exceeded the 3 ug/L effluent limitation specified in EPA's TSCA regulations for discharge to navigable waters.

Integrated remedial measures and activities over the past several decades have already contained and controlled runoff of oil, surface water and sediment, removed over 15,200 gallons of separate phase hydrocarbons (SPHs) from the water table under the Site, reduced TPH levels in upland surface soils, and reduced the PCBs in stormwater runoff from a portion of the Site by 94%. The erosion controls used to achieve this result received the Business and Industry Award from Water Resources

Association of the Delaware River Basin for reducing PCB discharges to Outfall 004. This system includes the best management practices (BMP's) for controlling erosion of contaminated soils. It includes a system of caps using geotextile fabrics, soil and vegetation, ballast, other stone and other features to minimize stormwater runoff, minimize the velocity of unavoidable runoff and thereby minimize the erosion of surface soils and sediments. Oil-stained drainages to the East Ditch have been cleaned and substantial improvement of water quality and vegetation along the West Ditch have already been achieved. Extensive ecological testing demonstrates that the diversity and abundance of species in the East Ditch are comparable to or better than the reference location evaluated in this study and other ponds in the region

This Site Model is based on the following conditions and information which control and describes the fate and transport of contaminants throughout the Fueling Facility (South Yard):

1. It is located south of the Maintenance Facility (North Yard).
2. It is separated from the Maintenance Facility by the former roundhouse and turntable area.
3. It consists of approximately 20 acres underlain by fill material which overlies approximately 10 feet of blue-gray clay.
4. It is surrounded to the west by the Western Drainage Ditch (West Ditch), to the north by the former roundhouse and turntable area, to the east by the Eastern Drainage Ditch (East Ditch); and to the south by the confluence area where the flows of the Eastern and Western Ditches converge.
5. Some surface water drains onto the South Yard and into the Eastern Drainage Ditch from the North Yard and from the former roundhouse and turntable area via Outfall 004 (which has award winning sediment and erosion controls) and Outfall 007, to which the previously proven sediment and erosion controls are to be extended.
6. Surface water drains from the South Yard to the East and West Ditches and the confluence area.
7. Likewise, groundwater in the water table aquifer above the dense clay layer flows to the Eastern and Western Drainage Ditches and to the confluence area.
8. A system of dams control flow in the Eastern Drainage Ditch (Dam B), the Western Drainage Ditch (Dam C) and the confluence area (12^{th} Street Dam). These dams were installed to restrict the loss of sediment from the site and the flow of oil and other floating materials into Brandywine Creek. In 1981, Woodward Clyde, Inc. and AMTRAK reported to EPA Region 3 that the ditches were serving as sediment collection ponds that would collect sediments (containing PCBs). The dams have successfully collected a large quantity of sediment containing variable levels of oil and PCBs and prevented its

discharge to the Brandywine Creek.

9. The efficiency of this collection system could be enhanced by reducing sediment discharges to the ditches and increasing the treatment efficiency of the sediment collection ponds.
10. Surface water discharges from the South Yard are regulated by an NPDES Permit issued by DNREC that establishes five (5) monitoring points (adjacent to the South Yard): (a) 001 and 003, above and below Dam B on the Eastern Drainage Ditch;(b) 004 and 005, above and at Dam C on the Western Drainage Ditch; and (c) 006 at 12th Street Dam. Surface water quality at Outfall 006 represents the combined flow of the Eastern and Western Ditches and the confluence area before it is commingled with flows from the City Ditch and the Brandywine Industrial Complex before flowing through a tide gate and into the Brandywine Creek.
11. All migration of oils or PCBs from the South Yard must discharge into the Eastern and Western Drainage Ditches from erosion or groundwater. Any off-site migration must pass through ditches, into and through the confluence area, and through the 12th Street Dam/ Outfall 006.
12. Reduction of discharges to the ditches will, in turn, reduce potential discharges from Outfall 006.
13. As part of the treatability studies and interim remedial measures performed previously, AMTRAK and APU constructed an erosion and sediment control system to minimize erosion and sediment runoff from approximately 11 acres that drain to Outfall 004. This award-winning pollutant minimization program reduced PCB discharges through Outfall 004 by 94%.
14. To date, no monitoring data for PCB discharge from Outfall 006 has exceeded the 3 ug/L standard for PCB discharges to navigable waters or municipal sewer systems that is established in EPA's regulations under the Toxic Substances Control Act at 40 C.F.R. 761.50(a)(3).
15. Surface water from Brandywine Creek back flushes "upstream" through 006 and through 12th Street Dam periodically up to twice each day because the tide gate has not functioned properly for many years.

As has been described, the Former Fueling Facility is currently used to store railcars, locomotives and other equipment. There are no active industrial activities in this portion of the site. The area is monitored by AMTRAK Police and any trespassers observed are removed from the property. In addition, a perimeter fence will be installed (planned for August 2007) in the portion of the property near 12th Street to further reduce trespasser access.

Diesel Fuel/Light Non-aqueous Phase Liquids

The Former Fueling Facility has been used for the fueling of locomotives since at least 1954 (based on the plate attached to the former 250,000 gallon AST). The former 250,000 gallon AST was removed in 199_ and fueling activities were moved to the Maintenance Facility during 1995.

Locomotives were formerly fueled over a catch pan designed to capture spillage from the fueling operations. Diesel fuel spillage prior to the installation of the catch pan or not captured by the catch pan was released to the surface or subsurface depending on the nature of the release. Fueling operations ceased in this area in November 1995 and were transferred to a newly constructed facility north of the former roundhouse. Other potential methods of hydrocarbon release include incidental spillage and overfilling associated with the previously described ASTs as well as any potential release from the two waste oil USTs.

Hydrocarbons released to the subsurface migrated vertically to the capillary fringe and the water table surface. The degree of aquifer hydrocarbon saturation in the subsurface varies with vertical distance from the water table (as a result of capillary forces) and laterally from source areas. Light non-aqueous phase liquids (LNAPL) in LNAPL- saturated aquifer materials migrate on top of the capillary fringe/water table in the direction of decreasing hydraulic gradient, toward groundwater discharge areas. In the vicinity of the Former Fueling Facility, the water table aquifer discharges to the drainage features and LPH may emanate in these drainage ditches as LPH seeps or sheens. As such, seep locations provide a general indication of the lateral extent of LPH occurrence. As LPH passes through the aquifer matrix, a portion of it adheres to the soil particles and remains as residual (adsorbed) hydrocarbons. Residual hydrocarbons at the surface attributed to surface spillage may be washed or leached by precipitation and migrate in surface water draining to the drainage ditches (as previously mentioned, booms and dams were constructed to control LPH movement on surface water bodies).

Hydrocarbons appear to have also entered the Eastern and Western Drainage Ditches through preferred pathways. Several subsurface pipes and conduits were encountered during test trenching and installation of the diesel fuel oil recovery system. The subsurface piping encountered was described in the Progress Report dated November 2001. All identified piping that may represent a potential migration pathway to the ditches has been removed or closed in-place. Subsurface fill, such as the construction debris described above, also appear to be areas in which LPH may collect.
Diesel fuel is a mixture of many individual hydrocarbon compounds and the composition of the fuel is altered in the environment as a result of natural processes such as biologic activity. Diesel fuel consists of high molecular weight polycyclic aromatic hydrocarbons and lower concentrations of

volatile aromatic compounds. The chemistry of the fuel changes with time in the environment as lighter more degradable components are lost. Diesel fuel components biodegrade under both aerobic and anaerobic conditions. Biodegradation of these compounds involves the oxidation of the hydrocarbon and the reduction of an electron acceptor (Piontek, et al, 1995). Under aerobic biodegradation oxygen is the major electron acceptor. As oxygen is depleted from the system, the redox potential of the system drops and conditions become increasingly anaerobic. Under these conditions new electron acceptors may be utilized (including nitrate, ferric iron, manganese, sulfate, or carbon dioxide). A common byproduct of anaerobic biodegradation is the production of soluble ferrous iron.

In the Former Fueling Facility, groundwater sampling and analyses were performed during the RI to evaluate biologic activity at the site. The data suggests that the groundwater is oxygen deficient (all dissolved oxygen concentrations were less than 2 mg/l) and biologic degradation at the site primarily occurs under anaerobic conditions. However, naturally occurring diesel-utilizing bacteria are more efficient under aerobic conditions. This is supported by the analyses of soil samples from MW-6A (2-4') and MW-14 (4-6') for diesel-utilizing bacteria. Plate counts of 1.7×10^3 and 3.2×10^2 (measured in colony-forming units per gram of soil) were reported. In an oxygen-rich environment these values may be in the order of 10^6. The depletion of oxygen is attributed to the consumption of oxygen by biologic degradation of hydrocarbons. The low permeability of subsurface material results in a relatively low flux of oxygen to the subsurface from percolating precipitation. The low flux of oxygen relative to the volume of hydrocarbons in the subsurface results in an oxygen-deficient environment.

Anaerobic biodegradation appears to result in the generation of soluble ferrous iron, dissolved in groundwater discharging to the Western Drainage Ditch where it becomes oxygenated and precipitates as insoluble ferric iron (as evidenced by the rust color staining). The release of iron to this ditch may also be a likely result of the composition of the fill material. The soil analyses for hydrocarbon utilizing bacteria indicate that these bacteria do occur at the site suggesting that bacteria toxins that would limit the effectiveness of bioremediation do not occur or are not significant.

Groundwater in the vicinity of the former fueling area discharges to the Eastern and Western Drainage Ditches. In addition, the ditches receive discharge from adjacent properties, including Former Atlas Sanitation to the west and other industrial operations to the east. Polycyclic aromatic hydrocarbons (PAHs), which are the dominant components of diesel fuel, generally have low solubilities resulting in lower dissolved hydrocarbon concentrations than those attributed to releases of lighter petroleum products. TPH-DRO concentrations measured during the Phase I RI ranged from 0.22 to 45 mg/l. As mentioned previously, groundwater is not used as a source of drinking water in the vicinity of the site.

Petroleum hydrocarbons (TPH) have historically been monitored at four NPDES outfall locations that receive storm water runoff from the Former Fueling Facility and has not exceeded the NPDES standard for oil and grease since monitoring began downstream sampling of Outfall 006.

As a result of the site hydrogeology and distribution of LPH (oil) in the subsurface, localized LPH seeps have been observed in the Western Drainage Ditch and residual oil stains and sheens have been observed in and adjacent to the Eastern Drainage Ditch. LPH seeps in the Western Drainage Ditch have been observed emanating from the eastern bank in a stretch extending from Dam C to the vicinity of standpipe WD-C. Test trenching and excavation activities indicated that these seeps are predominantly associated with preferential pathways such as subsurface piping (the piping has been removed or closed in-place) or areas of high permeability subsurface materials. Localized sheens have also been observed emanating from the western bank of the Eastern Drainage Ditch, from an area immediately north of the former 250,000-gallon AST location to approximately 100 feet north of Dam B. As indicated in the Progress Report dated November 2001, subsurface piping was also removed from this area. However, LPH was not detected in the standpipes installed adjacent to the Eastern Drainage Ditch. An isolated area of oil stained soils also occurs to the southeast of MW-10A, adjacent to the Eastern Drainage Ditch. The stained soils in this area are attributed to oil that has collected in a localized area of subsurface building debris in the vicinity of sump ED-1. As described in Section 3.2.6, surface soil bioremediation in this area as in the vicinity of the Eastern Drainage Ditch as part of the diesel fuel remedial program has resulted in a significant reduction in petroleum hydrocarbon in soils.

The design of the diesel fuel recovery system considered the heterogeneous nature of the site subsurface materials. A recovery trench system (rather than well point system) was installed so that product collected in highly permeable areas of fill or potential preferential pathways could be contained and recovered. Through December 2006, approximately 15,200 gallons of product has been recovered. Analyses of the recovered product for PCBs prior to disposal indicates a PCB concentration of generally 10 mg/kg to 20 mg/kg. Recovered fuel is shipped off-site for TSCA incineration.

Site Drainage Features

PCBs in site surface soils are a potential source for PCBs in site surface water and sediments. These soils may be washed into site drainage features during storm events. As described in Section 3.0, erosion control and sediment reduction measures implemented in the Outfall 004 drainage area reduced PCB concentrations in surface water monitored at Outfall 004 by over 90%.

As previously described, IT Corporation performed maintenance activities on Dam B and the 12th Street Dam in November 1999 and on Dam C during September 2001. Since at each location, the upstream face of the dams consist of steel sheet piling with inlet piping with a downward 90° fitting, they are effective in preventing the movement of floating product through the dams and function as effective sediment traps.

Sediment samples were collected from the drainage ditch north of the Eastern Drainage Ditch, the Eastern Drainage Ditch, the Western Drainage Ditch, and the Confluence Area. In general, the highest PCB concentrations in sediments were detected in the Eastern Drainage Ditch were a maximum site concentration in sediments of 320 mg/kg was detected. In all site drainage features, a dense blue gray clay was detected beneath the sediments. This clay reported a significantly lower PCB and petroleum hydrocarbon concentration than in the overlying sediments.

NPDES monitoring data since 1993 for Outfall 006 (the most downgradient outfall location) was reviewed as part of the Phase I and Phase II RI. For the NPDES data from 1993 through May 2006 (when the new permit became effective), at Outfall 006, the permit level of 0.5 ug/l was exceeded only on one occasion (January 2006; PCB concentration of 0.710 ug/l was reported) and PCBs were not detected in monthly follow-up sampling (refer to Section 3.2.5). The NPDES permit which became effective on May 1, 2006 requires annual congener analyses at Outfall 006. Wet and dry weather sampling and PCB congener analyses performed for the Phase II RI reported 0.122 ug/l and 0.109 ug/l total PCB congeners, respectively. Data collected at the site suggest that the dams and site drainage features are effective in controlling sediments and product in surface water and the implementation of surface soil and sediment reduction controls can significantly reduce PCB concentration in surface water.

Surface water samples collected from Outfall 006 during the Phase II RI indicate the PCBs are periodically flushed onto the site as a result of the tidal conditions. As has been described in this report, properties to the east and west of the AMTRAK facility contribute storm water to site drainage features. In addition, PCBs from sites along Brandywine Creek may also move onto the site as a result of the tidal conditions at Outfall 006.

10.0 REVISED HUMAN HEALTH RISK ASSESSMENT

A site-specific human health risk assessment (HHRA) for soil at the AMTRAK Former Fueling Facility (the Site), located at 4001 Vandever Avenue, Wilmington, Delaware (**Figure 1**), was previously presented in the Draft Phase I RI Report. The HHRA was based on the Delaware Department of Natural Resources and Environmental Control's (DNREC's) 1998 Remediation Standards Guidance Under the Delaware Hazardous Substance Cleanup Act (DNREC, 1998). This Guidance was revised in December 1999 and incorporated the United States Environmental Protection Agency (USEPA) risk assessment methodology such as the Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual, Part A, Human Health Evaluation (USEPA, 1989), as well as other state agency approaches, such as the Massachusetts Department of Environmental Protection (MADEP) approach for evaluating total petroleum hydrocarbons (TPH) by hydrocarbon ranges (MADEP, 1997).

A revised HHRA was conducted as part of the Phase II remedial investigation. In general, the four primary steps completed for the Phase II HHRA for soil at the Site were as follows (USEPA, 1989a; DNREC, 1999):

Step 1: Data Evaluation – reviews all available analytical data to select the constituents of potential concern (COPCs) in environmental media of interest.

Step 2: Exposure Assessment – identifies potential exposure to human receptors based on current and future land uses.

Step 3: Toxicity Assessment - summarizes and identifies the USEPA and DNREC toxicity values for the selected COPCs.

Step 4: Risk Characterization – incorporates the information from Steps 1 through 3 to estimate potential health risks from exposure to COPCs in environmental media of concern. Calculated risks are compared to acceptable USEPA and DNREC target risk levels to ensure protection of human health under both current and reasonably foreseeable future land uses.

10.1 Rationale for Revised (Phase II) HHRA -- Comparison of Phase I and Phase II Assessments

The Phase I HHRA completed by IT Corporation 1999 focused on site soils and attempted to be as realistic as possible. Because the estimated exposure and risk to an on-site worker from surface soils was previously calculated by DNREC (1994) and found to be within acceptable target risk levels and fueling operations have ceased in the area (lessening potential worker exposure), an on-site worker was not further evaluated by IT. As a result, exposure scenarios evaluated during the human health risk assessment described in the Phase I RI Report consist of:

- Youth (ages 12 to 18) trespasser to on-site soils.
- Adult trespasser to on-site soils.

The data set considered for the estimation of human health risk included information collected during the Phase I RI. Soil analyses for petroleum hydrocarbons, metals and PCBs reported in Inspection Report - AMTRAK Wilmington Refueling Facility, prepared by DNREC (dated December, 1994) and Results of Maintenance Yard Soil and Groundwater Investigation prepared by Smith Environmental (dated May, 1995) were considered. Using the information generated during the exposure assessment and the toxicity assessment, the theoretical upper-bound carcinogenic and non-carcinogenic risks to human health were estimated. The estimated risks are summarized as follows:

- the estimated upper-bound cancer and non-cancer risks for a youth (ages 12 to 18) trespasser exposure to on-site soils reported in the Phase I HHRA were 3 x 10-7 and 0.02, respectively; and
- the estimated upper-bound cancer and non-cancer risks for an adult trespasser exposure to site soils reported in the Phase I HHRA were 1 x 10-6 and 0.02, respectively.

These risk estimates were all within USEPA's target risk levels of 1 x 10-4 to 1 x 10-6 for cancer and a hazard index of 1.0. Since the Phase I human health risk assessment was performed in 1998, additional site fencing was installed and AMTRAK police security enhanced, further restricting site access by trespassers (which would result in lower target risk estimates than those reported).

A Phase II HHRA was performed at the request of DNREC to include appropriate data collected in the

Phase II remedial investigations and to consider site worker exposure scenarios. The Phase II HHRA performed by SECOR utilized the existing soil database augmented with the results of the Phase II soils investigations (discrete samples only; composite samples removed). In addition, the database was screened against the most recent DNREC soil criteria to determine the appropriate constituents of concern. Only soil samples collected within the Former Fueling Facility were considered (i.e., background samples collected by DNREC were not included). Lastly, the site was divided into two sections: the roundhouse and site-wide area, with older data removed from consideration in areas which are currently vegetated or paved. The two soil areas were considered separately because significantly higher PCB concentrations in soils were reported in the former roundhouse area and a fence surrounds the former roundhouse area with no current facility operations inside this fenced area. Surface soil (0-2 feet bgs) and subsurface soil (0 to 10 feet bgs) were evaluated separately, and the Phase II HHRA focused only on TPH and PCB data. Metals and SVOCs were not included, as these data were determined to be limited in scope and not representative of current site conditions.

Therefore, in order to preserve the conservative nature of human health risk assessment, and in light of the collection of new site data, the following exposure populations were evaluated in the Phase II HHRA:

- Carcinogenic risk and noncarcinogenic hazard from child trespassers ingesting soils.
- Carcinogenic risk and noncarcinogenic hazard from adult trespassers ingesting soils.
- Carcinogenic risk and noncarcinogenic hazard from on site workers (including short term construction worker).

The pathways evaluated for the workers were:

- outdoor inhalation of particulates/vapors emanating from soils
- incidental soil ingestion

10.2 Data Evaluation

Soil data evaluated for use in the original Phase I HHRA include 1994 data collected by DNREC (SS-1 to SS-3), Smith Environmental (MW-1 to MW-5 and MW-8 to MW-12), as well as the 1998 data collected by the IT Group (MW-8A, MW-10A, and MW-13 to MW-17). These data were summarized in **Table 7-1** of the original Phase I HHRA (IT, 1999). One background sample, SS-1, was also collected by DNREC. This sample was excluded from the original data summary and it was not considered to be part of the area of investigation. The soil data evaluated in the original Phase I HHRA did not appear to include sample quantitation limits (SQLs) for non-detected (ND) analytes.

During the Phase II remedial investigation (RI), both discrete and composite soil samples were collected from the Site. Since there are no valid statistical methods recommended for composite samples (USEPA, 2000), except the use of maximum chemical concentrations from composite sampling as a conservative estimate of the mean concentration for soil screening evaluation (USEPA, 2002), only discrete samples were included in the Phase II HHRA to be consistent with the original Phase I HHRA. With regard to composite samples, the USEPA has stated: "Composite samples reflect a physical rather than a mathematical mechanism for averaging. Therefore, compositing should generally be avoided if population parameters other than a mean are of interest" (USEPA, 2000).

Since soil at the former roundhouse area contains elevated chemical concentrations compared to the rest of the Site, two exposure areas of concern were evaluated in the Phase II HHRA:

1) Former roundhouse area; and

2) Site-wide area (exclusion of the former roundhouse area).

For the Phase II HHRA, the following surface soil (0 to 2 feet below ground surface [bgs]) and subsurface soil (0 to10 feet bgs, except at SB-24, data at 10 and 12 feet bgs were also included since PCBs were detected in these samples) data collected subsequent to Phase I HHRA were also included:

Site-wide Area: Discrete data collected from Former Fueling Facility upland (subdrainage) area (Areas 5 through Area 16); stained surface soil areas (SSA-1A to SSA-3C); and the proposed MOW building investigation (SB-16 to SB-23 and SB-33 to SB-38). Subdrainage areas 2, 3, and 4 were covered as part of the Outfall 004 erosion and sediment reduction measures (refer to Section 3.3). Therefore, no exposure to soils in these areas was assumed.

Former Roundhouse Area: Discrete data collected during the proposed CNOC building (SB-1 to SB-15; SB-24 to SB-32; and SS-1 to SS-5); upland (Subdrainage) Area 1.

These collected data were screened for adequate detection frequency; those constituents that had less than a 5% detection frequency out of a total sample size of 20 or greater were removed from the data set, as per USEPA methodology (1989a).

In order to establish potential risks using data from additional site characterization activities described in the Phase II RI/FFS Work Plan, this assessment focused only on TPH and PCB data collected Site-wide and in the former roundhouse area. Metals and SVOCs were not included, as these data were limited in scope and not deemed representative of current site conditions. The relevant soil datasets are presented in **Appendix Q**.

Statistical analyses of soil data were performed using the USEPA statistical program Pro-UCL (USEPA, 2004). Non-detected (ND) values were calculated assuming one-half the SQL. The following statistical descriptors are presented in **Tables 10-1** through **10-4** for surface soil, subsurface soil at the two exposure areas of concern (Site-wide Area and Former Roundhouse Area):

- Total sample size;
- Number of detections;
- Detection frequency;
- Minimum and maximum SQLs;
- Minimum and maximum detected values;
- Arithmetic mean;
- Standard deviation;
- 95 percent upper confidence limit (95% UCL) of the arithmetic mean (DNREC, 1998; USEPA, 1997a).
- Distribution; and
- Lesser of the maximum detect or 95% UCL, as the reasonable

The 95% UCL of the arithmetic mean is a value that, when calculated repeatedly for randomly drawn subsets of data equals or exceeds the true mean 95 percent of the time. Although the 95% UCL of the arithmetic mean provides an upper end estimate of the average (or mean) concentration, it should not be confused with the 95th percentile of site concentration data. As sample size increases, the 95% UCL of the mean moves closer to the true mean, while the 95th percentile of the distribution remains at the upper end of the distribution (USEPA, 1992a). For this analysis, as per USEPA (1997), when the data distributions were neither normal nor lognormal, the nonparametric bootstrap was used. Additionally, data sets with low sample size (i.e., less than 5 results) had representative statistics calculated on detections only.

The Pro-UCL model results for COPCs in the Site-wide Area and Former Roundhouse Area are presented in **Appendix R**. **Tables 10-1** and **10-2** present the statistical results for the soil site-wide (0-

2 feet bgs and all depths sampled). Similarly, **Tables 10-3** and **10-4** present the statistical results for soils of the former roundhouse area (0-2 feet bgs and all depths sampled).

10.3 Exposure Assessment

Exposure assessment is the process of identifying human and ecological receptors at the Site based on current and foreseeable future Site activities and uses. Both DNREC and USEPA require the identification of receptors, site activities and uses, exposure points, and calculation of exposure point concentrations (EPCs). The Exposure Assessment step includes identification of the followings:

Potential receptors: onsite adult (age >18) and youth (ages 12 to 18) trespassers; onsite commercial/industrial workers; onsite construction workers; and onsite utility workers.

Potential exposure routes: incidental ingestion, inhalation of outdoor particulates, and inhalation of outdoor VOCs.

Exposure points within the exposure areas: site soil

As described in this Phase II RI report, the Site is zoned industrial and will continue in the reasonably foreseeable future to be used as a rail yard. Therefore, residential exposure scenarios are not appropriate. Although the estimated exposure and risks to an onsite worker from surface soil previously calculated by DNREC were found to be within acceptable risk levels (DNREC, 1994), these results were based on historical soil data. Despite the fact that fueling operations have ceased in the area (lessening potential worker's exposure), an onsite worker was evaluated in this Phase II HHRA using the RBCA Tool Kit to provide updated health risks to this receptor. The potential health risks for both a youth (ages 12 to 18) and an adult (age >18) trespasser having contact with surface soil was also re-evaluated. In accordance with DNREC guidelines (DNREC, 1998), the potential exposure route for the trespassers was incidental ingestion. The exposure routes evaluated for the industrial/commercial workers are DNREC standard pathways. For the construction workers and utility maintenance workers, the exposure routes quantified were soil ingestion and inhalation of particulates and VOCs emitted during soil disturbance activities.

The chemical exposure via incidental ingestion of soil and inhalation of particulates and vapors was quantified using standard intake equations that include EPCs and variable exposure parameters for ingestion/inhalation rates, exposure frequency, exposure duration, receptor's average body weight, and averaging time, based on both DNREC and USEPA guidance adjusted for realistic site conditions. For the youth and adult trespassers, IT only considered the reasonable maximum (RME) scenario (IT, 1999). For construction workers, both the central tendency exposure (CTE) and RME cases were evaluated, per USEPA's recommendation (USEPA, 1989a, 1992b, and 1992c). The RME in this risk assessment is either the 95% UCL or the maximum detection, whichever was most statistically appropriate.

An on-site commercial scenario was also developed to evaluate risks to workers at the AMTRAK site. A current/future land-use scenario was used to depict ongoing and potential exposures to workers exposed to site-wide and former roundhouse soils in the absence of remedial activity (i.e., a "no-action scenario). Additionally, risks to construction workers performing excavation activities at the site were also evaluated.

It was assumed that these two groups would be exposed to onsite constituents of concern via the following complete pathways:

- outdoor inhalation of particulates/vapors
- incidental ingestion of soil

Dermal exposure pathways were not explored, as workers are expected to wear protective clothing and equipment as per the health and safety plan developed for the site.

The RBCA Tool Kit for Chemical Releases (Groundwater Services, Inc., Houston, TX) was used to calculate risks to potentially exposed populations at this site. The RBCA Tool Kit is based on equations outlined in ASTM PS-104, Standard Provisional Guide for Risk-Based Corrective Action (ASTM, 1998), and consists of a series of linked Microsoft Excel spreadsheets, which calculate baseline risk levels and/or cleanup standards. Risk assessment procedures employed in the RBCA Tool Kit are consistent with current USEPA guidelines (USEPA, 1989) and utilize the most up-to-date toxicity values and exposure parameters for the constituents and receptor populations of concern.

Commercial Workers

The following parameters were used to calculate the chronic daily intake of constituents of concern:

- constituent concentration in the 0-2 feet of surface soil, site-wide soils and former Roundhouse soils, respectively (CTE and RME)
- body weight = 70 kg

- inhalation rate = 20 m^3/day
- soil ingestion rate = 50 mg/day
- exposure frequency = 250 days/year for 25 years (site-wide); 12 days/year for 25 years (roundhouse area)

It is expected that commercial workers on the site would be exposed to COCs in the surface soils only; therefore, only the 0-2 ft data were used to evaluate risks to this receptor population.

Construction Workers

It is expected that soil excavation activities could expose construction workers to constituents of concern in the entire soil column. Therefore, the RME concentrations used were those derived from data collected from all depths. Furthermore, the following variables were used to calculate a chronic daily intake of the constituents of concern, as per the Exposure Factors Handbook (USEPA, 1990a):

- constituent concentration at all depths, site-wide soils and former roundhouse soils, respectively (RME and CTE)
- body weight = 70 kg
- inhalation rate = 20 m^3/day
- soil ingestion rate = 100 mg/day
- exposure frequency = 125 days/year for 1 year

It should be noted that risk calculations for construction workers would be expected to be protective of utility workers, who would be exposed for a much lower frequency and duration.

Exposure variables and the equations/models used to calculate concentrations of COCs in air were as per ASTM and are shown in **Appendix S**.

10.4 Toxicity Assessment

The USEPA has developed two sets of toxicity values to provide quantitative estimates of the health risks posed by chemicals. Toxicity values have been developed for both carcinogenic and noncarcinogenic effects. For carcinogenic effects, it is assumed that there is a "no threshold" level of exposure below which no adverse effects will be seen. In contrast, toxicity values for noncarcinogenic effects assume there exists a threshold below which there will be minimal risk, if any, for adverse health effects.

The most recent toxicity values for carcinogenic effects (i.e., slope factors, or SFs) and noncarcinogenic effects (i.e., reference doses, or RfDs) published for each of the COPCs were obtained from the USEPA's Integrated Risk Information System (IRIS) (USEPA, 2007), an online database that contains toxicity information on toxic substances. The USEPA Region 3's Risk-based Concentrations (RBC) Table (USEPA, 2006) (DNREC referred to the RBC Tables in the 1998 risk assessment guidance), the USEPA's Health Effects Assessment Summary Tables (HEAST) (USEPA, 1997b), or other USEPA or DNREC publications were used as secondary sources of toxicity values. As previously mentioned, toxicity values for the oral and inhalation routes of exposure are listed in **Appendix S** for all COPCs.

Carcinogenic Endpoints

The USEPA has developed a classification system for carcinogenic chemicals based on the strength of evidence that a chemical is a human carcinogen. The classification system is defined as:

Group A - Human Carcinogen
Group B – Probable Human Carcinogen
Group B1 – Limited human data available
Group B2 – Sufficient evidence in animals, inadequate or no evidence in humans
Group C – Possible Human Carcinogen
Group D – Not classifiable as to human carcinogenicity
Group E – Evidence of non-carcinogenicity for humans

The USEPA's Cancer Risk Assessment Verification Endeavor (CRAVE) Work Group reviews human, animal, and in vitro data regarding suspected chemical carcinogens and calculates SFs for those determined to be carcinogenic. SFs listed in the IRIS database are upper-bound estimates of the excess cancer risk due to continuous exposure to a chemical averaged throughout the course of a human lifetime (70 years). A SF has units of excess cancer risk per milligrams of chemical per kilogram of body weight per day $(mg/kg\text{-}day)^{-1}$.

The basis of the SFs is data from lifetime animal bioassays, although human data are used whenever available. The SF represents the 95% upper confidence limit of the slope of the linear portion of the dose-response curve for animal data. The excess cancer risk for the experimental animal is then extrapolated to the excess cancer risk expected for humans. The resulting values from this model are more likely to overestimate than to underestimate the potential risk.

As per DNREC (1999), this site-specific standard approach utilized 1E-05 (1 in 100,000) as the target cumulative upperbound lifetime risk.

Noncarcinogenic Endpoints

Noncarcinogenic effects, such as organ damage or reproductive effects, are evaluated by RfDs. RfDs are developed by the USEPA to provide a benchmark for the daily dose to which humans, including sensitive populations such as children, may be subjected without an appreciable risk of deleterious effects. RfDs are presented in units of mg/kg-day. A subchronic RfD is defined as the estimated daily exposure over a portion of a lifetime (2 weeks to 7 years), while a chronic RfD is defined as the estimated daily exposure over an entire lifetime (greater than 7 years; USEPA, 1989a). Because the nature of construction workers' exposure can be described as subchronic, subchronic RfDs were used to estimate potential noncarcinogenic hazard to construction workers.

The basis of a RfD calculation is usually the highest dose level that causes the no-observed-adverse-effect-level (NOAEL) after chronic or subchronic exposure in animal experiments. The NOAEL is then divided by uncertainty factors (or safety factors), and occasionally an additional modifying factor, to obtain the RfD. Uncertainty factors are usually factors of 10 that account for inter-species variation and sensitive human populations. Additional uncertainty factors can be used if the RfD is based on the lowest-observed-adverse-effect-level (LOAEL) instead of the NOAEL, or an experiment that includes a less-than-lifetime exposure.

For systemic (non-carcinogenic) toxicants, the target hazard index was 1.0, as per DNREC and the USEPA.

10.5 Risk Characterization

Using the information generated during the exposure assessment and toxicity assessment, the potential carcinogenic risk and noncarcinogenic hazard to human health were estimated as shown in different tables presented previously. The risk characterization phase compares the predicted exposure levels against chemical-specific toxicity information to determine if the EPCs of COPCs at the Site, either individually or in mixtures, present any unacceptable health risks under both current and future land use conditions.

The EPA has developed guidance on risk characterization for use in its risk assessment activities. As noted in its Guidelines for Carcinogenic Risk Assessment (U.S. EPA, 2005; p. 5-3), "In constructing high end estimates of risks, the assessor should bear in mind that the high-end risk is a plausible estimate of the risk for those persons at the upper end of the risk distribution."

In compliance with developing plausible estimates, the standard default assumptions for trespasser and worker scenarios have been used. Exposures to contaminants have been apportioned according to the amount of time that might be spent on the site including the roundhouse area where the concentrations are the highest.

Tables 10-5A and **10-5B** present the potential health risks results to youth and adult trespassers for the Site-wide Area. Similarly, **Tables 10-6A** and **10-6B** present the potential health risks results to youth and adult trespassers for the Former Roundhouse Area.

Tables 10-7 to **10-22** present the CTE and RME chemical-specific and pathway-specific health risks to onsite construction workers and onsite construction workers at the Site-wide Area and Former Roundhouse Area. The following text presents the health risks to all potentially exposed populations of concern per exposure area (Site-wide Area and Former Roundhouse Area).

Site-wide Area

The potential cumulative RME and CTE health risks, presented as excess carcinogenic risk and hazard index to potentially exposed populations within the Site-wide Area were estimated based on the lesser of 95% UCL or maximum detection for soils from 0-2 feet bgs; the entire soil column was evaluated for construction workers. The summary of carcinogenic risks and hazard indices for the Site-wide data are as follows:

Exposure Population	RME Carcinogenic Risk	RME Hazard Index	CTE Carcinogenic Risk	CTE Hazard Index
Youth Trespasser	7E-08	0.019	N/A	N/A
Adult Trespasser	2E-07	0.016	N/A	N/A
Onsite commercial worker (0-2 ft)				
Inhalation	7.9E-7	0.16	5.5E-7	0.097
Ingestion of soil	2.0E-6	0.16	1.4E-6	0.098

Total	2.79E-6	0.32	1.95E-6	0.195
Onsite construction worker (all depths)				
Inhalation	3.7E-8	0.87	4.1E-9	0.07
Ingestion of soil	3.1E-7	0.13	1.2E-8	0.038
Total	3.47E-7	1.0	1.61E-8	0.108

The results show that none of the quantified risks are above the established criteria of 1E-05 for carcinogens and 1.0, for non-carcinogens. The main carcinogenic risk driver was Aroclor 1260; the main hazard drivers were TPH-Aliph C09-C18 and TPH-Arom C11-C22. In all cases, the critical carcinogenic pathway of exposure was incidental ingestion of soil. The critical non-carcinogenic pathway of exposure for construction workers was air. Although the results of the Phase I HHRA and Phase II HHRA for trespassers both show that quantified risks are not above established criteria, the calculated risks differ since the databases were different, as previously described.

Former Roundhouse Area

The potential cumulative RME and CTE health risks, presented as excess carcinogenic risks and hazard indices, to potentially exposed populations within the former roundhouse area were estimated as follows:

Exposure Population	RME Carcinogenic Risk	RME Hazard Index	CTE Carcinogenic Risk	CTE Hazard Index
Youth Trespasser	2.0E-06	0.02	N/A	N/A
Adult Trespasser	6E-06	0.014	N/A	N/A
Onsite commercial worker (0-2 ft)				
Inhalation	8.3E-7	5.5E-4	5.4E-7	2.9E-4
Ingestion of soil	2.2E-6	3.1E-3	1.4E-6	2.3E-3
Total	3.03E-6	3.6E-3	1.94E-6	2.59E-3

Onsite construction worker (all depths)				
Inhalation	1.4E-6	0.14	1.0E-7	9.6E-3
Ingestion of soil	1.5E-6	0.11	3.6E-7	0.035
Total	2.9E-6	0.25	4.6E-7	0.045

The results show that under a no-action condition, on-site commercial and construction workers are exposed to Roundhouse surface soils at concentrations that do not exceed the carcinogenic criteria of 1.0E-05 (DNREC).

Therefore, the cumulative RME and CTE risk levels presented above are less than USEPA's target risk levels for site-wide soils.

10.6 Uncertainty Analysis

As part of the Phase II HHRA, information on the uncertainty associated with the characterization including data gaps in toxicological or exposure assessment information and the conservative assumptions or scientific judgments used to bridge these data gaps needs to be included, per USEPA guidance. Numerical estimates of potential health risks to human health and the environment presented in this report are only as reliable as the data and assumptions upon which they are based. General sources of variability and uncertainty in the Phase II HHRA include measurement errors in the site assessment process, variability in natural systems and human behavior, limitations in model simplifications and assumptions, limitations in literature derived data, and professional judgment used to select parameters. Therefore, the numeric risk estimates presented in this Phase II HHRA are merely predictors of whether carcinogenic or noncarcinogenic effects are likely to occur in the population, and do not represent absolute risk values. Based on the use of a mix of mid-range and upper-bound assumptions, the risk estimates are likely overestimates of actual risk at the Site that ensure protection of human health and the environment.

Risk assessment is primarily used in the regulation of chemicals and provides an upper limit of the risk due to the many conservative and health-protective assumptions used in the risk assessment calculations. The assumption of no threshold for cancer is very conservative. The true value of the risk is unknown, and may be as low as zero (USEPA, 1989).

In the Guidelines for Carcinogenic Risk Assessment (U.S.EPA, 2005; p. 5-4) the EPA has noted that, "In situations where there are alternative approaches for a risk assessment that have significant biological support, the decision maker can be informed by the presentation of these alternatives along with their strengths and uncertainties." Although this risk assessment has not included other approaches for addressing the risk characterization of PCBs, other approaches could be used.

In the case of PCBs, the mode of action for the increased incidence of liver tumors in rats, which the Phase II HHRA is based on, is most likely secondary to chronic liver toxicity produced by extremely high lifetime doses of PCBs in the animal bioassays. This means that very low doses of PCBs that would not produce toxicity in the liver may not produce an increased incidence of liver tumors. Consequently, the most likely risks is less than the values estimated at the low exposure levels experienced by potentially exposed populations evaluated in this Phase II HHRA.

For nongenotoxic carcinogens that act though mechanisms of toxicity such as PCBs, nonlinear dose-response or benchmark dose methods provide alternative approaches for risk assessment. Such approaches could lead either to lower risk estimates or would provide the basis for a margin of exposure (MOE) risk characterization. Based upon consideration of the mode of action for the PCB production of liver tumors in rodents and upon the low exposure levels found in the exposure assessment at the AMTRAK Former Fueling Facility, the true risk may even be zero. It should be noted that PCBs are not known to be carcinogenic in humans even though workers with documented exposures have been extensively studied.

10.7 Conclusions

Discrete soil samples utilized in this Phase II human health risk assessment include Smith Environmental (MW-1 to MW-5 and MW-8 to MW-12), 1998 data collected by the IT Group (MW-8A, MW-10A, and MW-13 to MW-17) and Phase II RI data. Two areas of concern were identified for this site: site-wide soils and former roundhouse soils, and it was determined that three exposure populations were relevant:

- adult and youth trespassers (0-2 feet)
- commercial workers (0-2 feet)
- construction workers (all depths)

Exposure to TPH and PCBs was evaluated in this assessment. Two potential exposure pathways were determined to be relevant:

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- incidental ingestion of soil (trespassers, commercial and construction)
- inhalation of particulates and vapors (commercial and construction)

Risk analyses determined that the reasonable maximum exposure (RME) concentrations of constituents of concern did not exceed DNREC or USEPA target risk levels for adult and youth trespassers as well as commercial or construction workers exposed to either site-wide soils (soils outside of the former roundhouse area) or roundhouse area soils.

11.0 ECOLOGICAL INVESTIGATIONS

11.1 Introduction

Extensive ecological investigations were conducted as part of the Phase I and Phase II Remedial Investigations (RI) for the AMTRAK Former Fueling Facility. The principal findings and conclusions of these investigations are summarized below.

11.1.1 Summary of Phase I RI Ecological Assessment

An ecological assessment was conducted as part of the Phase I Remedial Investigation (RI) for the AMTRAK Former Fueling Facility based on field data collected during the summer of 1998 (IT, 1999). This assessment focused on the biological communities within and adjacent to the Eastern Drainage Ditch and the confluence of the Eastern and Western Drainage Ditches at the Former Fueling Facility. The Phase I ecological assessment included characterization of biological communities at a nearby reference location, referred to as the Conectiv Impoundment.

The Conectiv Impoundment was selected, in consultation with DNREC, as the most appropriate reference location after a review of a number of sites in northern Delaware. Although the Conectiv Impoundment was deemed to be the best reference site, it is not an exact analog of the AMTRAK ditches. The Conectiv impoundment contains substantially more aquatic vegetation than do the AMTRAK ditches, receives less hydrological input than the AMTRAK ditches, and has greater retention time and internal nutrient cycling.

The principal findings and conclusions of the Phase I ecological assessment were as follows:

- The Former Fueling Facility ditches and the reference impoundment both support well developed and relatively diverse herbaceous wetland communities. However, differences in plant species diversity and composition were noted between the two locations. Vegetation stress was noted in several areas within wetlands at the Former Fueling facility where groundwater seeps have resulted in the discharge of diesel fuel. In most areas, however, wetlands at the Former Fueling Facility did not appear to be affected by exposure to the chemicals of concern.

- A functional ecosystem has developed within the Eastern Drainage Ditch and the confluence area adjacent to the Former Fueling Facility despite the presence of petroleum hydrocarbons, PCBs, and various metals in the sediments. The on-site ditches support well developed fish and aquatic macroinvertebrate communities, as well as several species of turtles and frogs.

The aquatic communities within the Former Fueling Facility ditches were generally similar to those in the reference impoundment, and are typical of those found in ponds and small impoundments in the surrounding area.

- Eight metals (chromium, copper, iron, manganese, tin, zinc, selenium, and mercury) and PCB Aroclors 1254 and 1260 were detected in the tissue of fish collected from the AMTRAK ditches. All fish tissue samples were non-detect for antimony, cadmium, cobalt, lead, nickel, arsenic, total cyanide, and the PCB Aroclors 1016, 1221, 1232, 1242, and 1248.

- The consumption of fish from the on-site ditches by piscivorous birds, such as great blue heron (*Ardea herodias*) and belted kingfisher (*Ceryle alcyon*), was identified as the only completed exposure pathway between the on-site drainage system and the ecosystem of the surrounding area.

- A dietary exposure model showed that the estimated doses of the chemicals of concern to great blue heron did not exceed the dietary “no observed adverse effect levels” (NOAELs) for birds developed by Oak Ridge National Laboratory (Sample et al., 1996). It was, therefore, concluded that exposure to these chemicals at the Former Fueling Facility did not pose a risk to the great blue heron population.

- The dietary exposure model showed that none of the estimated doses of the metals to belted kingfisher exceeded the NOAEL. The estimated doses of total PCBs to belted kingfisher exceeded the NOAEL, but were less than the Oak Ridge-derived “lowest observed adverse effect level” (LOAEL). Dietary exposures to PCBs and other chemicals falling between the NOAEL and the LOAEL are unlikely to result in significant adverse effects (Sample and Suter, 1999). Moreover, belted kingfisher are territorial and actively defend their feeding area. Based on population densities reported in the literature and on-site observations, this territoriality limits the number of kingfisher potentially exposed to the chemicals of concern at the AMTRAK site to approximately two individuals. Based on these factors, it was concluded that exposure to the chemicals of concern at the AMTRAK Former Fueling Facility did not pose a risk to the belted kingfisher population.

- Based on Phase I RI data, biota-sediment accumulation factors (BSAF) for PCBs were less than those reported in some literature. The BSAF is the ratio of the concentration of a chemical in tissue, normalized to lipid, to the concentration of the chemical in surface sediment, normalized to organic carbon. Total PCB concentrations in the tissues of “small” fish (whole body composites) ranged from 6.48-17.8 mg/kg (wet weight) and averaged 10.92 mg/kg. Total PCB concentrations in "large" fish (whole body composites) ranged from 6.48-78.1 mg/kg and averaged 22.08 mg/kg. Total PCB concentrations in surface sediment in the AMTRAK ditches ranged from 11.2-110 mg/kg and averaged 43.3 mg/kg. Total organic carbon concentrations in surface sediments ranged from 25,600-47,200 mg/kg and averaged 33,883 mg/kg. Lipid concentrations in the fish tissues were not determined, but can be estimated from the literature. Mean whole-body percent lipid content for various fish species ranged from 3.757-6.33 percent in the USEPA STORET database and 4.6-8.8 percent in the National Study of Chemical Residues in Fish (cited in USEPA, 2004). Using the above average tissue and sediment concentrations and an estimated lipid concentration of 3 percent, the BSAF is 0.28 for small fish and 0.86 for large fish. Using a lipid concentration of 9 percent, the BSAF is 0.09 for small fish and 0.29 for large fish. These values are less than the BSAF of 1.85 used by Greene (1997) in the calculation of bioaccumulation-based sediment quality criteria for the protection of human health. As indicated, the assumed BASF of 1.85 is not representative of conditions in the AMTRAK ditches. Therefore, numeric standards based on this BASF are not appropriate for the AMTRAK ditches.

11.1.2 Summary of Phase II RI Ecological Assessment

Ecological field sampling was performed during the Phase II RI to further characterize the ecosystem within the AMTRAK ditches and assess the potential effects of contaminants on that ecosystem. Macroinvertebrate, fish, and turtle sampling was performed seasonally in spring, summer, and fall over a two year period (fall 2004 through summer 2006) to examine seasonal variation in species composition, abundance, and variety. Sampling was conducted in the AMTRAK ditches and the Conectiv Impoundment at approximately the same stations and using the same methods as in the Phase I RI. Sampling was also conducted at two additional local water bodies to provide additional data for comparison with the AMTRAK ditches and further evaluate variation in biological community composition within and between sampling locations. The new sampling locations were the drainage ditch located between the former Atlas Sanitation property and Gander Hill Prison, herein referred to as the City Ditch, and the lower portion of Shellpot Creek.

The scope-of-work for the Phase II ecological sampling (Phase II RI/FFS Work Plan) was reviewed and approved by DNREC.

The principal findings and conclusions of the Phase II ecological assessment were as follows:

- The Phase II ecological sampling supported the conclusions of the Phase I ecological assessment and further demonstrated that a functional aquatic ecosystem exists within the AMTRAK ditches, despite the presence of petroleum hydrocarbons, PCBs, and various metals in the sediment. The ecological communities in the AMTRAK ditches are similar to, or of higher quality than, those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area.

- The macroinvertebrate community within the AMTRAK ditches is dominated by aquatic earthworms (Oligochaeta), midge fly larvae (Chironomidae), damselfly larvae (particularly *Enallagma*), and snails (particularly *Physella*). Other common macroinvertebrates in the AMTRAK ditches include snails of the families Planorbidae and Hydrobiidae, the prawn *Palaemonetes,* darner larvae (*Libellula* and *Erythemis*), the crawling water beetle *Peltodytes*, the water treader *Mesovelia*, and mollusks of the class Bivalvia.

- Three species of turtles, including two subspecies of painted turtle, were collected in the AMTRAK ditches. Eastern painted turtles were most abundant, followed by red-bellied turtles, snapping turtles, and a midland painted turtle.

- Bullfrog (*Rana catesbeiana*) and green frog (*Rana clamitans melanota*) adults and tadpoles were commonly observed in the AMTRAK ditches.

- The AMTRAK ditches support a relatively diverse fish community comprised of species typical of ponds and small impoundments in the general area. The dominant fish species in the AMTRAK ditches are banded killifish, pumpkinseed, bluegill, and mummichog. Other common species include goldfish, golden shiner, brown bullhead, and common shiner.

- Examination of length-frequency distributions for the four most abundant fish species show that young-of-the-year fish (i.e., age 0) are common in the AMTRAK ditches and evidenced the presence of multiple age classes of these species. Multiple size classes were also observed for many of the lesser abundant species. This shows that fish are successfully reproducing in the AMTRAK ditches, and are surviving/growing over multiple years. This is significant given the presence of PCBs in sediments of the AMTRAK ditches. Some laboratory studies have indicated that PCBs can affect fish reproduction and growth, but this does not appear to be occurring in the AMTRAK ditches.

- The proportion of fish from the AMTRAK ditches that evidenced disease or abnormalities was similar to, or less than, that at the other sampling locations.

- The apparent absence of effects of PCBs on the fish community in the AMTRAK ditches is consistent with recent studies that have indicated that exposure to PCB body burdens exceeding levels observed in fish from the AMTRAK ditches do not result in detectable effects on fish populations in their natural environments (Barnthouse et al., 2003; Reiser et al., 2004). Barnthouse et al. (2003) found no relationship between PCB body burdens (exceeding 100 ppm, lipid normalized) in female striped bass from the Hudson River, New York, and various indices of year class abundance, reproduction, and early life stage survival. Reiser et al. (2004), studying largemouth bass in the Housatonic River, Massachusetts, found no effect of PCBs on reproductive activity, relative abundance of young-of-the-year, young-of-the-year growth rates, adult growth, or adult condition. In this study, total PCB concentrations ranged from 34-556 mg/kg in adults and 16-41 mg/kg in young-of-the-year largemouth bass.

11.2 Study Area Description

11.2.1 AMTRAK Former Fueling Facility

The Former Fueling Facility comprises approximately the southern third of the AMTRAK Wilmington Shops site (**Figure 1-2**). The Former Fueling Facility is bounded to the east and the west by unnamed surface water drainage features, referred to as the Eastern Drainage Ditch and the Western Drainage Ditch (**Figure 1-2).** Both ditches flow to the south and empty into a ponded area in the southernmost portion of the project area. This ponded area drains through a dam (12^{th} Street Dam) to the lower portion of the City Ditch, which discharges through culverts under 12th Street to Brandywine Creek.

The Eastern and Western Drainage Ditches convey and control storm water from the AMTRAK site and several adjacent industrialized properties. Small dams were constructed across each of the ditches downgradient of the Former Fueling Facility (Dams B and C), and at the southern terminus of the combined ditches (12^{th} Street Dam). These dams, which are equipped with inverted discharge pipes, were installed to prevent the migration of petroleum sheens off the property and to trap sediment washed into the ditches during storm events.

With the agreement of DNREC, the study area for the ecological assessment included the Eastern Drainage Ditch and the confluence of the Eastern and Western Drainage ditches, but did not include the Western Drainage Ditch. The Eastern Drainage Ditch consists of two impounded sections and a narrower ditch section. The upper impounded area, formed by Dam B, is approximately 1,200 feet long and a maximum of 200 feet wide. From Dam B, the Eastern Drainage Ditch continues south through a channel that is approximately 30 feet wide through most of its length. Approximately 400 feet downstream, the ditch widens into a shallow pool that is approximately 250 feet long and a maximum of 200 feet wide**.** Water depth in the Eastern Drainage Ditch is less than 1-1.5 feet in most areas. Maximum water depth is approximately 2.5 feet, occurring near the center of the upper Eastern Drainage Ditch.

The confluence area, where the Eastern and Western Drainage Ditches join, consists of a shallow pool (1-1.5 feet deep), approximately 200 feet long and 100 feet wide at its widest point, formed by the 12th Street Dam.

Bottom substrate in the Eastern Drainage Ditch and confluence area consists of soft black muck, which exhibits a petroleum odor and creates petroleum sheen when disturbed.

Wetlands in the upper Eastern Drainage Ditch consist primarily of monotypic bands of narrow-leaved cattail *(Typha angostifolia*) or common reed (*Phragmites australis*) around the edges of the ditch. Wetland development is more extensive in the lower Eastern Drainage Ditch and confluence area, which contain several large emergent wetland beds in addition to a nearly continuous wetland fringe. These wetlands contain a variety of species, including common reed, narrow-leaved cattail, pickerel weed (*Pontederia cordata*), wild rice (*Zizania aquatica*), arrow arum (*Peltandra virginica*), American threesquare (*Scirpus americanus*), burreed (*Sparganium eurycarpum*), rice cutgrass (*Leersia oryzoides*), purple top (*Panicum rigidulum*), blunt broom sedge (*Carex tribuloides*), and purple-stem aster (*Aster puniceus*).

A large area to the east of the Eastern Drainage Ditch is vegetated by a monoculture of common reed. Although common reed has a wetland indicator status (FACW), it is extremely invasive and readily colonizes disturbed upland areas. Most of this area does not exhibit hydric soils or indicators of hydrology and, therefore, does not meet the criteria for a wetland.

11.2.2 Conectiv Impoundment

The Conectiv Impoundment is located along the southeastern side of the Norfolk Southern (NS) Edgemoor yard, approximately 1,000 feet east of the Former Fueling Facility (**Figure 11-1).** It consists of a shallow pond approximately 1,000 feet long and 200 feet wide at its widest point. At its northern end, the ponded area narrows to a channel that flows north, through a large area of common reed, approximately 750 feet to a confluence with Shellpot Creek. Aerial photographs suggest that the

Conectiv Impoundment may be a remnant channel of the historical Shellpot Creek. Runoff from the eastern portion of the NS yard appears to be the principal hydrologic input to the impoundment.

Water depths within the Conectiv Impoundment vary with season and rainfall amount, but average approximately 1 foot. Maximum depth is approximately 2.5 feet. Bottom substrate consists of deep muck, which contains a large amount of decomposing plant matter.

During the growing season, a large portion of the Conectiv Impoundment is covered by aquatic bed wetlands, dominated by arrow arum and yellow cowlily (*Nuphar luteum*). The open water portions of the impoundment are vegetated by dense growths of coontail (*Ceratophllum demersum*) and common duckweed (*Lemna minor*). Heavy growths of epiphytic and floating algae also occur within the Conectiv Impoundment.

Photosynthesis by the plants in the Conectiv Impoundment often results in supersaturated dissolved oxygen concentrations during the day, while microbial respiration associated with the decomposition of plant material results in very low dissolved oxygen concentrations at night. The daily photosynthesis-respiration cycle also causes substantial fluctuations in pH.

11.2.3 City Ditch

The City Ditch is an approximately 2,000 feet long storm water drainage ditch that originates near the intersection of Vandever Avenue and Railroad Avenue, and flows generally south between the former Atlas Sanitation property and Gander Hill Prison (**Figure 11-1).** The lower portion of the City Ditch receives flow from the AMTRAK ditches through the 12th Street Dam. The City Ditch discharges to Brandywine Creek through three large culverts under 12th Street. The City Ditch varies in width from approximately 10 feet at its upstream end to 50 feet at 12th Street.

The City Ditch experiences semi-diurnal tides with a typical range of approximately four feet at the 12th Street Dam. Water depth at mean low water ranges from approximately 0.5-2.0 feet with the deepest, occurring in a small pool immediately upstream of the 12th Street culverts. The bottom substrate consists mostly of soft muck. There is a substantial amount of woody debris within the ditch.

The banks of the City Ditch are lined in most places by a band of dense scrub-shrub vegetation. American sycamore (*Platanus occidentalis*), box elder (*Acer negundo*), black walnut (*Juglans nigra*), silver maple (*Acer saccharinum*), and white mulberry (*Morus alba*) are common woody plants within this community. Small pockets of wetland occur in a number of areas along the City Ditch where the tree canopy is sparse. These wetlands contain common reed, cattails (*Typha* spp.), pickerel weed, reed canary grass (*Phalaris arundinacea*), and American water horehound (*Lycopus americanus*).

11.2.4 Shellpot Creek

The Shellpot Creek study area comprised an approximately 2,000 foot reach of the lower creek from Hay Road to Route 495 (**Figure 11-1).** Shellpot Creek within the study area varies in width from approximately 30 feet at the Route 495 bridge to 75 feet in the central portion of the study area.

Tidal flow into the lower Shellpot Creek from the Delaware River is controlled by a large tide gate structure located downstream of Hay Road. The lower Shellpot Creek experiences semi-diurnal tides with a range of approximately 2-4 feet, although the tide gates attenuate the volume and modify the timing of tidal flow. Water depth within the study area at mean low water ranges from approximately 0.5-2.0 feet. Bottom substrate consists of mud and silt, with areas of accumulated organic debris. Vegetated subtidal and intertidal flats of varying widths occur on both sides of the creek. The subtidal flats are vegetated with yellow cowlily, while the intertidal flats contain primarily arrow arum, purple loosestrife (*Lythrum salicaria*), yellow water iris *(Iris pseudoacorus*), and marsh mallow (*Kosteletzkya virginica*). Large stands of common reed occur at higher elevations adjacent to the creek. Small stands of mixed deciduous trees and shrubs occur in a few locations along the banks. Common woody species within these stands include box elder, American sycamore, black gum (*Nyssa sylvatica*), princess tree (*Paulownia tomentosa*), and tree-of-heaven (*Ailanthus altissima*).

11.3 Aquatic Macroinvertebrates

11.3.1 Materials and Methods

Aquatic macroinvertebrates in the ditches adjacent to the AMTRAK Former Fueling Facility and the reference waterbodies were sampled using a D-frame net and by Hester-Dendy artificial substrate sampler in fall 2004, spring, summer, and fall 2005, and spring and summer 2006. The D-frame net provided comparative data on macroinvertebrate community composition on natural substrates. The Hester-Dendy artificial substrate samplers permitted comparison of locations without the potentially confounding influence of variable substrate type (Rosenberg and Resh, 1982).

Macroinvertebrate sampling was performed at two stations in the upper Eastern Drainage Ditch (Macro 3 and 4), one station in the lower Eastern Drainage Ditch (Macro 5), two stations at the confluence of the Eastern and Western Drainage ditches (Macro 1 and 2), three stations in the Conectiv Impoundment (Macro 6, 7, and 8), three stations in the City Ditch (Macro 9, 10, and 11), and

four stations in Shellpot Creek (Macro 12, 13, 14, and 15) (**Figures 11-2** through **11-5**).
The D-frame net consisted of a 0.7-0.9 mm nitex mesh bag attached to a 6-foot wooden handle. A standard D-frame net collection consisted of 20 thrusts of the net into productive habitats and substrates (e.g., within beds of submerged or emergent aquatic vegetation, along woody debris) near each Hester-Dendy sampling location. Each thrust traversed approximately three feet of the given habitat type. The D-frame net was emptied into a sieve bucket equipped with a 0.6 mm mesh bottom.

The Hester-Dendy sampler is a passive sampling device, consisting of eight 7.6 cm^2 tempered-hardboard plates, separated by spacers, which provides an artificial substrate upon which aquatic macroinvertebrates may colonize. Two samplers, attached to a cement block, were set at each station and allowed to incubate for approximately six weeks.

Water temperature, dissolved oxygen concentration, specific conductance, and salinity were measured at each macroinvertebrate sampling station using a Yellow Springs Instrument Company (YSI) Model 85 handheld meter; pH was measured using an Oakton pH meter. Field water quality data are presented in **Tables T-1** through **T-4** (**Appendix T**).

Samples were preserved with isopropyl alcohol and returned to the laboratory for processing. In the laboratory, the sample matrices were rinsed with tap water through a U.S. No. 40 standard sieve prior to processing to remove preservative and excess debris. Small aliquots of matrix were then placed into a petri dish and specimens removed with the aid of a stereo microscope. Macroinvertebrates were sorted by type into glass vials and preserved with isopropyl alcohol. Specimens were identified to the lowest practicable taxonomic level and enumerated. Taxonomic references included Needham and Needham (1962), Gosner (1971), Pennack (1989), Peckarsky et al. (1990),Thorp and Covich (1991), and Merritt and Cummins (1996).

11.3.2 Results

D-frame net collections are summarized in **Tables 11-1** through **11-5**, and data for individual collections are presented in **Tables T-5** through **T-28** (**Appendix T**). Hester-Dendy collections are summarized in **Tables 11-6** through **11-10**, and data for individual samples are presented in **Tables T-29** through **T-52** (**Appendix T**).

11.3.2.1 AMTRAK Ditches

A total of 17,320 specimens of 65 invertebrate taxa were taken in 30 D-frame net samples collected in the AMTRAK ditches during fall 2004 through summer 2006. The total number of macroinvertebrates in these collections averaged 577.33 specimens/collection (**Table 11-1**). Oligochaeta (aquatic earthworms) was the most abundant taxon in the D-frame net samples (n=6,785), comprising 39.2 percent of the total. Other common macroinvertebrate taxa were larvae of the damselfly *Enallagma* (n=2,748; 15.9 percent), midge fly larvae (Chironomidae) (2,486; 14.4 percent), the snail *Physella* (2,187; 12.6 percent), the prawn *Palaemonetes* (807; 4.6 percent), snails of the family Planorbidae (558; 3.2 percent), larvae of the darner *Libellula* (245; 1.4 percent), the crawling water beetle *Peltodytes* (207; 1.2 percent), the water treader *Mesovelia* (206; 1.2 percent), mollusks of the class Bivalvia (206; 1.2 percent), larvae of the darner *Erythemis* (186; 1.1 percent), and snails of the family Hydrobiidae (126; 0.7 percent) (**Table 11-2**).

Number per collection in the AMTRAK D-frame net samples was lowest in spring 2006 (no./coll.=58.40) and highest in spring 2005 (1,479.60). The number of taxa in these collections ranged from 27 in spring 2006 to 35 in fall 2006 (**Table 11-2**).

Hester-Dendy collections (60 samples) in the AMTRAK ditches during fall 2004 through summer 2006 yielded 23,608 specimens of 29 invertebrate taxa. The total number of macroinvertebrates in these collections averaged 393.47 specimens/collection (**Table 11-6**). The most abundant taxa in the AMTRAK Hester-Dendy samples were Oligochaeta (n=8,851; 37.5 percent) and Chironomidae (8,408; 35.6 percent). Other common taxa in the AMTRAK Hester-Dendy samples were Hydrobiidae (n=2,158; 9.1 percent), flatworms (Planariidae) (1,527; 6.5 percent), *Physella* (1,074; 4.5 percent), unidentified Annelida (733; 3.1 percent), and Planorbidae (360; 1.5 percent) (**Table 11-6**),

Number per collection in the AMTRAK Hester-Dendy samples was lowest in fall 2004 (no./coll.=22.80) and highest in summer 2006 (767.30). The number of taxa in these collections ranged from 10 in fall 2004 to 16 in spring 2005 and summer 2006 **(Table 11-7).**

11.3.2.2 Conectiv Impoundment

A total of 20,189 specimens of 64 invertebrate taxa were taken in 18 D-frame net samples collected in the Conectiv Impoundment during fall 2004 through summer 2006. The total number of macroinvertebrates in these collections averaged 1,121.61 specimens/collection (**Table 11-1**). The snail *Physella* was the most abundant taxon in the D-frame net samples (n=6,931), comprising 34.3 percent of the total. Other common macroinvertebrate taxa were the pigmy back swimmer *Neoplea* (n=5,483; 27.2 percent), Chironomidae (1,668; 8.3 percent), *Enallagma* (947; 4.7 percent), Oligochaeta (770; 3.8 percent), the mayfly *Callibaetis* (767; 3.8 percent), phantom midges

(Chaoboridae) (503; 2.5 percent), *Libellula* (409; 2.0 percent), the water boatmen *Trichorixa* (303; 1.5 percent), the back swimmer *Notonecta* (263; 1.3 percent), and Planorbidae (260; 1.3 percent (**Table 11-3**).

Number per collection in the Conectiv Impoundment D-frame net samples was lowest in fall 2004 (no./coll.=325.00) and highest in spring 2005 (2,040.33). The number of taxa in these collections ranged from 24 in fall 2004 to 37 in spring 2005 (**Table 11-3**).

Hester-Dendy collections (36 samples) in the Conectiv Impoundment during fall 2004 through summer 2006 yielded 8,489 specimens of 28 invertebrate taxa. The total number of macroinvertebrates in these collections averaged 235.81 specimens/collection (**Table 11-6**). The most abundant taxa in the Conectiv Hester-Dendy samples were Oligochaeta (n=3,324; 39.2 percent) and Chironomidae (3,275; 38.6 percent). Other common taxa in the Conectiv Hester-Dendy samples were *Physella* (n=802; 9.4 percent), *Enallagma* (309; 3.6 percent), Planorbidae (137; 1.6 percent), leeches (Hirudinea) (131; 1.5 percent), *Libellula* (126; 1.5 percent), and the crawling water beetle *Haliplus* (106; 1.2 percent) (**Table 11-8**).

Number per collection in the Conectiv Hester-Dendy samples was lowest in summer 2006 (no./coll.=32.00) and highest in spring 2005 (372.00). The number of taxa in these collections ranged from five in spring 2006 to 17 in fall 2004 and summer 2005 (**Table 11-8**).

11.3.2.3 City Ditch

A total of 4,055 specimens of 36 invertebrate taxa were taken in 18 D-frame net samples collected in the City Ditch during fall 2004 through summer 2006. The total number of macroinvertebrates in these collections averaged 225.28 specimens/collection (**Table 11-1**). The D-frame net samples from the City Ditch were dominated by Oligochaeta (n=2,960), which comprised 73.0 percent of the total. Chironomidae (n=571; 14.1 percent), Hydrobiidae (113; 2.8 percent), Bivalvia (79; 1.9 percent), *Enallagma* (77; 1.9 percent) and aquatic springtails (Collembola) (63; 1.6 percent) were also relatively common in these samples (**Table 11-4**).

Number per collection in the City Ditch D-frame net samples was lowest in summer 2005 (no./coll.=16.33) and highest in summer 2006 (544.00). The number of taxa in these collections ranged from 10 in spring and fall 2005 to 17 in fall 2004 and spring 2006 (**Table 11-4**).

Hester-Dendy collections (32 samples) in the City Ditch during fall 2004 through summer 2006 yielded 7,571 specimens of 24 invertebrate taxa. The total number of macroinvertebrates in these collections averaged 236.59 specimens/collection (**Table 11-6**).

The most abundant taxa in the Conectiv Hester-Dendy samples were Oligochaeta (n=3,368), comprising 44.5 percent of the total. Other common taxa in these collections were Hydrobiidae (n=1,720; 22.7 percent), Chironomidae (1,045; 13.8 percent), Planariidae (863; 11.36 percent), and *Physella* (240; 3.2 percent) (**Table 11-9**).

Number per collection in the City Ditch Hester-Dendy samples was lowest in fall 2004 (no./coll.=37.83) and highest in spring 2005 (466.33). The number of taxa in these collections ranged from eight in spring and summer 2006 to 15 in summer 2005 (**Table 11-9**).

11.3.2.4 Shellpot Creek

A total of 16,716 specimens of 60 invertebrate taxa were taken in 24 D-frame net samples collected in Shellpot Creek during fall 2004 through summer 2006. The total number of macroinvertebrates in these collections averaged 696.50 specimens/collection (**Table 11-1**). Hydrobiidae was the most abundant taxon in the D-frame net samples (n=6,633), comprising 39.7 percent of the total. Other common taxa were Oligochaeta (n=4,062; 24.3 percent), *Trichocorixa* (1,688; 10.1 percent), the water boatmen *Hesperocorixa* (1,216; 7.2 percent), Collembola (672; 4.0 percent), *Physella* (605; 3.6 percent), Chironomidae (596; 3.6 percent), the amphipod *Gammarus* (340; 2.0 percent), *Enallagma* (250; 1.5 percent), and Bivalvia (168; 1.0 percent) (**Table 11-5**).

Number per collection in the Shellpot Creek D-frame net samples was lowest in spring 2006 (no./coll.=283.75) and highest in summer 2005 (2,016.75). The number of taxa in these collections ranged from 20 in spring 2005 to 28 in summer 2005 (**Table 11-5**).

Hester-Dendy collections (44 samples) in Shellpot Creek during fall 2004 through summer 2006 yielded 15,887 specimens of 21 invertebrate taxa. The total number of macroinvertebrates in these collections averaged 361.07 specimens/collection (**Table 11-6**).

The Shellpot Creek Hester-Dendy samples were dominated by Oligochaeta (n=10,775), which comprised 67.8 percent of the total. Other common taxa in these collections were Chironomidae (n=2,691; 16.9 percent), Hydrobiidae (745; 4.7 percent), Planariidae (657; 4.1 percent), and *Gammarus* (586; 3.7 percent) (**Table 11-10**).

Number per collection in the Shellpot Creek Hester-Dendy samples was lowest in fall 2004 (no./coll.=104.50) and highest in spring 2005 (951.50). The number of taxa in these collections ranged from nine in spring 2006 to 14 in summer 2005 (**Table 11-10**).

11.3.2.5 Comparison of Sampling Locations

Although some differences in taxonomic composition were evident, all of the sampling locations evidenced well developed macroinvertebrate communities. These communities were dominated by organisms that are tolerant of the range of environmental conditions typical of small impoundments and tidal creeks. Abundant taxa in all of the sampling locations included aquatic earthworms (Oligochaeta), snails of the families Physidae, Planorbidae, and/or Hydrobiidae, midge fly larvae (Chironomidae), damselfly larvae (particularly *Enallagma*), and flatworms (Planariidae). Larvae of the darner *Libellula* were common in the AMTRAK ditches and the Conectiv Impoundment, but only a few were collected in the City Ditch or Shellpot Creek. The pigmy backswimmer *Neoplea* was very abundant in the Conectiv Impoundment, but uncommon in the other locations. The sand shrimp *Palaemonetes* and the crawling water beetle *Peltodytes* were common in the AMTRAK ditches, but uncommon in the other locations. The mayfly *Callibaetis* was common in the Conectiv Impoundment, rare in the AMTRAK ditches and the City Ditch, and absent from Shellpot Creek. The water boatmen *Trichocorixa* and *Hesperocorixa* were abundant in Shellpot Creek and relatively common in the Conectiv Impoundment, but only a few were collected at AMTRAK and none were taken in the City Ditch. The amphipod *Gammarus* was abundant in Shellpot Creek, but uncommon in the other locations. *Gammarus* are very abundant in the tidal Delaware River and their abundance in Shellpot Creek probably reflects tidal exchange with the Delaware River.

Mean catch rates (no./coll.) in the D-frame net and Hester-Dendy samples at each of the Phase II sampling locations is plotted in **Figures U-1** and **U-2** (**Appendix U**), respectively, along with the 95 percent confidence intervals of each mean. For both collection methods, the confidence intervals for all sampling locations overlapped each other, indicating that the mean catch rates were not statistically different.

11.3.2.6 Comparison with Phase I RI Results

Macroinvertebrate sampling for the Phase I RI consisted of a single sampling event (D-frame net and Hester-Dendy sampling) in the AMTRAK ditches and the Conectiv Impoundment during summer 1998. A total of 19 invertebrate taxa were collected in the Phase I D-frame net samples in the AMTRAK ditches. Aquatic earthworms of the family Naididae comprised 76 percent of the specimens collected. Larvae of the damselfly *Chromagrion* (7 percent), midge fly larvae (6 percent), the snail *Physella* (2 percent), flatworms (2 percent), and the prawn *Palaemonetes* (2 percent) were common in these samples. The Phase I Hester-Dendy samples in the AMTRAK ditches yielded eight taxa and were dominated by Naididae (52 percent) and Chironomidae (46 percent). Species variety was much greater in the Phase II macroinvertebrate samples (65 taxa in the D-frame net collections and 29 taxa in the Hester-Dendy samples), due primarily to sampling over multiple seasons and years. Aquatic earthworms, midge fly larvae, damselfly larvae, *Physella*, and *Palaemonetes* were abundant or common in both the Phase I and II D-frame net and Hester-Dendy samples in the AMTRAK ditches.

A total of 21 taxa were collected in the Phase I D-frame net samples in the Conectiv Impoundment. These samples were dominated by aquatic earthworms (81 percent), followed by midge fly larvae (12 percent), damselfly larvae (*Chromagrion*) (2 percent), and flatworms (1.6 percent). Ten taxa were collected in the Phase I Hester-Dendy samples in the Conectiv Impoundment. Aquatic earthworms of the family Nadidae (59 percent) and midge fly larvae (39 percent) were again the dominant taxa. Species variety was much greater in the Phase II collections compared with the Phase I samples (64 taxa in the D-frame net collections and 28 taxa in the Hester-Dendy samples). The Phase II D-frame net samples were dominated by *Physella* and pigmy backswimmers (*Neoplea*), although aquatic earthworms, midge fly larvae, and damselfly larvae, the dominant forms in the Phase I samples, were common. Aquatic earthworms and midge fly larvae were the dominant taxa in both the Phase I and Phase II Hester-Dendy samples in the Conectiv Impoundment.

11.3.2.7 Bioassessment

The macroinvertebrate community in the AMTRAK ditches and in the reference waterbodies were compared using the biological metrics developed by the Mid-Atlantic Coastal Stream Workgroup (MACSW, 1997). These metrics are based on the EPA's Rapid Bioassessment Protocol III (RBP III) (EPA, 1989), modified for macroinvertebrate communities in low gradient non-tidal streams. The following metrics were used to assess the macroinvertebrate community: 1) taxa richness, 2) the EPT (Ephemeroptera, Plecoptera, and Tricoptera) index, 3) percent EPT abundance, 4) percent Chironomidae, 5) percent contribution of the dominant taxon, and 6) the modified Hilsenhoff Biotic Index. These metrics were calculated separately for the D-frame net and Hester-Dendy collections (**Tables 11-11** and **11-12**).

Taxa richness (Metric 1) is defined as the number of discrete macroinvertebrate taxa found at each sampling location, and generally increases with water quality and habitat quality (MACSW, 1997). A total of 65 macroinvertebrate taxa were collected by D-frame net in the AMTRAK ditches, 64 taxa were collected in the Conectiv Impoundment, 36 taxa were collected in the City Ditch, and 60 taxa were collected in Shellpot Creek. Hester Dendy collections in the AMTRAK ditches yielded 29 taxa, while 28 taxa were taken in the Conectiv Impoundment, 24 taxa were collected in the City Ditch, and 21 taxa were collected in Shellpot Creek.

The EPT index (Metric 2) is the total number of distinct taxa within the Ephemeroptera (mayfly), Plecoptera (stonefly), and Tricoptera (caddisfly) orders. The number of EPT taxa generally increase with water quality and habitat quality (MACSW, 1997). D-frame net collections yielded three EPT taxa from the AMTRAK ditches, two each from the Conectiv Impoundment and City Ditch, and one from Shellpot Creek. One EPT taxon was collected by Hester-Dendy sampler from the AMTRAK ditches and the Conectiv Impoundment, three were taken in the City Ditch, and no EPT taxa were collected from Shellpot Creek.

Metric 3 is the percent contribution of the EPT groups to the total number of organisms in the sample. The EPT taxa comprised a minor component of the macroinvertebrate community at all of the sampling locations. Percent EPT abundance in the D-frame net samples was 0.08 in the AMTRAK ditches, 3.80 in the Conectiv Impoundment, 0.05 in the City Ditch, and <0.01 in Shellpot Creek. Percent EPT abundance in the Hester-Dendy samples was <0.01 in the AMTRAK ditches, 0.26 in the Conectiv Impoundment, 0.04 in the City Ditch, and 0.00 in Shellpot Creek.

Metric 4 is the percent contribution of the Chironomidae (midge flies) to the total number of organisms in the sample. Chironomids are considered to be pollution tolerant, and the relative abundance of this family generally increases as water quality and habitat quality decrease (MACSW, 1997). Percent Chironomidae was 14.35 in the AMTRAK ditches, 8.26 in the Conectiv Impoundment, 14.08 in the City Ditch, and 3.58 in Shellpot Creek. In the Hester-Dendy samples, percent Chironomidae was 35.62 in the AMTRAK ditches, 38.58 in the Conectiv Impoundment, 13.80 in the City Ditch, and 16.94 in Shellpot Creek.

Metric 5 is the percent contribution of the dominant taxon to the total number of organisms in the sample, and generally increases as water quality and habitat quality decrease (MACSW, 1997). Percent contribution of the dominant taxon in the D-frame net samples was 39.17 in the AMTRAK ditches, 34.33 in the Conectiv Impoundment, 73.00 in the City Ditch, and 39.68 in Shellpot Creek. This metric in the Hester-Dendy samples was 37.49 in the AMTRAK ditches, 39.16 percent in the Conectiv Impoundment, 44.49 percent in the City Ditch, and 67.82 percent in Shellpot Creek.

The modified Hilsenhoff Biotic Index (HBI) (Metric 6) ranges from 0-10 and increases as water quality decreases. This index was developed by Hilsenhoff (1987) to summarize the pollutant tolerance of the benthic arthropod community with a single value. The index is computed as:

$$HBI = \sum \frac{x_i \; t_i}{n}$$

where

x_i = number of individuals within a taxon,
t_i = tolerance value of a taxon (EPA, 1990), and
n = total number of organisms in a sample.

HBI valves based on D-frame net collections were 7.767 for the AMTRAK ditches, 5.440 for the Conectiv Impoundment, 8.896 for the City Ditch, and 8.259 for Shellpot Creek. HBI valves based on the Hester-Dendy collections were 7.813 for the AMTRAK ditches, 7.894 for the Conectiv Impoundment, 8.678 for the City Ditch, and 8.956 for Shellpot Creek.

In addition to the selected MACSW metrics, the Shannon-Weaver diversity index (H') and Shannon-Weaver evenness (J') were calculated using the D-frame net and Hester-Dendy results for each waterbody using base 2 logarithms. The Shannon-Weaver diversity index is based on information theory and is dependent on the number of species in a collection (i.e., species richness) and the relative abundance of each species. Evenness is the ratio of the observed diversity to the maximum possible diversity for that number of species. For the Shannon Weaver index, evenness is computed as J'=H'/H'max and ranges from 0 to 1. H'max is the maximum possible value for H', which would occur if all species are equally abundant (Towner, 1992). Stressed biological communities typically evidence lower species diversity and evenness than unstressed communities (Cornell et al., 1976; Poole, 1974).

Shannon-Weaver diversity, calculated using the D-frame net data, was 2.846 for the AMTRAK ditches, 3.136 for the Conectiv Impoundment, 1.582 for the City Ditch, and 2.707 for Shellpot Creek. Evenness was 0.473 for the AMTRAK ditches, 0.523 for the Conectiv Impoundment, 0.306 for the City Ditch and 0.458 for Shellpot Creek.

Shannon-Weaver diversity, calculated using the Hester-Dendy data, was 2.258 for the AMTRAK ditches, 2.176 for the Conectiv Impoundment, 2.228 for the City Ditch, and 1.596 for Shellpot Creek. Evenness was 0.465 for the AMTRAK ditches, 0.453 for the Conectiv Impoundment, 0.486 for the City Ditch, and 0.363 for Shellpot Creek.

11.4 Fish

11.4.1 Materials and Methods

Fish in the ditches adjacent to the AMTRAK Former Fueling Facility and the reference waterbodies were sampled by electrofishing and trap netting in October 2004, May, August, and October 2005, and May and August 2006.

Electrofishing was performed at two stations in the upper Eastern Drainage Ditch (ES-3 and 4), one station in the lower Eastern Drainage Ditch (ES-7), two stations in the confluence area (ES-5 and 6), two stations in the Conectiv Impoundment (ES-1 and 2), three stations in the City Ditch (ES-8, 9 and 10), and four stations in Shellpot Creek (ES-11, 12, 13, and 14) (**Figures 11-2** through **11-5**). Electrofishing was performed with a boat-mounted Coffelt VVP-2C-2000 variable voltage pulsator powered by a 3.5-kW generator. Pulsed-DC current was used to minimize fish mortality. The boat was maneuvered through the shallow waters with a 12-volt trolling motor and/or paddles. Stunned fish were netted and placed in a holding tub. Sampling was conducted for a duration of approximately 10 minutes (actual shocking duration) at each station. Sampling duration was recorded by a digital meter on the electrofishing unit.

Trap nets were fished at two stations in the upper Eastern Drainage Ditch (TN-3 and 4), two stations in the Conectiv Impoundment (TN-1 and 2), and two stations in Shellpot Creek (TN-5 and 6) (**Figures 11-2** and **11-5**). The City Ditch was too narrow and shallow to effectively fish trap nets. Each trap net consisted of a 3 x 50-foot lead net and a 3 x 6-foot metal frame connected to two traps (four 2.6-foot diameter hoops). The lead and trap nets were made of 0.5-inch mesh. Nets were set perpendicular to shore, with the distal end of the lead net anchored at the shoreline and the trap offshore. Trap nets were typically set in the afternoon and allowed to fish overnight.

Water temperature, dissolved oxygen concentration, and specific conductance were measured after each electrofishing sample and at the time the trap nets were set and retrieved using a Yellow Springs Instrument Company (YSI) Model 85 handheld meter and pH was measured with an Oakton pH meter.

Collected fish were identified, counted, examined for lesions/abnormalities, measured to the nearest millimeter (total length, TL), and weighed by species to the nearest 0.1 g. Fish were processed and released near the site of capture. Nomenclature and taxonomic order of presentation (**Table 11-13**) followed Nelson et al. (2004).

11.4.2 Results

Electrofishing results are summarized in **Tables 11-14** through **11-18**, and data for individual collections are presented in **Tables T-53** through **T-76** (**Appendix T**). Trap net collections are summarized in **Tables 11-19** through **11-22**, and data for individual samples are presented in **Tables T-77** through **T-94** (**Appendix T**).

11.4.2.1 AMTRAK Ditches

A total of 4,287 specimens of 18 species of fish were taken in 30 electrofishing samples (286.6 minutes of shocking time) collected in the AMTRAK ditches during October 2004 through August 2006 **(Table 11-14**). Total catch rate averaged 14.958 fish/minute. Banded killifish was the most abundant species (n=2,288) and comprised 53.4 percent of the electrofishing catch. Other common species included pumpkinseed (n=1,421; 33.1 percent), bluegill (255; 5.9 percent), mummichog (104; 2.4 percent), goldfish (49; 1.1 percent), golden shiner (42; 0.9 percent), brown bullhead (42; 0.9 percent), and common shiner (31; 0.7 percent). The electrofishing catch in the AMTRAK ditches included 11 largemouth bass and four smallmouth bass (**Table 11-15**).

Total catch rate in the electrofishing samples was lowest in October 2005 (7.178 fish/minute) and highest in May 2006 (23.730 fish/minute). The number of species taken per sampling period was lowest in October 2004 (9) and highest in August 2006 (14). Catch composition was similar during each sampling period with banded killifish or pumpkinseed typically ranking first or second. Bluegill ranked first in October 2004 (**Table 11-15**).

A total of 388 specimens of eight species of fish were collected in 12 trap net collections (245.1 hours of trap netting effort) in the upper Eastern Drainage Ditch during October 2004 through August 2006 (**Table 11-19**). Total catch rate in these collections averaged 1.583 fish/hour. Pumpkinseed was most abundant (n=176), comprising 45.3 percent of the trap net catch, followed by bluegill (87; 22.4 percent), banded killifish (66; 17.0 percent), golden shiner (30; 7.7 percent), and brown bullhead (18; 4.6 percent) (**Table 11-20**).

Total catch rate in the trap net collections was lowest in August 2006 (0.704 fish/hour) and highest in August 2005 (2.298 fish/hour). The number of species taken was similar during all sampling periods, ranging from four (October 2004 and August 2006) to six (August 2005). Pumpkinseed was the most abundant species in all sampling periods (**Table 11-20**).

11.4.2.2 Conectiv Impoundment

A total of 246 specimens of 11 species of fish were collected in 12 electrofishing samples (128.4 minutes of shocking time) in the Conectiv Impoundment during October 2004 through August 2006 (**Table 11-14**). Total catch rate in these samples averaged 1.916 fish/minute. Eastern mudminnow was most abundant (n=103), comprising 41.9 percent of the electrofishing catch, followed by pumpkinseed (42; 17.1 percent), eastern mosquitofish (28; 11.4 percent), and bluegill (27; 11.0 percent). The electrofishing catch in the Conectiv Impoundment included nine redfin pickerel (**Table 11-16**).

Total catch rate in electrofishing samples in the Conectiv Impoundment was lowest (0.933 fish/minute) in May 2005 and highest (3.715 fish/minute) in October 2004. Catch composition varied somewhat between sampling events, with eastern mudminnow being particularly abundant in October 2004 and August 2006. The number of species taken per sampling period ranged from five (August 2005, October 2005, and August 2006) to eight (October 2004 and May 2006) (**Table 11-16**).

A total of 66 fish of eight species were taken in 12 trap net collections (268.2 hours of trap netting effort) during October 2004 through August 2006 (**Table 11-19**). Total catch rate in these collections averaged 0.246 fish/hour. Pumpkinseed was the most abundant (n=36; 54.5 percent) species in the trap net collections, while bluegill (11; 16.7 percent) ranked second and golden shiner (9; 13.6 percent) ranked third (**Table 11-21**).

Total catch rate in the trap net collections in the Conectiv Impoundment ranged from zero (August 2006) to 0.733 fish/hour in (October 2004). The number of species taken per sampling period ranged from zero (August 2006) to five (October 2004) (**Table 11-21**).

11.4.2.3 City Ditch

A total of 688 specimens of 16 species of fish were collected in 18 electrofishing samples (173.4 minutes of shocking time) in the City Ditch during October 2004 through August 2006 (**Table 11-14**). Total catch rate in these samples averaged 3.968 fish/minute. Mummichog was the most abundant species (n=196), comprising 28.4 percent of the electrofishing total, followed by banded killifish (191; 27.8 percent), pumpkinseed (158; 23.0 percent), common shiner (62; 9 percent), bluegill (22; 3.2 percent), and spottail shiner (21; 3.1 percent). The electrofishing catch in the City Ditch included eight smallmouth bass and one largemouth bass (**Table 11-17**).

Total catch rate in the electrofishing samples was lowest in October 2004 (2.484 fish/minute) and highest in August 2006 (7.232 fish/minute). The number of species taken was similar during all sampling periods, ranging from eight (October 2004 and May 2006) to 10 (August 2005 and August 2006). Catch composition was similar during most of the sampling periods. Mummichog were particularly abundant in August 2005 (n=114) and all but one of the common shiner (n=61) were taken in August 2006 (**Table 11-17**).

11.4.2.4 Shellpot Creek

A total of 1,072 specimens of 26 species of fish were collected in 24 electrofishing samples (250.8 minutes of shocking time) in Shellpot Creek during October 2004 through August 2006 (**Table 11-14**). Total catch rate in these samples averaged 4.274 fish/minute. Banded killifish was the most abundant species (n=283), comprising 26.4 percent of the electrofishing total, followed by pumpkinseed (167; 15.6 percent), mummichog (123; 11.5 percent), white sucker (117; 10.9 percent), American eel (114; 10.6 percent), golden shiner (46; 4.3 percent), eastern mudminnow (36; 3.4 percent), and bluegill (34; 3.2 percent). The electrofishing catch in Shellpot Creek included 12 smallmouth bass and three largemouth bass (**Table 11-18**).

Total catch rate in the electrofishing samples was lowest in August 2005 (2.118 fish/minute) and highest in May 2006 (5.757 fish/minute). The number of species taken ranged from 13 (May 2005, August 2005, and August 2006) to 17 (October 2004 and October 2005). Catch composition was similar during most of the sampling periods, with banded killifish, mummichog, and pumpkinseed being among the most abundant species (**Table 11-18**).

A total of 121 specimens of 12 species of fish were collected in 12 trap net collections (254.2 hours of trap netting effort) in Shellpot Creek during October 2004 through August 2006 (**Table 11-19**). Total catch rate in these collections averaged 0.476 fish/hour. Brown bullhead was most abundant (n=25), comprising 20.7 percent of the trap net catch, followed by common shiner (20; 16.5 percent), banded killifish (20; 16.5 percent), and pumpkinseed (17; 14.0 percent) (**Table 11-22**).

Total catch rate in the trap net collections was lowest in May 2006 (0.088 fish/hour) and highest in August 2006 (0.679 fish/hour). The number of species taken ranged from two (October 2004 and May 2006) to six (August 2006) (**Table 11-22**).

11.4.2.5 Length-Frequency Distributions for Selected Species

Length-frequency distributions (electrofishing and trap net collections combined) for banded killifish, mummichog, pumpkinseed, and bluegill, the four most abundant species collected in the Phase II fish sampling, are presented in **Tables 11-23** through **11-36**. The length distribution and probable ages of these fish in the AMTRAK ditches are discussed below.

The length of banded killifish collected in the AMTRAK ditches (1,188 of 2,354 specimens taken were measured) ranged from 16-110 mm TL, with specimens 46-75 mm TL comprising over 65 percent of those measured (**Table 11-23**). Banded killifish may live to age 4, although age 3 is a more typical maximum age (Jenkins and Burkhead, 1993). Age 3 banded killifish averaged 66 mm TL in a Wisconsin Lake (Becker, 1983) and ranged from 67-80 mm TL in Nova Scotia (Fritz and Garside, 1975). The maximum length attained by banded killifish is approximately 114 mm TL (Jenkins and Burkhead, 1993). The length-frequency distribution (**Table 11-23**) indicates that banded killifish of ages 0-3, and possibly age 4, were represented in the catch from the AMTRAK ditches.

Mummichogs collected in the AMTRAK ditches (all 107 specimens collected were measured) ranged from 26-110 mm TL, with fish 51-85 mm TL comprising 70 percent of the catch (**Table 11-24**). Fritz and Garside (1975) reported the following lengths-at-age for mummichogs in Nova Scotia: age 1 – 35-50 mm TL, age 2 – 51-74 mm TL, age 3 – 68-83 mm TL, and age 4 – 78-95 mm TL. Denoncourt et al. (1978) reported somewhat larger lengths-at-age for a freshwater population of mummichogs in Conodoguinet Creek in Pennsylvania: age 0 – 16-45 mm FL (fork length), age 1 – 56-76 mm FL, and age 2 – 86-96 mm FL. Based on these lengths-at-age, mummichog of ages 0-3 and, possibly age 4, were represented in the catch from the AMTRAK ditches.

Pumpkinseed collected in the AMTRAK ditches (1,367 of 1,597 specimens taken were measured) ranged from 26-170 mm TL, with specimens 56-105 mm TL comprising 73 percent of those measured (**Table 11-25**). The following average lengths-at-age were reported for pumpkinseed in a Michigan pond (Scott and Crossman, 1973): age 0 – 51 mm TL, age 1 – 74 mm TL, age 2 – 104 mm TL, age 3 – 124 mm TL, age 4 – 145, age 5 – 157 mm TL, age 6 – 173 mm TL, age 7 – 185 mm TL, and age 8 – 198 mm TL. Slightly larger lengths-at-age were indicated for pumpkinseed in Pennsylvania lakes (Loranta et al., 2005). Based on these lengths-at-age, pumpkinseed of ages 0-5, and possibly age 6, were represented in the catch from the AMTRAK ditches.

Bluegill collected in the AMTRAK ditches (all 342 specimens collected were measured) ranged from 26-185 mm TL, with specimens 36-65 mm TL comprising 51 percent of those measured (**Table 11-26**). The following average lengths-at-age were reported for bluegill in a Michigan pond (Scott and Crossman, 1973): age 0 – 43 mm TL, age 1 – 79 mm TL, age 2 – 109 mm TL, age 3 – 137 mm TL, age 4 – 168, age 5 – 185 mm TL, age 6 – 196 mm TL, age 7 – 208 mm TL, age 8 – 213 mm TL, age 9 – 221 mm TL, and age 10 – 226 mm TL. Martin (2007) reported somewhat larger lengths-at-age (statewide average) for bluegill collected from eight ponds in Delaware: age 1 – 75 mm TL, age 2 –

122 mm TL, age 3 – 158 mm TL, age 4 – 179 mm TL, and age 5 – 191 mm TL. Based on these lengths-at-age, pumpkinseed of ages 0-5 were likely represented in the catch from the AMTRAK ditches.

The length-frequency data show that young-of-the-year fish (i.e., age 0) were common in the AMTRAK ditches and evidences the presence of multiple age classes of these species. This shows that fish are successfully reproducing in the AMTRAK ditches, and are surviving/growing over multiple years.

11.4.2.6 Comparison of Sampling Locations

Banded killifish, pumpkinseed, and mummichog comprised major components of the fish community in the AMTRAK ditches, the City Ditch, and Shellpot Creek, although their rankings differed slightly between locations. Bluegill were abundant in the AMTRAK ditches, but occurred in lower relative abundance in the other waterbodies.

The composition of the fish community in the Conectiv Impoundment differed from the other sampling locations. The fish community in the Conectiv Impoundment was dominated by eastern mudminnow, which occurred in relatively small numbers in the AMTRAK ditches and Shellpot Creek, but were not taken at all in the City Ditch. No banded killifish or mummichog were collected in the Conectiv Impoundment, although pumpkinseed and bluegill were relatively common. The Conectiv Impoundment evidenced the lowest catch rates and the fewest species of the locations sampled. The much heavier growth of aquatic vegetation in the Conectiv Impoundment, and the effects of photosynthesis by these macrophytes on water quality (large fluctuations in dissolved oxygen concentration and pH) are likely significant factors that shape its fish community.

Mean catch rates in both electrofishing and trap net collections were highest in the AMTRAK ditches. These catch rates are plotted in **Figures U-3** and **U-4** (**Appendix U**) respectively, along with their 95 percent confidence intervals. The confidence intervals for the AMTRAK catch rates did not overlap those for the other sampling locations, indicating that, statistically, catch rates were significantly higher at AMTRAK.

More fish species were collected in Shellpot Creek (26), than in the AMTRAK ditches, (18), the City Ditch (16), or the Conectiv Impoundment (11). The species variety and composition in the Shellpot Creek reflects that it is a more open system than the other sampling locations. Fish can readily move into the lower Shellpot Creek from the Delaware River below, and the non-tidal creek, above the study reach. Fish species that are likely of Delaware River origin are American eel, white perch, and striped bass. Fish that reflect the non-tidal creek and the more riverine character of the Shellpot Creek study area include white sucker, quillback, creek chubsucker, longnose dace, and tessellated darter.

11.4.2.7 Comparison with Phase I RI Results

Fish sampling for the Phase I RI consisted of a single sampling event (electrofishing and trap netting) in the AMTRAK ditches and Conectiv Impoundment during August 1998. Phase I electrofishing in the AMTRAK ditches yielded eight species of fish occurring at a catch rate of 4.967 fish/minute (**Table 11-15**). A total of 18 species were taken in Phase II electrofishing (six sampling events) at an average catch rate of 14.958 fish/minute (**Table 11-15**). The number of species taken (9-14) and the catch rate (7.178-23.730 fish/minute) were higher in all of the Phase II electrofishing events. Mummichog was the most abundant species at AMTRAK in the Phase I sampling, but ranked fourth in Phase II collections. Conversely, the closely related banded killifish ranked first in the Phase II electrofishing, but none were taken during Phase I. Pumpkinseed ranked second in both the Phase I and II electrofishing collections. Bluegill ranked third in the Phase II electrofishing, but none were taken during Phase I.

Phase I trap netting in the AMTRAK ditches took six species occurring at a catch rate of 3.310 fish/hour (**Table 11-20**). Phase II trap netting (six sampling events) yielded eight species at an average catch rate of 1.583 fish/hour (**Table 11-20**). The catch rate in all of the Phase II trap netting events (0.704-2.219 fish/hour) was lower than in the Phase I collections. The number of species collected in the Phase II trap net events ranged from 4-6. Pumpkinseed ranked first in both the Phase I and II trap net collections. Bluegill ranked second in the Phase II samples but comprised only a small portion of the Phase I total. Banded killifish ranked third in the Phase II trap net collections, but were not taken during Phase I.

Phase I electrofishing in the Conectiv Impoundment resulted in the collection of only six specimens of five species of fish (catch rate = 0.300 fish/minute (**Table 11-16**). Phase II electrofishing (six sampling events) yielded 246 specimens of 11 species (catch rate = 1.916 fish/minute (**Table 11-16**).

Phase I trap netting in the Conectiv Impoundment was more productive, yielding six species of fish at a catch rate of 2.133 fish/hour. Phase II trap netting (six sampling events) took six species at an average catch rate of 0.246 fish/hour (**Table 11-21**). The catch rate in all of the Phase II trap netting events (0.000-0.733 fish/hour) was lower than in Phase I. Black crappie was the most abundant species in the Phase I trap net samples (n=51), but only four were collected during Phase II sampling. Mummichog ranked second in the Phase I collections (n=30), but none were taken in the Phase II trap net collections (**Table 11-21**).

11.4.2.8 Bioassessment

The fish communities in the AMTRAK ditches and in the reference waterbodies were compared using selected biological metrics based on the Index of Biological Integrity (IBI) developed by Karr et al. (1986). The IBI and most published modifications of the concept (Miller et al., 1988; USEPA, 1989b; USEPA, 1999) were developed to evaluate fish communities in flowing water, non-tidal, streams. No modifications of the full IBI protocol suitable for application to small coastal plain impoundments or tidal ditches/creeks, such as those sampled in the present study, have been developed. In the full IBI, biological metrics for a given site are scored against values estimated from sites located within a similar geographic region and with similar environmental characteristics (e.g., size, hydrologic regime), but having minimal human disturbance. The scores are then summed to assess the overall biotic integrity or health of the subject site. Since a comparative reference database has not been developed for small coastal plain impoundments, IBI scores cannot be calculated. However, selected IBI metrics are applicable to the habitats sampled in the Phase II study, and were calculated separately for electrofishing and trap net collections (**Tables 11-37** and **11-38**).

The following metrics were used to assess the fish community: 1) total number of species, 2) number of intolerant species, 3) number of tolerant species, 4) proportion of individuals as omnivores, 5) proportion of individuals as insectivores, 6) catch per unit effort, and 7) proportion of individuals with disease/anomalies. Metrics 1-3 assess species richness and composition, metrics 4 and 5 assess the quality of the food base and the trophic dynamics of the community, and metrics 6 and 7 evaluate fish abundance and condition.

The total number of fish species (Metric 1) generally decreases with increased degradation of the aquatic environment (USEPA, 1989). A total of 18 fish species were collected by electrofishing in the AMTRAK ditches, 11 species were collected at the Conectiv Impoundment, 16 species were taken from the City Ditch, and 26 species were collected in Shellpot Creek. Trap net collections yielded eight species each in the AMTRAK ditches and the Conectiv Impoundment, and 12 species in Shellpot Creek.

One intolerant species (Metric 2) was collected by electrofishing in the AMTRAK ditches (swallowtail shiner, n=1) and another intolerant species was taken in Shellpot Creek (longnose dace, n=1), based on the tolerance classifications given in Appendix C of USEPA (1999). No intolerant species were collected by electrofishing in the Conectiv Impoundment or the City Ditch. No intolerant species were taken in any of the trap net collections. It is considered unlikely for intolerant species to occur in small man-made impoundments or tidal ditches/creeks such as those sampled in the present study.

Electrofishing yielded seven tolerant species (Metric 3) in the AMTRAK ditches, four in the Conectiv Impoundment, five in the City Ditch, and 10 in Shellpot Creek, based on the tolerance classifications given in Appendix C of USEPA (1999). Four tolerant species were collected by trap net in the AMTRAK ditches, while three each were taken in the Conectiv Impoundment and Shellpot Creek. Tolerant species typically account for a substantial proportion of the fish community in small man-made impoundments and tidal ditches/creeks.

Omnivores are defined as species that consistently feed on substantial proportions of both plant and animal material. The proportion of omnivores in a community (Metric 4) is typically inversely proportional to physical and chemical habitat quality (USEPA, 1989b). For the electrofishing samples, the proportion of individuals as omnivores was 0.024 for the AMTRAK ditches, 0.061 for the Conectiv Impoundment, 0.009 for the City Ditch, and 0.185 for Shellpot Creek, based on the trophic classifications given in Appendix C of USEPA (1999). For the trap net samples, the proportion of individuals as omnivores was 0.007 for the AMTRAK ditches, 0.152 for the Conectiv Impoundment, and 0.050 for Shellpot Creek.

Insectivores are defined as species that feed primarily on aquatic insects and other invertebrates. The proportion of insectivores in a community (Metric 5) is typically directly proportional to physical and chemical habitat quality, and reflects the quality of the macroinvertebrate food base (USEPA, 1989b). For the electrofishing samples, the proportion of individuals as insectivores was 0.944 for the AMTRAK ditches, 0.447 for the Conectiv Impoundment, 0.669 for the City Ditch, and 0.521 for Shellpot Creek, based on the trophic classifications given in Appendix C of USEPA (1999). For the trap net samples, the proportion of individuals as insectivores was 0.915 for the AMTRAK ditches, 0.758 for the Conectiv Impoundment, and 0.736 for Shellpot Creek.

Catch per unit effort (Metric 6) is a measure of the number/density of fish in a waterbody. In general, bodies of water with poor physical and chemical habitat quality will support fewer individuals, and will evidence a lower catch per unit effort in fishery collections (USEPA, 1989b). Electrofishing catch per unit effort was 14.958 fish/minute in the AMTRAK ditches, 1.918 fish/minute in the Conectiv Impoundment, 3.968 fish/minute in the City Ditch, and 4.274 fish/minute in Shellpot Creek. The trap netting catch per unit effort was 1.583 fish/hour in the AMTRAK ditches, 0.246 fish/hour in the Conectiv Impoundment, and 0.476 fish/hour in Shellpot Creek.

The proportion of individual fish with evidence of disease or abnormality (Metric 7) in the electrofishing catch was 0.025 for the AMTRAK ditches, 0.053 for the Conectiv Impoundment, 0.161 for the City Ditch, and 0.118 for Shellpot Creek. For the trap net catch, the proportion evidencing disease or abnormalities was 0.026 for the AMTRAK ditches, 0.015 for the Conectiv Impoundment, and 0.050 for Shellpot Creek. External parasites were the most common disease/abnormality noted in all sampling locations. A listing of diseases and abnormalities noted in the present study is given in **Table 11-39**.

In addition to the selected IBI metrics, the Shannon-Weaver diversity index (H') and Shannon-Weaver evenness (J') were calculated using the electrofishing and trap netting results for each waterbody using base 2 logarithms. Shannon-Weaver diversity, calculated using electrofishing data, was 1.757 for the AMTRAK ditches, 2.599 for the Conectiv Impoundment, 2.524 for the City Ditch, and 3.434 for Shellpot Creek. Evenness was 0.421 for the AMTRAK ditches, 0.751 for the Conectiv Impoundment, 0.631 for the City Ditch, and 0.731 for Shellpot Creek. The lower diversity and evenness calculated for the AMTRAK ditches were a function of the high contribution of a few species (primarily banded killifish and pumpkinseed) to the total electrofishing catch.

Shannon-Weaver diversity, calculated using trap net data, was 2.113 for the AMTRAK ditches, 2.034 for the Conectiv Impoundment, and 3.091 for Shellpot Creek. Evenness was 0.704 for the AMTRAK ditches, 0.678 for the Conectiv Impoundment, and 0.862 for Shellpot Creek.

11.5 Turtles

11.5.1 Materials and Methods

Turtles were collected using the fish traps nets described in Section 11.4.1. Trap nets were fished at two stations in the upper Eastern Drainage Ditch (TN-3 and TN-4), two stations in the Conectiv Impoundment (TN-1 and TN-2), and two stations in Shellpot Creek (TN-5 and TN-6) (**Figures 11-2, 11-3,** and **11-5**). Turtles were identified, counted, and measured for carapace length. Common and scientific names of turtles collected in this study are given in **Table 11-40**; nomenclature followed Conant (1975).

11.5.2 Results

11.5.2.1 AMTRAK Ditches

Twelve trap net collections (245.1 hours of trap netting effort) in the upper Eastern Drainage Ditch during October 2004 through August 2006 resulted in the capture of 43 turtles of three species, including two subspecies of painted turtle (**Table 11-20**). Eastern painted turtles were most abundant (n=29; 67.4 percent of the total), followed by red-bellied turtles (12; 27.9 percent), snapping turtles (4; 9.3 percent), and a midland painted turtle (1; 2.3 percent).

11.5.2.2 Conectiv Impoundment

Twelve trap net collections (268.2 hours of trap netting effort) in the Conectiv Impoundment during October 2004 through August 2006 yielded 188 turtles of three species, including two subspecies of painted turtle (**Table 11-21**). Eastern painted turtles were most abundant (n=176; 93.6 percent of the total), followed by stinkpots (6; 3.2 percent), midland painted turtles (5; 2.7 percent), and a red-bellied turtle (1; 0.5.percent). One collection on October 18, 2005 accounted for 58.1 percent (n=100) of the eastern painted turtles captured in the Conectiv Impoundment (**Appendix Table T-87).** The abundance of painted turtles in the Conectiv Impoundment is likely related to the heavy growth of aquatic vegetation, which provides cover and is used as food by adults. Painted turtles also eat snails and insect larvae, which are abundant in the Conectiv Impoundment.

11.5.2.3 Shellpot Creek

Twelve trap net collections (254.2 hours of trap netting effort) in Shellpot Creek during October 2004 through August 2006 captured 31 turtles of four species, including two subspecies of painted turtle (**Table 11-22**). Eastern painted turtles were most abundant (n=14; 45.1 percent of the total), followed by red-bellied turtles (13; 41.9 percent), snapping turtles (2; 6.5 percent), a stinkpot (1; 3.2 percent), and a midland painted turtle (1; 3.2 percent).

11.6 Brandywine Creek Macroinvertebrate Sampling

11.6.1 Materials and Methods

Sediment samples were collected from the tidal reach of the Brandywine Creek along transects in the vicinity of the surface water outfall from the Former Fueling Facility and in depositional areas. Sampling locations are shown in **Figure 6-2.** The sediment samples were analyzed for PCBs, total organic carbon (TOC), and grain size (see Section 8.2 for analytical results). All samples were collected using a Petite Ponar grab sampler.

Benthic macroinvertebrates were also collected at each sediment sampling location using the Petite Ponar grab (0.023 m^2 per replicate); five replicates were collected at each station and composited to form one sample. Samples were washed through a 0.5-mm sieve and preserved with 10 percent rose-bengel formalin solution. At the laboratory, specimens were removed from attendant sediment/detritus, identified to the lowest practicable taxonomic level, and enumerated.

11.6.2 Results

Fifteen Petite Ponar samples were collected in the tidal Brandywine Creek on November 3 and 5, 2004. Field water quality data and sediment characteristics for these samples are presented in **Table 11-41**. A total of 1,335 specimens of 17 macroinvertebrate taxa were collected (**Table 11-42**). The tidal Brandywine Creek samples were dominated by aquatic earthworms (Oligochaeta) of the family Naididae (n=811), which comprised 60.8 percent of the total. Chironomidae ranked second (n=285; 21.4 percent) and Asian clams (*Corbicula*) ranked third (132; 9.9 percent). Aquatic earthworms of the family Tubificidae (n=36; 2.7 percent) and snails of the family Bithyniidae (27; 2.0 percent) were also relatively common is some of the samples (**Table 11-42**).

Number per collection ranged from 17 at station BC-SED-3 to 253 at BC-SED-6. The number of taxa collected ranged from three at BCT-3C and BCT-2-B to seven at BCT-1-B (**Table 11-42**).

A single quagga mussel shell (*Dreissena bugeusis*) was collected at station BCT-1-B. The quagga mussel is an exotic invasive species of the same genius as the zebra mussel (*Dreissena polymorpha*). The quagga mussel has not previously been reported from Delaware, but has been collected in eastern Pennsylvania.

The general taxonomic composition of the macroinvertebrate community in the tidal Brandywine Creek is typical of other tidal freshwater environments in the Delaware River basin and the Delaware River itself. Metcalf & Eddy (1996) sampled benthic macroinvertebrates in the tidal Christina River and the adjacent Churchmans Marsh, a tidal freshwater system in Delaware. These samples contained relatively few taxa, and were dominated by oligochaete worms and chironomids. Oligochaete worms and chironomids were also the predominant taxa collected by Crumb (1977) in a three-year survey of the benthic macroinvertebrate community in the upper tidal Delaware River. A more recent study also reported oligochaetes and chironomids to be the predominant taxa in the macroinvertebrate community in the tidal freshwater Delaware River (ECSI, 1993). *Corbicula* were also abundant in some regions of the river in the ECSI (1993) study.

11.7 Discussion

Ecological sampling was performed during October 2004 through August 2006 as part of the Phase II Remedial Investigation for the AMTRAK Former Fueling Facility. The objectives of the Phase II ecological investigation were to further characterize the ecosystem within the AMTRAK ditches, building upon the results of the Phase I ecological assessment, and to obtain additional data upon which to assess the potential effects of contaminants on that ecosystem. The Phase II ecological investigation included sampling at the Conectiv Impoundment, which served as a reference impoundment in the Phase I studies, as well as two new comparative locations, the City Ditch and the lower Shellpot Creek.

The Phase II ecological sampling supported the conclusions of the Phase I ecological assessment and further demonstrated that a functional aquatic ecosystem exists within the AMTRAK ditches, despite the presence of petroleum hydrocarbons, PCBs, and various metals in the sediment. The ecological communities in the AMTRAK ditches are similar to, or of higher quality than, those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area.

The macroinvertebrate community within the AMTRAK ditches is dominated by aquatic earthworms (Oligochaeta), midge fly larvae (Chironomidae), damselfly larvae (particularly *Enallagma*), and snails (particularly *Physella*). Other common macroinvertebrates in the AMTRAK ditches include snails of the families Planorbidae and Hydrobiidae, the prawn *Palaemonetes*, darner larvae (*Libellula* and *Erythemis*), the crawling water beetle *Peltodytes*, the water treader *Mesovelia*, and mollusks of the class Bivalvia. In the AMTRAK ditches, these macroinvertebrates live primarily in association with the stems and leaves of emergent aquatic vegetation. Qualitative observations have indicated that few macroinvertebrates live in or on the sediments in the AMTRAK ditches, probably because of the high concentration of petroleum hydrocarbons. Nonetheless, the AMTRAK ditches support macroinvertebrates in sufficient abundance to support a substantial fish community, comprised primarily of insectivorous species that rely on macroinvertebrates as their food source.
The comparative locations support similar macroinvertebrate communities, although some differences in taxonomic composition were noted. These taxonomic differences reflect differences in environmental characteristics between locations, such as the high degree of coverage of the Conectiv Impoundment by aquatic vegetation. Taxa richness was highest in the AMTRAK ditches in both the D-frame net and Hester-Dendy samples. The mean catch rate (no./coll.) of macroinvertebrates in the D-frame net collections was highest in the Conectiv Impoundment and lowest in the City Ditch. For the Hester-Dendy collections, the mean catch rate was highest in the AMTRAK ditches, slightly lower in Shellpot Creek, and nearly identical in the Conectiv Impoundment and the City Ditch. Comparison of 95 percent confidence limits, however, indicates that the mean catch rates were not statistically different between locations.

The AMTRAK ditches support a relatively diverse fish community comprised of species typical of ponds and small impoundments in the general area. The dominant fish species in the AMTRAK ditches are banded killifish, pumpkinseed, bluegill, and mummichog. Other common species include goldfish, golden shiner, brown bullhead, and common shiner. A small number of largemouth bass and smallmouth bass were collected in the AMTRAK ditches. These bass species are sought by recreational fishermen, but the AMTRAK property is patrolled private property and no fishing is allowed.

Fish communities of similar taxonomic composition occur in the City Ditch and Shellpot. The fish community in the Conectiv Impoundment, however, differed from the other locations, probably because of the high density of aquatic vegetation and the effect of photosynthesis by this vegetation on water quality. More fish species were collected in Shellpot Creek than the other locations and the composition of the catch evidenced species from the Delaware River below, and the non-tidal creek above, the study area.

Mean catch rates in both electrofishing and trap net collections were highest in the AMTRAK ditches. Comparison of 95 percent confidence limits indicated that the mean catch rates at AMTRAK were statistically higher than at the other locations.

Examination of length-frequency distributions for the four most abundant fish species show that young-of-the-year fish (i.e., age 0) are common in the AMTRAK ditches and evidences the presence of multiple age classes of these species. Multiple size classes were also observed for many of the lesser abundant species. This shows that fish are successfully reproducing in the AMTRAK ditches, and are surviving/growing over multiple years. This is significant given the presence of PCBs in sediments of the AMTRAK ditches. Some laboratory studies have indicated that PCBs can affect fish reproduction and growth (Davis, 1997; Nimrod and Benson, 1997; Monosson, 1999; and Kahn and Thomas, 2006), but this does not appear to be occurring in the AMTRAK ditches.

The proportion of fish from the AMTRAK ditches that evidenced disease or abnormalities was similar to, or less than, that at the other sampling locations.

Fish from the AMTRAK ditches were not analyzed for PCBs or other contaminants in the Phase II RI studies. PCB Aroclors 1254 and 1260, and eight metals (chromium, copper, iron, manganese, tin, zinc, selenium, and mercury) were detected in fish tissue collected during the Phase I RI (IT, 1999). Total PCB concentrations in the tissues of “small” fish (whole body composites) ranged from 6.48-17.8 mg/kg (wet weight) and averaged 10.92 mg/kg. Total PCB concentrations in “large” fish (whole body composites) ranged from 6.48-78.1 mg/kg and averaged 22.08 mg/kg. Several recent studies have indicated that exposure to PCB body burdens exceeding levels observed in fish from the AMTRAK ditches do not result in detectable effects on fish populations in their natural environments. Reiser et al. (2004) studied the effects of PCBs on reproduction and growth of largemouth bass in the Housatonic River, Massachusetts. In this study, total PCB concentration in adult largemouth bass collected in 2002 averaged 121 mg/kg (range = 34-556 mg/kg). PCB concentrations in young-of-the-year largemouth bass in 2000 and 2002 averaged 28 mg/kg (range = 21-41 mg/kg) and 19 mg/kg (range = 16-24 mg/kg), respectively. Reiser et al. (2004) found no effect of PCBs on reproductive activity, relative abundance of young-of-the-year, young-of-the-year growth rates, adult growth, and adult condition. Analyzing long time series of data from the Hudson River, New York, Barnthouse et al. (2003) did not find any relationship between PCB body burdens in female striped bass and various indices of year class abundance, reproduction, and early life stage survival. Maternal PCB concentrations exceeded 100 ppm (lipid normalized) in many of the fish in this study.

12.0 SUMMARY OF REMEDIAL INVESTIGATIONS

SECOR performed a Phase II remedial investigation (RI) at the Former Fueling Facility portion of the AMTRAK Wilmington Shops located along Vandever Avenue in Wilmington, Delaware. The remedial investigation was conducted under the Delaware Voluntary Cleanup Program enacted under 7 Del. C. Chapter 91: Delaware Hazardous Substance Cleanup Act (HSCA). Phase II RI activities were performed in accordance with Revised Phase II Remedial Investigation and Focused Feasibility Study Work Plan (Phase II RI/FFS Work Plan) dated August 28, 2003.

The purpose of the Phase II remedial investigation was to further characterize drainage features associated with the Former Fueling Facility as well as portions of the Brandywine Creek. The Draft (Phase I) Remedial Investigation Report documented the occurrence of petroleum hydrocarbons and PCBs in sediment samples and PCBs in fish tissue collected in the Eastern Drainage Ditch and confluence area. In comments to the Draft Phase I RI Report, DNREC indicated that they considered additional remedial investigation work beyond the boundaries of the previous remedial investigation necessary. As a result, sediment samples were collected from the Brandywine Creek and other drainage ditches in the immediate vicinity of the site as well as from site ditches. Soil samples were collected in the Former Fueling Facility and other areas which drain to the site drainage ditches in order to characterize potential erodible soils. As will be summarized below, additional human health risk assessment and ecological investigations were performed.

The AMTRAK Wilmington Shops consist of the Maintenance Facility and include the Former Fueling Facility. The Former Fueling Facility encompasses approximately 20 acres and is the area of the AMTRAK Wilmington Shops south of the former roundhouse, bounded to the east by the unnamed surface water drainage feature (referred to as the Eastern Drainage Ditch) and to the west by a drainage ditch (referred to as the Western Drainage Ditch) which separates the AMTRAK Wilmington Shops from the former Atlas Sanitation property. Both the Eastern and Western Drainage Ditches flow to the south and empty into a confluence area. The Former Fueling Facility is bounded to the south by the confluence of the two surface water features and by 12th Street. Dams equipped with containment booms were installed in the ditches to contain fuel oil and reduce sediment transport.

The AMTRAK Wilmington Shops were constructed in 1903 and used essentially for the maintenance, fueling, and service of locomotives and passenger cars since construction of the original facility. Ownership and operation of the facility was conveyed by Penn Central Transportation Company, debtor to Consolidated Rail Corporation (CONRAIL), effective April 1, 1976. CONRAIL subsequently conveyed ownership and operation of the facility to AMTRAK, also effective April 1, 1976.

The Former Fueling Facility was used primarily for the servicing of locomotives with diesel fuel, lubricating oil and sand. Fueling operations were ceased in this area in November 1995 and were transferred to a newly constructed facility north of the former roundhouse. Other operations historically performed in the Former Fueling Facility included the refilling of caboose cabin heaters with kerosene and supplying steam engines with water, sand and coal. The area is currently used for the storage of passenger railcars and will continue to be used for that purpose in the future.

Phase II remedial investigations included sediment and surface water sample collection in site drainage features, surface soil sample collection in the Former Fueling Facility and the AMTRAK property to the east of the Eastern Drainage Ditch, advancement of soil borings adjacent to site drainage features and on the AMTRAK property to the east of the Eastern Drainage Ditch, and sediment sample collection in Brandywine Creek and nearby drainage features. Surface water and sediment sample collection as well as dye testing in an abandoned sewer was also performed. A summary of the findings of investigation activities is provided below.

12.1 Geology/Hydrogeology

The site-specific geology is characterized as black sand and gravel surficial fill material of varying thickness above medium grained sand. Localized zones of brick, crushed concrete and other debris were encountered in the fill material. A dense blue-gray clay associated with organic material was encountered beneath sediments in the Eastern and Western Drainage Ditches and beneath the fill and sand deposits at a depth of approximately 13 to 15 feet in the Former Fueling Facility. Geotechnical borings advanced as part of the design of a possible new building encountered this clay material at depths of approximately 15 to 25 bgs and competent bedrock at a depth of approximately 55 feet bgs. This clay was encountered beneath all site drainage features from which sediment samples were collected.

Groundwater occurs under unconfined conditions at depths generally ranging from 1.5 to 10 feet bgs. Water level measurements indicate that the Former Fueling Facility is bisected by an east-west trending groundwater divide with groundwater movement away from the former fueling area towards the drainage ditches. Groundwater is not used as potable water in the area of the site.

12.2 Interim Remedial Measures

Interim measures included implementation of the activities outlined in the Interim Remedial Measures Plan (1998) which initiated the recovery of product from the water table and included product characterization and containment activities. Implementation of the diesel fuel recovery program described in the Diesel Fuel Remedial Work Plan (2000) began in 2000. An erosion control and sediment reduction measures program was implemented in the Outfall 004 drainage area.

During 2000, approximately 1,200 linear feet of product recovery trenches were installed. Product was pumped from product recovery pumps placed in five 30-inch diameter recovery wells placed in the recovery trenches. An additional section of recovery trench with a recovery well was installed during April 2007. Components of the ongoing diesel fuel remedial program include operation of pumps in the recovery trenches, manual product recovery, operation of compressed gas powered recovery pumps, and surface soil bioremediation in three areas adjacent to the Eastern Drainage Ditch. Through December 2006, approximately 15,200 gallons of diesel has been recovered.

Erosion control and sediment reduction measures installed in the Outfall 004 drainage area (approximately 11 acres) included bioretention caps, stone/fabric filter berms, placing fabric/stone on certain areas, and stone check dams. These measures resulted in a 94% decrease in storm water PCB concentrations measured at Outfall 004.

A Pollution Minimization Plan (PMPs) (dated September 28, 2005) for the AMTRAK Wilmington Yard was prepared in accordance with the Delaware River Basin Commission (DRBC) PMP Rule 4.30.9. The PMP was developed and implemented to reduce the discharge of PCBs from the facility.

12.3 Results of Environmental Sampling

12.3.1 On-Site Environmental Sample Results

As mentioned, Phase II on-site remedial investigations included sediment sample collection, soil sample collection and surface water sample collection. The results of these sampling activities are summarized below.

- Sediment samples were collected from the drainage ditch north of the Eastern Drainage Ditch, the Eastern Drainage Ditch, the Western Drainage Ditch and the confluence area. Sediment samples were collected from the upper three inches of sediment (“A” interval), in 3-foot horizons from inches into the sediment to the top of the clay substrate "B" interval and from the clay substrate ("C" interval). Total PCB aroclor concentrations in site sediments ("A" and "B" intervals) ranged from 0.74 mg/kg to 320 mg/kg while TPH/DRO concentrations ranged from 61 mg/kg to 240,000 mg/kg. Total PCB and TPH/DRO concentrations in the "C" interval (clay substrate) ranged from below detection limits to 9.90 mg/kg and from below detection limits to 57,000 mg/kg, respectively.

- Soil samples were collected from soil borings adjacent to site drainage features in order to characterize surface soils and "B" horizon sediments. Total PCB aroclor concentrations in samples collected from the soil borings ranged from below detection limits to 3,200 mg/kg. TPH/DRO concentrations ranged from 0.100 mg/kg to 57,000 mg/kg.

- Surface soil samples were collected from upland (subdrainage) areas in the vicinity of the Former Fueling Facility and from the AMTRAK property to the east of Eastern Drainage Ditch. Discrete and composite samples were collected. Total PCB aroclor concentrations for discrete and composites in the vicinity of the Former Fueling Facility were 0.34 mg/kg to 39 mg/kg, and from 0.37 mg/kg to 39 mg/kg respectively. The highest discrete sample PCB concentration was reported in the former roundhouse area. The area reporting the highest composite sample PCB concentration has been covered with geotextile and stone as part of the Outfall 004 drainage area project. Total PCB aroclor concentrations in discrete and composite surface soil samples collected in the AMTRAK property to east of the Eastern Drainage Ditch ranged from 0.370 mg/kg to 110 mg/kg, and from 0.83 mg/kg to 10 mg/kg, respectively.

- Dry weather and storm water surface samples were collected from site drainage features for PCB congener analyses. The dry weather and storm water total PCB congener concentrations for samples collected at Outfall 006 (the most downgradient sampling location) were 108,818.17 pg/l (0.109 ug/l) and 121,707.40 pg/l (0.122 ug/l), respectively. Higher total PCB congeners were reported in surface water samples collected upgradient of this location. A sample collected from water coming onto the site through Outfall 006 as a result of tidal conditions reported 2,873 pg/l (0.0029 ug/l) total PCB congeners.

- Surface water and sediment samples were collected from an abandoned sewer. Total PCB aroclor concentrations in the surface water samples ranged from below detection limit (0.48 ug/l) at the most-downgradient location to 237 ug/l. Total PCB aroclor concentration in sediment samples ranged from 16.2 mg/kg to 290 mg/kg.

12.3.2 Off-Site Environmental Sample Results

Phase II off-site remedial investigations included sediment sample collection in drainage ditches in the vicinity of the site and from the tidal and non-tidal portions of the Brandywine Creek. The results of these investigations are summarized below.

- Sediment samples were collected at five samples in the City Ditch. Total PCB aroclor concentrations in these samples ranged from 0.247 mg/kg to 20.46 mg/kg.

- Sediment samples were collected in two drainage ditches on the AMTRAK property to the east of the Eastern Drainage Ditch. These drainage ditches receive storm water runoff from industrial properties to the east of the AMTRAK property. A sediment sample was collected in a drainage ditch that enters the Eastern Drainage Ditch (approximately 300 feet south of Dam B) at a location in the ditch adjacent to where the water is routed under Railcar Avenue from adjacent properties (the most upgradient location on AMTRAK property). This sample reported up to 16 mg/kg total PCB aroclors. A sediment sample from the pipe under Railcar Avenue reported 11 mg/kg total PCB aroclors.

- A total of nine samples were collected from tidal portions of the Brandywine Creek for PCB congener analyses. Total PCB congener concentrations in these samples ranged from below detection limits to 3.6 mg/kg. The highest concentration was reported in a sample collected from a depositional area near the confluence of Brandywine Creek with the Christina River. As discussed in this Report, several PCB impacted sites have been identified along the tidal reaches of the Brandywine Creek.

- Sediment samples were collected from three sampling locations in the non-tidal portion of Brandywine Creek. Total PCB aroclor concentrations ranged from below detection limits to 0.10 mg/kg. Total PCB congener concentrations in the two samples analyzed for PCB congeners in the non-tidal Brandywine Creek were 0.0027 mg/kg and 0.0011 mg/kg.

- PCB aroclors 1248, 1254, and 1260 were detected in sediments in the tidal and non-tidal portion of Brandywine Creek.

12.4 Site Conceptual Model

In the Former Fueling Facility, liquid phase hydrocarbons (LPH) in LPH-saturated aquifer materials migrate on top of the capillary fringe/water table from the former fueling area in the direction of decreasing hydraulic gradient, towards groundwater discharge areas. In the vicinity of the former fueling area, the water table aquifer discharges to the adjacent drainage features and LPH may emanate in these drainage channels as LPH seeps or sheens. Interim remedial measures implemented at the site included identification and removal/closure of abandoned pipes or conduits which may serve as preferential pathways for LPH movement. Sheens observed on site drainage features are addressed through a sorbent boom maintenance program and dams installed in site drainage ditches.

Fuel oil and PCB contamination at the Former Fueling Facility is contained and controlled. It is contained vertically by dense layer approximately 10 feet thick (based on geotechnical borings) encountered beneath the Former Fueling Facility at a depth of approximately 7 to 15 feet and beneath all site drainage features samples. It is contained laterally by a system of drainage ditches, dams and water retention ponds that collect oil and sediment that would otherwise discharge to Brandywine Creek.

In the Former Fueling Facility, the groundwater is oxygen deficient and biologic degradation occurs primarily under anaerobic conditions. Soil analyses indicate that hydrocarbon utilizing bacteria do occur although their activities are limited by the lack of oxygen. Anaerobic degradation appears to result in generation of soluble ferrous iron which may result in the rust color staining in the Western Drainage Ditch. Since groundwater is not used at the site and there are no occupied buildings in the Former Fueling Facility, discharge to surface water is the most significant groundwater receptor. Surface water data collected during NPDES monitoring at locations adjacent to the Former Fueling Facility is reviewed in order to monitor surface water chemistry.

PCBs in site surface soils are a potential source for PCBs in site surface water and sediments. Surface soils may be washed into site drainage features during storm events. Erosion and sediment control measures implemented in the Outfall 004 drainage area reduced PCB concentrations in surface water monitored at Outfall 004 by over 90%.

As has been described, dams have been installed in the Eastern Drainage Ditch (Dam B), the Western Drainage Ditch (Dam C), and in the confluence area (12th Street Dam). During 1999 and 2000, the integrity of these dams was upgraded by the placement of steel sheet piling in the upstream side of each dam. A 90° downward extending fitting was placed on the inlet piping on the upgradient side of each dam. The dam construction makes them effective in preventing the movement of floating product through the dams and effective sediment traps.

The site is situated in a historically industrialized area of Wilmington. Properties to the east and west of the AMTRAK facility contribute storm water to site drainage features. In addition, PCBs from sites along Brandywine Creek may also move onto the site as a result of the tidal conditions at Outfall 006. As described previously, PCBs have been detected in surface water moving onto the site through Outfall 006 during tidal reversal.

12.5 Revised Human Health Risk Assessment

The human health risk assessment (HHRA) presented in the Draft Phase I Report has been revised to include additional exposure scenarios (at the request of DNREC) and more recent site data (date collected since the Phase I RI was completed). In addition to youth and adult trespasser exposure to soil (included in the Phase I HHRA), industrial/commercial worker exposure scenarios were also considered.

Since soil in the former roundhouse area contains elevated PCB concentrations compared to the rest of the site and a fence surrounds the former roundhouse with no active operations within this fenced area, two exposure areas of concern were evaluated. These consist of the former roundhouse area and the site-wide area (exclusion of the former roundhouse area).

Risk analyses determined that the reasonable maximum exposure (RME) concentrations of constituents of concern do not exceed DNREC or USEPA target risk levels for site-wide soil or former roundhouse area soils.

12.6 Ecological Assessment

Phase II RI ecological field sampling was performed to further characterize the ecosystem within the AMTRAK ditches and assess the potential effects of constituents of concern on that ecosystem. Macroinvertebrate, fish, and turtle sampling was performed seasonally in spring, summer, and fall over a two year period to examine seasonal variations. Sampling was performed in the AMTRAK ditches and Conectiv Impoundment at approximately the same stations as in the Phase I RI. Sampling was also performed in the City Ditch and the lower portion of Shellpot Creek to provide additional data for comparison with the AMTRAK ditches and further evaluate variation in biological communities within and between sampling locations.

The Phase II ecological sampling supported the conclusions of the Phase I ecological assessment and further demonstrated that a functional aquatic ecosystem exists within the AMTRAK ditches, despite the presence of petroleum hydrocarbons, PCBs, and various metals in sediments. The ecological communities in the AMTRAK ditches are similar to, or are of higher quality than those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area.

13.0 FOCUSED FEASIBILITY STUDY

This Focused Feasibility Study (FFS) has been prepared for the AMTRAK Wilmington Former Fueling Facility based on the scope of work provided in Revised Phase II Remedial Investigation and Focused Feasibility Study Work Plan (Phase II RI/FFS Work Plan) prepared by SECOR and dated August 28, 2003. This FFS was conducted under the Delaware Voluntary Cleanup Program (VCP) enacted under 7 Del. C. Chapter 91: Delaware Hazardous Substance Cleanup Act (HSCA).

The report is organized to meet the recommended format suggested by DNREC described in Appendix C of *Hazardous Substance Cleanup Act Guidance Manual* (DNREC, 1994). In addition, this FFS follows the guidelines set out in this document, and where appropriate follows the recommendations in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA, 1988).

13.1 Introduction

This introductory section of the FFS has been organized to follow the guidance documents referenced above. However, additional site background, history, and findings of the remedial investigations have been described in previous sections of this report.

13.1.1 Site Description

As described in Section 1.2, the AMTRAK Wilmington Shops consist of the Maintenance Facility and Former Fueling Facility. The Former Fueling Facility encompasses approximately 20 acres (refer to **Figures 1-2** and **1-3**). The Former Fueling Facility is situated in an industrial area of southeast Wilmington. The site is zoned General Industrial (M-2) by the City of Wilmington.

The Former Fueling Facility is located south of the former roundhouse, bounded to the east by the unnamed surface water drainage feature (referred to as the Eastern Drainage Ditch), and to the west by a drainage ditch (referred to as the Western Drainage Ditch), which separates the AMTRAK Wilmington Shops from the former Atlas Sanitation property. Both of the drainage ditches flow to the south and empty into a confluence area. The Former Fueling Facility is bounded to the south by the confluence of the two surface water features and the 12th Street Dam. Located immediately east of the Eastern Drainage Ditch is an undeveloped, vegetated area owned by AMTRAK and then an access road (referred to as Railcar Avenue). On the east side of the access road is the former CONRAIL

Edgemoor Yards, now owned and operated by Norfolk Southern (NS), a tank car cleaning company, an asphalt plant, and a cement plant. The Western Drainage Ditch separates the Former Fueling Facility from a tract of land formerly operated by Atlas Sanitation which is now a materials recycling facility. The area across 12th Street to the south of the study area is also industrialized and is referred to as the Brandywine Industrial Complex.

13.1.2 Site History

The AMTRAK Wilmington Shops were constructed in 1903 and were used essentially for the maintenance, fueling, and service of locomotives and passenger cars. Ownership and operation of the facility was conveyed by Penn Central Transportation Company, debtor, to Consolidated Rail Corporation (CONRAIL), effective April 1, 1976. CONRAIL subsequently conveyed ownership and operation of the facility to AMTRAK, also effective April 1, 1976.

The Former Fueling Facility was used primarily to service locomotives with coal and later diesel fuel, lubricating oil and sand. Fueling operations ceased in this area in November 1995 and were transferred to a newly constructed facility north of the former roundhouse. Other operations historically performed in the Former Fueling Facility included the refilling of caboose cabin heaters with kerosene and supplying steam engines with water, sand and coal. The area is currently used to store passenger railcars, maintenance of way equipment, and other equipment, and will continue to be used for that purpose in the future. Additional discussion of site history is presented in Section 1.3.

Interim measures included implementation of the activities outlined in the Interim Remedial Measures Plan (1998) which initiated the recovery of product from the water table and included product characterization and containment activities. Implementation of the diesel fuel recovery program described in the Diesel Fuel Remedial Work Plan (2000) began in 2000. An erosion control and sediment reduction measures program was implemented in the Outfall 004 drainage area during 2003.

During 2000, approximately 1,200 linear feet of product recovery trenches were installed. Product is pumped from product recovery pumps installed in five 30-inch diameter recovery wells placed in the recovery trenches. An additional section of recovery trench with a recovery well was installed during April 2007. Components of the ongoing diesel fuel remedial program include operation of pumps in the recovery trenches, manual product recovery, operation of compressed gas powered recovery pumps, and surface soil bioremediation in three areas adjacent to the Eastern Drainage Ditch. Through December 2006, approximately 15,200 gallons of diesel has been recovered.

Erosion control and sediment reduction measures installed in the Outfall 004 drainage area (approximately 11 acres) include bioretention caps, stone/fabric filter berms, placing fabric/stone on certain areas, and stone check dams. These measures resulted in a 94% decrease in storm water PCB concentrations measured at Outfall 004.

A Pollution Minimization Plan (PMP) (dated September 28, 2005) for the AMTRAK Wilmington Yard was prepared in accordance with the Delaware River Basin Commission (DRBC) PMP Rule 4.30.9. The PMP was developed and implemented to reduce the loading of PCBs to the Delaware River Estuary from the facility.

13.1.3 Nature and Extent of Contamination

As described in previous sections of this report, environmental samples have been collected from site groundwater, sediments (on-site and off-site), soils, and surface water. Product samples and fish tissue samples (from site drainage features) were also collected. Surface water and sediment samples were also collected from an abandoned sewer. Samples were collected during: Phase I RI investigations; investigations performed subsequent to the Phase I RI and prior to the Phase II RI; during the Phase II RI; and as part of the on-going diesel fuel remedial program. This data has been discussed in previous sections of this Report and is summarized below.

<u>Soils</u>

- Eight soil borings (MW-6A, MW-8A, MW-10A, MW-14, MW-15, MW-16 and MW-17) were advanced during the Phase I RI. TPH-DRO concentrations in surface soils ranged from 270 mg/kg (MW-14) to 36,000 mg/kg (MW-15). TPH-DRO concentrations in subsurface samples ranged from 840 mg/kg [MW-14 (2' - 4')] to 56,000 mg/kg [MW-15 (2' - 4')] (refer to Section 2.1) .

- Site drainage ditch bank soil samples were collected from soil borings adjacent to site drainage features in order to characterize surface soils and the lateral extent of “B” horizon sediments (the zone extending from three inches into the sediment to the top of the clay substrate). Total PCB aroclor concentrations in samples collected from the soil borings ranged from below detection limits to 3,200 mg/kg. TPH/DRO concentrations ranged from 0.100 mg/kg to 57,000 mg/kg (refer to Section 7.2.1).

- Nine surface soil samples were collected from three stained soil areas adjacent to the Eastern Drainage Ditch during June 2005. Total PCB aroclor concentrations for the samples collected ranged from 0.67 mg/kg to 3.6 mg/kg. Surface soil in-situ bioremediation to reduce petroleum hydrocarbon concentrations was performed in these areas beginning in 2001 as part of the diesel fuel remedial program. All samples collected in June 2005 reported C5-C8 aliphatic hydrocarbons, C9-C12 aliphatic hydrocarbons, and C9-C-10 aromatic hydrocarbon concentrations below detection levels. In general, C9-C-18 aliphatic hydrocarbons, C19-C-36 aliphatic hydrocarbons, and C11 and C22 aromatic hydrocarbons, reported lower concentrations in 2005 than in 2001 (these are heavier molecular weight hydrocarbons and generally take longer to biodegrade than lighter molecular weight hydrocarbons) (refer to Section 7.2.2).

- Surface soil samples were collected from upland (subdrainage) areas in the vicinity of the Former Fueling Facility and from the AMTRAK property to the east of Eastern Drainage Ditch. Discrete and composite samples were collected. Total PCB aroclor concentrations for discrete and composites in the vicinity of the Former Fueling Facility were 0.34 mg/kg to 39 mg/kg, and from 0.37 mg/kg to 39 mg/kg respectively. The highest discrete sample PCB concentration was reported in the former roundhouse area. The area reporting the highest composite sample PCB concentration has been covered with geotextile and stone as part of the Outfall 004 drainage area erosion control and sediment reduction project (refer to Section 7.2.3).

- Soil samples were also collected from upland (subdrainage) areas on the AMTRAK property to east of the Eastern Drainage Ditch. Total PCB aroclor concentrations in discrete and composite surface soil sample collected in the AMTRAK property to east of the Eastern Drainage Ditch ranged from 0.370 mg/kg to 110 mg/kg, and from 0.83 mg/kg to 10 ug/kg, respectively (refer to Section 7.2.3).

- Between October 2004 and January 2005, 24 soil borings were advanced and five surface soil samples were collected in the area of the former roundhouse as part an investigation for proposed building (CNOC Building) construction (it was later decided that the building would not be constructed). Total PCB concentrations in soil samples collected between 0 to 2 feet bgs ranged from below detection limits to 1,400 mg/kg (SB-11, 0.25 to 1 feet bgs). Total PCB concentrations in subsurface soils (samples collected at depths greater than 2 feet bgs) ranged from below detection limits to 1,100 mg/kg (SB-11, 2 to 3 feet bgs). Separate-phase hydrocarbons were not apparent in any soil boring (refer to Section 2.2.3).

- During October 2004, eight soil borings were advanced in the general area of the proposed MOW building (northeastern portion of the Former Fueling Facility). Total PCB concentrations in surface soil samples (sample; collected between 0 to 2 feet bgs) ranged from detection limits to 41.5 mg/kg (SB-18, 0 to 0.25 feet bgs). Total PCB concentrations in subsurface samples (samples collected at depths greater than 2 feet bgs) ranged from below detection limits to 2.1 mg/kg (SB-18, 4 to 5 feet bgs) (refer to Section 2.2.4).

Site Sediments

- Sediment samples were collected from the drainage ditch north of the Eastern Drainage Ditch, the Eastern Drainage Ditch, the Western Drainage Ditch and the confluence area. Sediment samples were collected from the upper three inches of sediment ("A" interval), in 3-foot horizons from three inches into the sediment to the top of the clay substrate "B" interval and from the clay substrate ("C" interval). Total PCB aroclor concentrations in site sediments ("A" and "B" intervals) ranged from 0.74 mg/kg to 320 mg/kg while TPH/DRO concentrations ranged from 61 mg/kg to 240,000 mg/kg. Total PCB and TPH/DRO concentrations in the "C" interval (clay substrate) ranged from below detection limits to 9.90 mg/kg and from below detection limits to 57,000 mg/kg (refer to Section 7.1).

- Sediment samples were collected from the Western Drainage Ditch, north (upgradient) of Dam C during May 2001. The highest petroleum hydrocarbon and PCB concentrations (ranging from 76,000 to 150,000 mg/kg and 21.0 to 45.0 mg/kg, respectively) were measured in the sample collected at a depth of 0 to 0.5 feet below the surface of the saturated sediment material at each location. The lowest petroleum hydrocarbon and PCB concentrations (ranging from 850 to 8,800 mg/kg and 0.1 to 2.5 mg/kg, respectively) were reported in the deepest sample (collected at a depth of 3.5 to 4.0 feet below the surface of saturated material and in the clay) at each location. The data also indicates that the saturated material above the clay consisted of 66.5% to 78.8% water (refer to Section 7.1).

Surface Water

- Dry weather and storm water surface water samples were collected from site drainage features for PCB congener analyses. The dry weather and storm water total PCB congener concentrations for samples collected at Outfall 006 (the most downgradient sampling location) were 108,818.17 pg/l (0.109 ug/l) and 121,707.40 pg/l (0.122 ug/l), respectively. Higher total PCB congeners were reported in surface water samples collected upgradient of this location. A sample collected from water coming onto the site through Outfall 006 as a result of tidal conditions reported 2,873 pg/l (0.0029 ug/l) total PCB congeners (refer to Section 7.3).

- Surface water is also monitored in accordance with an NPDES permit. A new NPDES permit (DE0050962) became effective May 1, 2006 and includes monitoring for PCB congeners. Prior to the implementation of the new NPDES permit, the only detection of PCBs (detection limit of 0.5 ug/l) in locations receiving run-off from the former fueling area (Outfalls 001, 005, and 006) occurred during January 2006. During January 2006, total PCB aroclors were reported at a concentration of 0.710 ug/l at Outfall 006. PCBs were not detected in any of these subsequent sampling events. Oil and grease was reported at a concentration of 17 mg/l in Outfall 005 (above the permit standard of 15 mg/l) during January 2006, but was below the permit standard in February 2006 and subsequent sampling events.

Groundwater/LNAPL

- Groundwater samples were collected on July 1, 1998 from all wells that did not contain measurable liquid phase hydrocarbons (LPH). Groundwater samples were collected from monitoring wells MW-1, MW-2, MW-3, MW-4, MW-8A, MW-11, MW-12, MW-13 and MW-14. TPH-DRO concentrations ranged from 0.22 mg/l (MW-12) to 45 mg/l (MW-8A). In general, wells away from the former fueling area (MW-1, MW-2, MW-3, MW-11, MW-12, and MW-13) reported lower TPH-DRO concentrations (0.22 mg/l to 6.3 mg/l) while wells closer to the former fueling area (MW-4, MW-8A and MW-14) reported higher TPH-DRO concentrations (19 mg/l to 45 mg/l) (refer to Section 3.2).

- Groundwater monitoring was included in the diesel fuel remedial program. Groundwater monitoring data is summarized in **Appendix G**. In general, the wells located at a greater distance from the former fueling area reported lower TPH-DRO concentrations than the wells closer to the former fueling area. Because of the heterogeneous nature of the subsurface materials at the site, the water chemistry at each well location will reflect local subsurface conditions. The groundwater generally has a low redox potential (less than 0 mV) and low dissolved oxygen content (less than 1.0 mg/l in the majority of the wells sampled; discussion of anaerobic biodegradation is provided below).

- As previously described, review of the historic groundwater monitoring data indicates that natural attenuation of dissolved hydrocarbons is occurring in most of the site wells that do not contain free product. The data suggests that the groundwater system is limited by the availability of electron acceptors for aerobic biodegradation (primarily oxygen and nitrates) as evidenced by the elevated concentrations of dissolved iron and manganese (characteristic of anaerobic biodegradation). Although natural attenuation is occurring, the availability of oxygen in the subsurface is limited because it is consumed at a rate faster than it is recharged to the system through percolating rainfall. As separate-phase product is recovered and dissolved petroleum hydrocarbons are degraded, dissolved TPH-DRO concentrations will decrease.

- **Figure 3-6** presents the apparent product thickness measurements recorded on March 21, 2007 from all monitoring wells and test pit standpipes.

- During the Phase I RI, product samples were also collected from monitoring wells, standpipes, the Western Drainage Ditch and a sump located at the base of the sand tower for PCB content. PCB content in product samples collected ranged from below detection levels (sand tower sump) to 72.3 mg/kg (in the Western Drainage Ditch at Dam C). All PCBs detected in product were PCB aroclor 1260 (refer to Section 2.1).

- On October 24, 2001, oil samples were collected from recovery wells and standpipes installed in the recovery trench system for PCB analyses. As indicated, PCB concentrations (all aroclor 1260) in oil samples ranged from 2.8 mg/kg (Sump #1) to 69.0 mg/kg (SP-6). In general, the highest PCB concentrations were detected in the western (RW-5) and southern (SP-6 and SP-9) portion of the area covered by the recovery trenches (refer to **Table 3-1)**.

- On September 13, 2005, oil samples were collected from test pit standpipes TP-101, TP-105, TP-106, TP-114, and TP-115 for PCB aroclor analyses (refer to **Table 3-2**). Total PCB concentrations ranged from below detection limits (TP-101) to 299 mg/kg (TP-106). PCB aroclors 1254 and 1260 were detected in test pit standpipes TP-105 and TP-106. Only PCB aroclor 1260 was detected in test pits standpipes TP-114 and TP-115 located to the east of the recovery trench containing RW-1 and RW-4. As described in Section 3.2.1, an additional recovery trench was installed in April 2007 to prevent the southerly movement of product from the area of TP-101 and TP-106.

13.1.4 Contaminant Fate and Transport

In the Former Fueling Facility, light non-aqueous phase liquids (LNAPL) in LNAPL-saturated aquifer materials migrate on top of the capillary fringe/water table from former fueling area in the direction of decreasing hydraulic gradient, towards groundwater discharge areas. In the vicinity of the former fueling area, the water table aquifer discharges to the adjacent drainage features and LNAPL may emanate in these drainage channels as LNAPL seeps or sheens. Interim remedial measures implemented at the site included: product recovery; identification and removal/closure of abandoned pipes or conduits which may serve as preferential pathways for LNAPL movement; and management of sheens observed on site drainage features through a sorbent boom maintenance program and dams installed in site drainage ditches. Vertical migration of LNAPL and PCBs is inhibited by a dense clay layer encountered beneath the Former Fueling Facility and in all site drainage features where sediment samples were collected.

In the Former Fueling Facility, the groundwater is oxygen deficient and biologic degradation occurs primarily under anaerobic conditions. Soil analyses indicate that hydrocarbon utilizing bacteria do occur although their activities are limited by the lack of oxygen. Anaerobic degradation appears to result in generation of soluble ferrous iron which may result in the rust color staining in the Western Drainage Ditch. Since groundwater is not used at the site and there are no occupied buildings in the Former Fueling Facility, discharge to surface water is the most significant groundwater receptor. Surface water data collected during NPDES monitoring at locations adjacent to the Former Fueling Facility is reviewed in order to monitor surface water chemistry.

PCBs in site surface soils are a potential source for PCBs in site surface water and sediments. Surface soils may be washed into site drainage features during storm events. Erosion and sediment control measures implemented in the Outfall 004 drainage area reduced PCB concentrations in surface water monitored at Outfall 004 by 94%.

Dams have been installed in the Eastern Drainage Ditch (Dam B), the Western Drainage Ditch (Dam C), and in the confluence area (12th Street Dam). During 1999 and 2000, the integrity of these dams was upgraded by the placement of steel sheet piling in the upstream side of each dam. A 90° downward extending fitting was placed on the inlet piping on the upgradient side of each dam. The dam construction makes them effective in preventing the movement of floating product through the dams and effective sediment traps.

The site is situated in a historically industrialized area of Wilmington. Properties to the east and west of the AMTRAK facility contribute storm water to site drainage features. In addition, PCBs from sites along Brandywine Creek may also move onto the site as a result of the tidal conditions at Outfall 006. As described previously, PCBs have been detected in surface water moving onto the site through Outfall 006 during tidal reversal.

13.1.5 Baseline Risk Assessment

The Phase II RI included additional human health risk assessment and ecological investigations. These activities are summarized below.

Revised Human Health Risk Assessment

The human health risk assessment (HHRA) presented in the Draft Phase I Report has been revised to include additional exposure scenarios and more recent site data. In addition to youth and adult trespasser exposure to soil (included in the Phase I HHRA), industrial/commercial worker exposure scenarios were also considered.

Since soil in the former roundhouse area contains elevated PCB concentrations compared to the rest of the site, two exposure areas of concern were evaluated. These consist of the former roundhouse area and the site-wide area (exclusion of the former roundhouse area).

Risk analyses determined that the reasonable maximum exposure (RME) concentrations of constituents of concern do not exceed DNREC or USEPA target risk levels for site-wide soils and former roundhouse area soils. The former roundhouse area is fenced and there are no active site operations inside the fenced area.

Ecological Assessment

Phase II RI ecological field sampling was performed to further characterize the ecosystem within the AMTRAK ditches and assess the potential effects of constituents of concern on that ecosystem. Macroinvertebrate, fish, and turtle sampling was performed seasonally in spring, summer, and fall over a two year period to examine seasonal variations. Sampling was performed in the AMTRAK ditches and Conectiv Impoundment at approximately the same stations as in the Phase I RI. Sampling was also performed in the City Ditch and the lower portion of Shellpot Creek to provide additional data for comparison with the AMTRAK ditches and further evaluate variation in biological communities within and between sampling locations.

The Phase II ecological sampling supported the conclusions of the Phase I ecological assessment and further demonstrated that a functional aquatic ecosystem exists within the AMTRAK ditches. The ecological communities in the AMTRAK ditches are similar to, or are of higher quality than those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area.

13.1.6 Applicable Local, State and Federal Requirements

Applicable local, state and federal environmental requirements that will be considered for the development and screening of remedial alternatives are summarized below.

CERCLA requires that actions performed as part of a remediation of a release of hazardous substances are in compliance with applicable or relevant and appropriate requirements. The purpose of this section of the report is to summarize the regulations that are applicable to the remedial alternatives presented in this study. The applicable regulatory requirements are used as a guide for development of remedial action objectives, to evaluate remedial alternatives and to govern the implementation and operation of the selected remedy (DNREC, 1994).

There are essentially three types of applicable regulations considered in the FFS. These three types of regulations include chemical specific, action specific and location specific regulations. Chemical specific requirements are generally risk or health based considerations and limit the amount or concentration of a chemical in a particular media. Action based requirements are usually technology based requirements or actions taken with respect to hazardous wastes. Location specific requirements are restrictions placed on the concentrations of hazardous substances because they occur in a special location or are requirements that restrict actions because of the characteristics of a site or its immediate environs. The potential chemical, action and location specific requirements that may pertain to the various remedial alternatives are identified below.

The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (as further amended, herein referred to as RCRA) established the federal program regulating solid and hazardous waste management. RCRA allows EPA authority to control hazardous waste, including the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes.

Regulations developed as a result of RCRA include 40 CFR 261, Identification and Listing of

Hazardous Waste; require the proper identification, manifesting, transportation and disposal of wastes. Any soils removed from the site for disposal must be properly characterized and disposed according to these regulations.

Excavated soils from the site must be properly characterized and disposed. Should any soil be determined to be a characteristic hazardous waste, land ban regulations (40 CFR 268) may prohibit their disposal by landfill. Soils which are identified as hazardous wastes should be treated onsite prior to being disposed in a landfill, or disposed in a permitted incinerator. All soils designated for off-site disposal will be properly characterized. At this time, no soils are anticipated to be classified as hazardous wastes under RCRA regulations.

Delaware Regulations Governing Hazardous Waste would also be applicable to the characterization and disposal of site wastes. These regulations would require similar identification, tracking and disposal requirements as RCRA regulations.

The Clean Water Act (CWA) establishes requirements for actions that affect surface water. Some of the applicable CWA requirements are reinforced by Delaware's Regulations Governing the Control of Water Pollution and Surface Water Quality Standards. These requirements include concentration limitations on specific contaminants of concern.

Additional CWA regulations, reinforced by Delaware's Wetlands regulations, include specific requirements to the disturbance of wetlands. Wetlands have been identified at the site. As these wetlands are established, any disturbance of these wetlands would require a permit and possibly wetlands restoration or mitigation pursuant to the appropriate regulations, including 40 CFR 230 and 33 CFR 323.

The Toxic Substances Control Act (TSCA) is an extensive statute allowing EPA the ability to track the numerous chemicals currently produced or imported into the United States. TSCA allows EPA to track chemicals, require testing of certain chemicals, develop specific regulations related to the use and/or disposal of certain chemicals, and in some cases, ban or limit the production and/or use of chemicals.

Management of PCBs, including the remediation of PCB contaminated sites and the disposal of PCB-contaminated materials, is controlled by regulations developed under the authority of TSCA. 40 CFR 761 sets specific requirements for materials, including site soils, contaminated by PCBs. These regulations set specific requirements for the characterization, remediation and disposal of PCB soils.

EPA issued the Polychlorinated Biphenyl (PCB) Site Revitalization Guidance under the Toxic Substances Control Act (TSCA) (PCB Guidance) in November 2005. This PCB Guidance document will be used as a reference throughout this FFS and in developing and implementing the appropriate remedial alternative.

The Delaware Hazardous Substance Cleanup Act (7 Del. C., Chapter 91) provides the regulatory basis for cleanup. The Delaware Regulations Governing Hazardous Substances Cleanup provide the basis for the Voluntary Cleanup Program under which this site is currently being remediated.

The Delaware Coastal Zone Act is not applicable as the site lies outside of the area identified as the coastal zone.

The Delaware River Basin Commission (DRBC) implemented the Pollutant Minimization Plan for PCBs (PMP) process in accordance with the Delaware River Basin Commission (DRBC) PMP Rule 4.30.9. The PMP process was implemented to reduce PCB loadings to the Delaware River Estuary.

Remediation Standards Guidance under the Delaware Hazardous Substance Cleanup Act (DNREC, December 1999) provides media-specific numeric Uniform-Risk-Based Standards (URS) for the protection of human health and the environment. The guidance also allows for the development of site-specific standards established using a traditional EPA risk assessment approach that characterizes the risk posed by a site and allows pathway elimination remedial options that can eliminate complete exposure pathways.

13.1.7 Remedial Action Objectives

Remedial action objectives are medium-specific or unit specific goals developed to protect human health and the environment. Remedial action objectives were developed considering the contaminants of concern and the exposure routes and receptors. The objectives consider the current and future uses of the site, the use and level of contamination of surrounding properties, facility specific risk assessments, and applicable laws and regulations. Remedial action objectives can be qualitative or quantitative.

The remedial action objectives for the site are to limit the risk posed by site sediments and to limit potential future contamination of those sediments by Site soils and light non-aqueous phase liquids (LNAPL) in the subsurface. The risks may be reduced through pathway elimination or by removal of contaminated material to acceptable levels. Remedial action objectives have been developed for sediments, surface soils and the LNAPL in the subsurface.

DRBC approved Resolution No. 2005-9 to amend the *Water Quality Regulations* and *Comprehensive Plans* on May 18, 2005. Under this Resolution, DRBC desires to achieve a 50 percent reduction on the aggregate loads of total PCBs to the Delaware estuary within five years. The Delaware River Estuary has been classified by EPA, and the states of Delaware, New Jersey, and Pennsylvania as impaired because it exceeds water quality standards for PCBs. As a result, EPA established total maximum daily loads (TMDLs) for PCBs based on attaining water quality criteria for Zones 2 (from Trenton, NJ to approximately Philadelphia, PA) through Zone 6 (Delaware Bay). DRBC established regulations to require PMPs to reduce PCB loading from facilities located within the Delaware River Estuary. One forerunner of these PMP requirements was an award-winning (Water Resources Association of the Delaware River Basin, Business and Industry Award, 2005) sediment reduction and erosion control program implemented in the Outfall 004 drainage area. As described in Section 3.3, these measures resulted in a 94% reduction in PCB concentrations in surface water from Outfall 004.

Remedial Action Objectives were identified in DNREC's August 12, 2002 letter to AMTRAK. This letter stated "For those alternatives not eliminating exposure to contaminants of concern altogether, such as excavation or encapsulation of contaminated sediments, additional work, in certain cases, be required to determine cleanup concentrations for PCBs and diesel fuel compounds". This suggests that pathway elimination for contact with sediments may be an acceptable alternative to numeric standards. DNREC identified the following as remedial objectives.

Qualitative remedial action objectives identified by DNREC include:

- Reduce risk to Site ecological receptors (fish, herptiles, aquatic macroinvertebrates and vegetation) to acceptable levels,

- Reduce the movement of contaminants into the Brandywine Creek to acceptable levels

Quantitative remedial action objectives identified by DNREC include:

- HSCA Standards (URS)

- Eliminate exposure of ecological receptors to concentrations of PCBs and diesel fuel compounds in sediments that result in significant mortality or impaired growth and reproduction.

- Eliminate exposure of fish to concentrations of PCBs in sediment and surface water that result in near-lethal body burdens or significant reproductive and metabolic effects.

- Reduce concentrations of PCBs in sediment that cause exceedances of surface water criteria for aquatic life: 2.0 ug/l (2,000,000 pg/l) (freshwater acute) and 0.014 ug/L (14,000 pg/l) (freshwater chronic)

- Reduce the mass loading of PCBs from the Refueling Facility to levels that do not result cause exceedances of the surface water quality criterion for the protection of human health: 0.056 ng/l (56 pg/l) in both the on-site ditches and the Brandywine Creek.

- Reduce the mass loading of PCBs from the Refueling Facility to levels that do not result in State-issued fish consumption advisory (fish tissue concentrations greater than 29 ppb in edible muscle).

However, there is no human consumption of fish from the site drainage features. As a result, sediment standards (and resulting water quality standards) based on human consumption of fish do not apply to site drainage features. Furthermore, findings from the Phase I ecological investigations indicated that biota-sediment accumulation factors (BSAF) for PCBs used in the calculation of bioaccumulation-based sediment quality criteria for the protection of human health, are not representative of conditions in the AMTRAK ditches (refer to Section 11.1.1). Therefore, numeric standards based on a non-representative BASF are not appropriate for the AMTRAK ditches. The Phase II ecological assessment indicated that the ecological communities in the AMTRAK ditches are similar to, or are of higher quality than those in the comparative sampling locations, and are typical of the communities found in ponds and small impoundments in the area and functional ecosystems exist in the AMTRAK ditches.

The low level (56 pg/l) PCB water quality criterion mentioned in the DNREC letter is not attainable and are not applicable to this site. As has been discussed, the sampling of water moving onto the AMTRAK property (through Outfall 006 during tidal reversal) from the Brandywine Creek reported a total PCB congener concentration of approximately 3,000 pg/l (i.e., two orders of magnitude higher than the standard).

The DNREC letter was prepared prior to the DRBC adoption of the PMP approach to reducing PCB loadings to the Delaware Estuary. The following remedial action objectives are proposed for this site and are consistent with the PMP and NPDES permit already in-place at the site. By meeting the remedial action objectives for PCBs described below for sediment and soils, petroleum hydrocarbon occurrence in these media will also be addressed.

13.1.7.1 Sediments

The remedial action objectives for sediments include reducing exposure of ecological receptors to site sediments, minimizing the pathway for potential migration of PCBs in sediments, and managing surface water contact with PCBs in sediments in order to reduce PCB concentrations in surface water and reduce the PCB loading from the site.

13.1.7.2 Surface Soils

Remedial action objectives developed for the surface soils include minimizing the migration of PCBs in surface soils to the drainage ditches which is consistent with the PMP for the site. Control of soil erosion would minimize the migration of PCBs in surface soils to site sediments and will prevent the future re-contamination of sediments and aid in the realization of the sediment remedial action objectives.

The remedial goal is also to be protective of human exposure to site soils to the established DNREC criteria of 1E-05 for carcinogens and a Hazard Index of less than 1.0, for non-carcinogens.

13.1.7.3 LNAPL in Subsurface/Groundwater

Efforts are on-going to recover and contain LNAPL movement in the subsurface at the Site. The remedial action objectives for LNAPL on the water table surface include reducing the quantity and mobility of LNAPL in the subsurface in order to prevent LNAPL and PCBs in the LNAPL from impacting site surface water and sediments.

Recovery of LNAPL will be performed to the extent practical (as discussed in EPA Guide for State Regulators EPA 510-R-96-001). Practical objectives for the recovery of LNAPL provided in the EPA

Guide include 0.10 feet of apparent product thickness on the water table over 2 years of monitoring; product recovery of less than 2 gallons/month; and less than 0.02 ratio of product recovery to water pumped.

The strategy for addressing groundwater within the Former Fueling Facility considers the risk to human health and the natural biodegradability of the constituents of diesel fuel. Exposure to groundwater was not considered in the human health risk assessment because potable water in the vicinity of the site is supplied by the City of Wilmington and there are no occupied buildings (for inhalation exposure scenarios) in the Former Fueling Facility. Data collected at the site indicates that groundwater beneath the vicinity of the former fueling area discharges to the site drainage features. As a result, the only receptors of concern are the discharge of groundwater to the Eastern and Western Drainage Ditches.

Surface water quality within the drainage ditches has been and will continue to be monitored at several locations. As described in Section 3.2.5, NPDES outfall locations 001, 003, 005, and 006 receive drainage from both the Former Fueling Facility as well as adjacent properties. Surface water monitoring will continue under the new NPDES permit. Data collected as part of the NPDES monitoring program will be evaluated as part of the remedial action in order to monitor surface water leaving the site. As has also been discussed, the ecological communities in the AMTRAK ditches are similar to, or higher quality than those in the comparative ecological sampling locations, and are typical of the communities found in ponds and small impoundments is the area.

Woodward Clyde (1981) recommended that the existing site drainage features be used as sediment traps to reduce PCB transport in storm water. As described previously, the dams in the Eastern Drainage Ditch, Western Drainage Ditch and confluence area were upgraded between 1999 and 2001 allowing them to function as more effective sediment traps (refer to Section 2.1.2). Also, ecological investigations indicate that the ecological communities in AMTRAK ditches investigated are of similar or higher quality than those in comparative sampling locations.

The rate of natural biodegradation of dissolved diesel fuel components will be enhanced as product is removed from the subsurface. As the mass of hydrocarbons in the subsurface is reduced from product recovery, the relative flux of oxygen to the subsurface from precipitation will increase.

Once LNAPL remedial objectives have been attained, the groundwater sampling of perimeter monitoring wells for laboratory analyses will be performed to monitor/verify natural attenuation processes. Monitoring will continue until HSCA Standards for petroleum hydrocarbons (using

EPH/VPH analyses of groundwater samples) can be attained in order to be protective of surface water quality leaving the site.

13.1.8 Volumes of Contaminated Media

This FFS has been prepared primarily to address sediments in the Eastern Drainage Ditch, Western Drainage Ditch and Confluence Area as described in the Phase II RI/FFS Work Plan. Additional media, including site soils and LNAPL, are also addressed in this FFS to prevent future impact to sediments by these media. The contaminant of concern for all media, as addressed by this FFS, is PCBs. In addressing PCBs in sediments, petroleum hydrocarbons in sediments will also be addressed. The remedial alternatives distinguish between PCB concentrations at and above 50 milligrams per kilogram (mg/kg) and below 50 mg/kg in drainage ditch bank soils and sediments based on TSCA soil criteria.

Sampling has shown evidence of PCBs in the sediments in the drainage ditch north of the Eastern Drainage Ditch, Eastern Drainage Ditch, Western Drainage Ditch and Confluence Area. The total estimated volume of sediments in site ditches is approximately 64,000 cubic yards of sediment. This sediment volume and sediment and bank soil volumes described below include all material above the clay substrate within each area. For the purposes of remedial alternatives development, and based on the results of remedial investigations, sediments volumes by drainage feature are summarized as follows:

- Drainage Ditch North of the Eastern Drainage Ditch (north of Railcar Avenue; sediment sample locations NED-1 through NED-12) – approximately 5,400 cubic yards (less than 50 mg/kg total PCBs).

- Eastern Drainage Ditch and drainage ditch to the south of Railcar Avenue – approximately 49,800 cubic yards (assumed to be greater than 50 mg/kg PCBs for practical alternative development). This volume includes bank soils with PCB concentrations greater than 50 mg/kg adjacent to sediment sample locations NED-13, NED-14 and NED-15 (approximately 2,200 cubic yards), since the channel in this area is not well defined.

- Western Drainage Ditch – 6,200 cubic yards of sediment (less than 50 mg/kg total PCBs) and 300 cubic yards of sediment (greater than 50 mg/kg total PCBs; assumed to be the 100 foot section of the ditch centered at sediment sample location WDT-1).

- Confluence Area: 550 cubic yards (greater than 50 mg/kg PCBs; area of transects CAT-1) and 1100 cubic yards (less than 50 mg/kg PCBs; area of transects CAT-2 and CAT-3).

Soils with detectable PCBs occur throughout the area of investigation. In defined areas, such as areas adjacent to the Eastern Drainage and in the former roundhouse area, total PCB concentrations exceeded 50 mg/kg. General areas reporting PCB concentrations in soils at or above 50 mg/kg are depicted on **Figure 13-1**. As noted above, bank soils with PCB concentrations greater than 50 mg/kg adjacent to sediment sampling locations NED-13, 14 and 15 (refer to **Figure 7-6**) were included in the sediment volume previously presented. The remaining areas are described as follows:

- Bank soil sample EDT-4W area (western bank of Eastern Drainage Ditch) – 9,150 cubic yards
- Bank soil sample EDT-14W area (western bank of Eastern Drainage Ditch) – 16 cubic yards
- Bank soil sample EDT-14E area and discrete upland (subdrainage) surface soil sample E-1A area (eastern bank of Eastern Drainage Ditch) – 960 cubic yards
- Former roundhouse area – approximately 3,500 cubic yards

An estimate of LNAPL volume in the subsurface was presented in the Diesel Fuel Remedial Work Plan. The results of the product bail-down testing and liquid level measurements collected prior to implementation of IRM activities were evaluated to develop an order of magnitude estimate of the volume of liquid-phase product at the site. By evaluating the extent of product occurrence, interpolating average "true" product thickness (estimated from bail-down tests) in areas of product of occurrence and considering estimates of the porosity of saturated aquifer materials, the volume of liquid-phase product was estimated to be on the order of 30,000 to 50,000 gallons. This volume is considered a rough estimate since volume calculations are influenced by factors such as: the interpretation of product bail-down test data; liquid (groundwater and product) level fluctuations; the groundwater/product elevation at the time of bail-down testing; well diameter; aquifer heterogeneity; preferential product movement; and capillary forces near the water/product interface. As has been described previously, apparent product thicknesses in wells at the site fluctuate based on the water table elevation. USEPA (1995) indicates that only 20% to 30% of the total product release is typically recovered (approximately 6,000 to 15,000 gallons). The percentage of the total product that is recoverable depends on factors such as product physical properties (such as viscosity), residual water saturation in the formation, aquifer heterogeneity, hydraulic conductivity of aquifer materials and other factors. As described previously, approximately 15,200 gallons of product have been recovered at the site though December 2006.

13.2 Treatability Studies

As described in the Phase II RI/FFS Work Plan and noted above, this FFS is focused on sediments in the site drainage ditches. In order develop remedial alternatives for site sediments, laboratory-scale treatability studies on sediments were performed. Sediment laboratory-scale treatability tests performed by IT Corporation during 2001 and by SECOR during 2006 are described below. As will also be discussed, other field activities were performed that could be considered field pilot tests.

As discussed in Section 5.6, wetland vegetation was placed over an approximately 100 foot section of the Western Drainage Ditch between Dam C and the Confluence Area (refer to **Figure 5-11**). The wetland plantings were installed during August 2006. The plantings were placed in order to evaluate if selective plantings can reduce the iron content in surface water in the Western Drainage Ditch as well as to evaluate which plants will grow in the sediment conditions in the Western Drainage Ditch. The plantings should function to locally provide oxygen to the surface water, filtering the surface water to reduce particulate material; uptake dissolved organic compounds and improve overall water quality. As of May 18, 2007, the plants were still emerging from their winter/dormant conditions. However, based on visual observations, it appears that all plant species placed will thrive in the sediment conditions of the Western Drainage Ditch.

The implementation of the sediment reduction and erosion control measures in the Outfall 004 drainage area was described in the Section 3.3. Surface water monitoring performed before and after implementation of these measures indicated a significant reduction of PCB concentrations in storm water run-off. This field verifies that the implementation of erosion control best management practices (BMPs) can significantly reduce PCB concentrations in storm water run-off.

13.2.1 Western Drainage Ditch Sediments Treatability Testing - 2001

Treatability studies were performed on the sediment samples collected from the Western Drainage Ditch. These studies were performed by the IT Corporation Technology Development Laboratory in Knoxville, Tennessee in order to begin evaluating remedial alternatives for the portion of the Western Drainage Ditch north of Dam C. The specific objectives of the studies included:

- Determination of the dosage of different drying agents in order to pre-treat the sediments prior to off-site disposal;
- Determination of dosage of different reagents that will achieve a compressive strength necessary such that future capping can be accomplished; and

- Development of a formulation that will produce a material that will minimize organic leaching.

The results of these treatability studies for the Western Drainage Ditch material are presented in **Appendix V**.

13.2.2 Eastern Drainage Ditch and Confluence Area Sediments Treatability Testing - 2006

Treatability testing was performed by SECOR on sediment samples collected from the Eastern Drainage Ditch and the confluence area for evaluation of stabilization and capping remedial options. The treatability testing showed that stabilization with lime provided no actual destructive treatment of PCBs, but that stabilization was able to reduce PCB leachability. However, the testing also showed that remedial capping would provide similar benefits to stabilization at potentially much lower costs.

There are three primary goals for a sediment capping program:

- Reduce the flux of dissolved contaminants into the water column from the sediment.
- Physically isolate the contaminated sediments from the benthic environment.
- Prevent re-suspension and transport of impacted sediments by erosion.

The results of the treatability testing indicated that all three of these goals can be achieved by installation of a remedial cap consisting of bentonite-coated gravel and sand.

Flume tests and column tests show that PCBs at the AMTRAK facility are highly insoluble and that the majority of PCBs enter the water body by the erosive forces of water. Testing shows that the PCBs have a high organic carbon partitioning coefficient, and that the high organic content of the sediment (TOC = 16%) tends to keep the PCBs in the adsorbed state. The maximum solubility for PCBs in non-turbid water observed during testing was 0.1 ug/l. However, when water was transferred across sediment in a flume at a velocity of 2 ft/min, the concentration of PCBs in the water increased nearly two orders of magnitude to 8 ug/l in the turbid water. High concentrations of suspended solids were observed in the water at flume velocities greater than 2 ft/min, thus confirming that fine, organic-rich particles were the primary transporter of PCBs into the water body.

Regular bentonite materials were tested as a capping material but were found to swell too much to be useful since they were easily scoured due to their gelatinous nature. However, when bentonite was mixed with other materials, it produced a low-permeability capping material that was resistant to erosion and was capable of supporting a protective sand covering. In particular, bentonite-coated gravel sold under the trade name of AquaBlok® performed very well at resisting erosion while also supporting an overlying sand layer. Testing of the bentonite/sand cap showed that it could resist erosion and reduce PCB transport in both dissolved and adsorbed states. With the cap in place, the moving water in the flume appeared clear at water velocities up to 10 ft/min. Tests showed that the suspended solids in water were reduced significantly by capping, and that the PCB concentrations were reduced 80-fold. Based on the results of the treatability study, an in-situ capping remedial action alternative was developed. This treatability study report is presented in **Appendix W**.

13.3 Development of Remedial Action Alternatives

The following discussion provides identification of remedial response actions, identification and screening of remedial technologies and process options, and development of remedial action alternatives.

Based on the results of the site investigations and remedial action objectives, remedial action alternatives have been developed for the following media:

- Sediments in site ditches and bank soils with total PCB concentrations greater than 50 mg/kg, ,
- Site-wide surface soils,
- Soils in the former roundhouse area, and
- LNAPL in the subsurface.

13.3.1 Identification of Remedial Response Actions

<u>Sediments</u>

A focused list of potential remedial alternatives for site sediments was presented in the Phase II RI/FFS Work Plan. Potential response actions for drainage ditch sediments include:

- No action/maintenance of existing sediment controls
- Containment

- Removal/Disposal
- Stabilization

Management of PCB impacted sediment within on-site drainage ditch to prevent their re-suspension and potential off-site migration will also be considered.

Soils

As described previously, additional response actions are considered for other media to be protective of site drainage features. PCBs in site soils may potentially be washed into site drainage features during storm events. Therefore, site soils will be addressed. As has been described, the former roundhouse area contains soils within a small geographically area with higher PCB concentrations than in site-wide soils. These soils may also be potentially washed into site drainage features during storm events. Therefore, soils in the former roundhouse area will also be addressed. Potential response actions for soils include:

- No action,
- Capping/containment,
- Erosion and sedimentation control measurers (BMPs) (site-wide soils only),
- Removal (roundhouse area soils only)

LNAPL

LNAPL recovered as part of the on-going diesel fuel recovery operations contains approximately 10 to 20 mg/kg PCBs. Therefore, potential LNAPL migration to site drainage features would also be addressed. Potential response actions for LNAPL include:

- Collection and recovery of LNAPL (continue operation of the current recovery system) and
- Interception/containment of all LNAPL prior to migration to site ditches (continue operation of the current recovery system with the addition of perimeter recovery trenches).

These general response actions will be combined to prepare a comprehensive remedy to meet remedial objectives.

13.3.2 Identification and Screening of Technology Types

PCBs are not volatile, have a low solubility in water and have a high tendency to sorb to soil and sediment particles. Transport of PCBs adsorbed to soils through soil erosion processes and transport of PCBs adsorbed to sediments in site ditches are the primary mechanisms of PCB mobility in the environment as demonstrated through bench-scale treatability testing (refer to Section 13.2.2). Soil capping, soil removal and implementation of erosion control and sediment reduction measures are effective technologies for reducing the mobility of PCBs associated with soils. Ingestion of suspended solids containing PCBs at the lowest levels of the food chain may result in the bio-magnification of PCBs in animal tissue at higher levels of the food chain. Capping and encapsulation remedies effectively block this exposure pathway at the lowest levels of the food chain and have proven to be very effective technologies to remediate PCB impacted materials.

LNAPL containing PCBs on the water table surface is another PCB migration mechanism at the Site. LNAPL recovery and containment technologies are effective methods of addressing PCB mobility associated with LNAPL on the water table surface.

For purposes of the FFS, soils and sediments will be addressed generally through erosion control and sediment reduction measures/best management practices (BMPs), and capping/encapsulation remedies. Nonetheless, excavation and off-site disposal alternatives are also presented. LNAPL on the water table surface would be addressed through LNAPL recovery and interception/containment. Recovered LNAPL containing PCBs will be transported off-site for disposal in accordance with TSCA, most likely incineration.

13.3.3 Identification and Screening of Process Options

The technologies that will be retained for further evaluation are removal, capping/encapsulation and erosion control and sediment reduction measures/(BMPs). The removal and capping/encapsulation alternatives will be utilized to address impacted sediment and soil. Erosion control and sediment reduction measures (BMPs) will also be considered for surface soil. LNAPL on the water table surface will be addressed through LNAPL recovery and interception/containment.

The process options that will be evaluated for capping and encapsulation of sediments in the on-site ditches (Drainage Ditch north of the Eastern Drainage Ditch, Eastern Drainage Ditch, Western Drainage Ditch, and Confluence Area) are defined below:

- Encapsulation of existing drainage ditches by stabilizing sediments, filling ditches in with soil, and providing a cover over the sediments to prevent direct contact with aquatic life or surface water. New drainage ditches would be constructed through non-impacted soils;

- Removal of sediments and bank soils (with PCB concentrations in excess of 50 mg/kg) from and adjacent to the existing on-site drainage ditches. Excavated soils and sediments would be disposed off-site at an appropriately licensed land disposal facility;

- In-situ capping of ditch sediments with PCBs using the AquaBlok® or equivalent technology (refer to Section 13.2.2). The AquaBlok® technology utilizes bentonite coated gravel to form a low-permeability direct contact barrier; and

- Creation of sedimentation basins within the ditches. The sedimentation basins would allow sediments to settle within the basins, preventing the migration of site soil and sediments from the site.

The process options that will be evaluated for site-wide soils are defined below:

- Capping of PCB impacted soils with geotextile and a minimum one foot earthen cap. A vegetative cover would be established over the capped area to prevent future erosion in these areas; and

- Implementation of erosion control and sediment reduction measures (similar to those used in the Outfall 004 area project).

The process options that will be evaluated for roundhouse area soils are defined below:

- Excavation of PCB impacted soils with PCB concentrations at or above 50 mg/kg. Excavated soils would be disposed off-site at an appropriately licensed land disposal facility, and

- Capping of PCB impacted soils with geotextile and a minimum one-foot earthen cap. A vegetative cover would be established over the capped area to prevent future erosion in these areas:

The process options that will be evaluated for LNAPL are collection and recovery which is consistent with the on-going diesel fuel recovery operations. LNAPL present on the groundwater would be prevented from migrating to on-site drainage ditches by collecting the LNAPL in high permeability collection trenches. The LNAPL collected in the high permeability trenches would be recovered using pumps installed in recovery sumps. All recovered LNAPL would be pumped to storage tanks until sufficient volume has been generated to make handling and transportation to an off-site TSCA incinerator efficient.

13.4 Description of Remedial Action Alternatives and Preliminary Screening

The remedial technologies and process options retained from the discussion presented above, were developed into remedial alternatives. Based on the results of environmental sampling performed at the site and the layout of the site, the remedial alternatives consider media and areas as follows:

- Sediments which contain PCBs within the on-site storm water drainage ditches; since PCB concentrations equal to or greater than 50 mg/kg have been detected adjacent to portions of the drainage ditch north of the Eastern Drainage Ditch and the Eastern Drainage Ditch, those soils will be addressed with site sediment (refer to Section 13.1.8);

- Upland (subdrainage area) soils within the Site property boundaries; to be consistent with the distribution of the PCBs in site soils, soils in the former round house and site-wide (outside of the former roundhouse) areas will be addressed as separate alternatives; and

- LNAPL in the subsurface containing PCBs on surface

As described in this report, PCBs and petroleum hydrocarbons have been detected in surface and sediment samples collected in a former (believed to have been abandoned)sewer. Since this sewer system is a potential source of these constituents to site drainage features, this sewer system will be properly abandoned/sealed. The procedures for closing this will be developed consistent with facility operations to prevent drainage problems with site operations. Therefore, it can be assumed that closure of this sewer will be included in all alternatives described below.

AMTRAK is considering building a Central Electrification and Traffic Control (CETC) facility for the Northeast Corridor to replace a facility in Philadelphia. The state-of-the-art facility would house the CETC and Consolidated National Operations Center (CNOC) operations in the approximately 66,000 gross square feet of building area, consisting of two floors. The general location where this building would be placed is displayed on **Figure 13-2**. AMTRAK has not yet determined if this building will be constructed. As previously discussed with DNREC, if the building is constructed, a geotextile fabric and at least two feet of clean fill would be placed over the project area. Also, a vapor barrier (designed considering input from DNREC) would be placed beneath the building structure to alleviate concerns with vapor intrusion related to LNAPL in the subsurface. The design of the vapor barrier would be developed (for review by DNREC), once it has been determined that building will be constructed.

The tide gate located along the Brandywine Creek to the south of the site (at the Brandywine Industrial Complex) has not functioned properly for several years. As have been described, water frequently moves on to the site through Outfall 006 as a result of tidal conditions. Therefore, it is assumed that this tide gate would be fixed by the appropriate governmental agency.

The discussion below describes the remediation alternatives for the general groupings of media/location identified above. As such, recommended remedies will be provided for site sediments, site-wide soils, former roundhouse area soils, and LNAPL (Section 13.7) The alternatives will then be preliminarily screened to eliminate alternatives which do not meet the broad screening criterion. The criterion used to screen alternatives includes the effectiveness in meeting cleanup goals, whether the alternative employs acceptable engineering practices, and relative cost. **Table 13-1** summarizes the remedial alternatives and the preliminary screening status.

13.4.1 Sediments in On-Site Drainage Ditches and Bank Soil with PCB Concentrations Greater than or Equal to 50 mg/kg

As described in previous sections of this report storm water runoff from the Former Fueling Facility drains to the Eastern and Western Drainage Ditches. The Eastern and Western Drainage Ditches converge in the confluence area where flow in routed through the 12th Street dam and under 12th Street to the Brandywine Creek. There is a drainage ditch north of the Eastern Drainage Ditch. The reach of this ditch south of a drainage divide flows to the Eastern Drainage Ditch The reach of this ditch to the north of the drainage divide flows to Shellpot Creek. Site drainage features were described in Section 2.1.2 and are displayed on **Figures 1-2** and **1-3.** The results of flow measurements for the site drainage features were described in Section 7.3. As have been described, the site drainage ditches also receive flow from adjacent properties. Also, PCBs have been detected in surface water moving onto the site through the 12th Street Dam during tidal back-flooding.

Six remedial alternatives will be preliminarily screened to determine viable methods to address sediment in on-site drainage ditches. These alternatives are summarized below:

- Maintenance of exiting sediment controls (dams) in the site drainage features.

- Alternative 1 – Stabilization and encapsulation of existing drainage ditch sediments and capping of adjacent bank soils with PCB concentrations greater than or equal to 50 mg/kg and construction of new drainage ditches;

- Alternative 2 – Removal and off-site disposal of sediment from existing drainage ditches and bank soils (equal to or greater than 50 mg/kg PCBs) and restoration and lining the existing ditches with stone revetment to prevent future erosion of the ditches;

- Alternative 3 – In-situ capping of sediments in the drainage ditches, excavation of bank soils (equal to or greater than 50 mg/kg PCBs) adjacent to site ditches and lining the existing ditches with stone revetment to prevent future erosion of the ditches; and

- Alternative 4 – Construction of sedimentation basins within the existing drainage ditches to facilitate the settlement of suspended solids conveyed in storm water from the site and capping bank soils with PCB concentrations equal to or greater than 50 mg/kg.

- Alternative 5 – This alternative includes construction of sedimentation basins draining to constructed wetlands as a BMP (lower Eastern Drainage Ditch and confluence area), re-routing the Eastern Drainage Ditch, stabilization and encapsulation of Western Drainage Ditch and Drainage Ditch north of the Eastern Drainage Ditch, and capping bank soils with PCB concentrations equal to or greater than 50 mg/kg.

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The components of these alternatives are described below.

13.4.1.1 Maintenance of Existing Sediment Controls

Dams were constructed in the Eastern Drainage Ditch (Dam B), the Western Drainage Ditch (Dam C) and the Confluence area (12^{th} Street Dam). These dams were constructed to control the movement of oil and reduce sediment transport (refer to Section 2.1.2 for dam construction). As has been described, maintenance of these dams was performed between 1999 and 2001 to improve the overall integrity of the dams as well as to increase their effectiveness as sediment traps. As also described, surface water monitoring data collected as part of the NPDES monitoring program indicates that these structures have been effective in reducing the transport of PCBs in surface water.

This alternative provides for the continued maintenance of the site dams. However, because this alternative does not result in the further reduction in the PCB loading in surface water from the site, this alternative will not be evaluated any further.

13.4.1.2 Alternative 1 – Stabilization and Encapsulation of Existing Drainage Ditches and Construction of New Drainage Ditches

Alternative 1 would result in the stabilization and encapsulation (filling and capping) of the existing drainage ditch north of the Eastern Drainage Ditch, Eastern Drainage Ditch, Western Drainage Ditch and Confluence Area and the construction of new drainage ditches to replace them. In the process, bank soils (to the top of the clay substrate) with PCB concentrations greater than or equal to 50 mg/kg PCBs and sediments within the existing drainage ditches would be isolated and would no longer represent a complete pathway to aquatic receptors or available for off-site transport. Sediments to the top of the clay substrate would be addressed. As a result, storm water would no longer flow through existing on-site drainage ditches containing PCBs in sediments. Finally, perimeter swales would be constructed along the eastern boundary of the Site to prevent the run-on of storm water from adjacent properties flowing into the newly constructed ditches.

The conceptual layout of this alternative is shown on **Figure 13-3**.

The general scope of work for implementation of this alternative is described below:

- Stabilization of site sediments with cement kiln dust at a 70% mix ratio (refer to Section 13.2.1 for the treatability study). The reagent and the mix ratio may be adjusted based on preliminary field operations. After surface water is diverted, the reagent would be mixed into the site sediments using an excavator with a rotary mix head.

- Fill approximately 2,300 lineal feet of the Eastern Drainage Ditch (south of Railcar Avenue). For purposes of this evaluation, it is assumed the ditch cross section is 120 feet wide by 8 feet deep;

- Construction of approximately 2,400 lineal feet of new channel for the Eastern Drainage Ditch on the AMTRAK property to the east of the current Eastern Drainage Ditch. For purposes of this evaluation, it is assumed that the proposed ditch cross section is 20 feet wide by 8 feet deep with a 1 on 1 side slope;

- Reconstruct approximately 1,200 lineal feet of the drainage ditch north of the Eastern Drainage Ditch. Geotextile and rock revetment would be placed over the stabilized sediment. For purposes of this evaluation, it is assumed the ditch cross section is 20 feet wide by 8 feet deep with 1 on 2 side slope;

- Reconstruct approximately 2,200 lineal feet of the Western Drainage Ditch. Geotextile and rock revetment would be placed over the stabilized sediments. For purposes of this evaluation, it is assumed the ditch cross section is 10 feet wide by 6 feet deep with a 1 on 2 side slope;

- Stabilize (fill and cap) approximately 90 lineal feet of the Confluence Area. Geotextile and rock revetment would be placed over the stabilized sediment. For purposes of this evaluation, the cross section of the Confluence Area is assumed to be 130 feet wide by 12 feet deep

- Cover bank soils with PCB concentrations greater than 50 mg/kg with geotextile and one foot of compacted soil, and

- Construction of approximately 2,800 lineal feet of a perimeter swale to the east of the new Eastern Drainage Ditch channel to prevent storm water from adjacent properties from running on to the site.

Approximately 96,000 cubic yards of material would be needed to backfill the existing ditches. Approximately 20,000 cubic yards of material from the new Eastern Drainage ditch and 44,000 cubic yards of kiln dust would be used. Subsequently approximately 32,000 cubic yards of clean fill material would be imported to the site to be used as cover in the existing ditches.

The ditch stabilized filling and capping procedures would include the placement of geotextile fabric over stabilized existing ditch sediments, followed by the placement of soil/fill from the new Eastern Drainage Ditch construction, and finally clean fill. The upper portion of all stabilized ditches would be filled with clean fill material. Finally, a six inch layer of topsoil would be placed and the soil would be fertilized and seeded to facilitate the establishment of a vegetative cover. An erosion control fabric would be then be placed over the seeded area to prevent soil erosion while the vegetative cover is being established.

The reconstructed drainage ditch north of the Eastern Drainage Ditch and Western Drainage Ditch would include placement of a geotextile fabric at the base of the ditches followed by 12-inches of stone revetment. The upper portions of the ditch side slopes would be seeded to prevent future erosion.

This alternative serves to meet the remedial goal of the reduction of PCB loading in surface water from the site. This alternative will be retained for further consideration.

13.4.1.3 Alternative 2 - Excavation of Impacted Soils and Sediments from Existing Drainage Ditches and Reconstruction of Existing Drainage Ditches

Alternative 2 would result in the excavation of sediments in the drainage ditch north of the Eastern Drainage Ditch, Eastern Drainage Ditch, Western Drainage Ditch and the Confluence Area. Sediments and bank soils with PCB concentrations greater than 50 mg/kg would be excavated to the top of the clay substrate. Finally, perimeter swales would be constructed along the eastern boundary of the site to prevent the migration of storm water from adjacent properties onto the site. The conceptual layout of this alternative is shown on **Figure 13-4**.

The general scope of work for implementation of this alternative is described below:

- Excavate approximately 64,000 cubic yards of sediment from site ditches (refer to Section 13.1.8 for sediment volume by drainage ditch). This material would be disposed off-site at an appropriately licensed land disposal facility.

- Reconstruct approximately 1,200 lineal feet of the drainage ditch north of the Eastern Drainage Ditch. For purposes of this evaluation, it is assumed the ditch cross section is 20 feet wide by 8 feet deep with a 1 on 1 side slope;

- Reconstruct approximately 2,300 lineal feet of the Eastern Drainage Ditch. For purposes of this evaluation, it is assumed the ditch cross section is 120 feet wide by 8 feet deep with 1 on 1 side slope;

- Reconstruct approximately 2,200 lineal feet of the Western Drainage Ditch. For purposes of this evaluation, it is assumed the ditch cross section is 20 feet wide by 6 feet deep with a 1 on 1 side slope;

- Reconstruct approximately 90 lineal feet of the confluence area. For purposes of this estimate, the cross section of the confluence area is assumed to be 150 feet wide by 12 feet deep,

- Excavation (and backfilling) of approximately 10,200 yards of bank soils (EDT-4W, EDT-14E, and EDT-14W areas) with PCB concentrations greater or equal to 50 mg/kg. This material would be disposed off-site at an appropriately licensed land disposal facility.

- Construction of approximately 2,800 lineal feet of a perimeter swale to prevent storm waters from adjacent properties from impacting the Site.

Ditch re-grading activities would involve the handling and placement of approximately 64,000 cubic yards of fill material. The ditch reconstruction procedures would include the placement of geotextile fabric over the new fill material followed by 12-inches of stone revetment once the existing sediments have been removed and the fill has been placed. The upper portions of the ditch side slopes would be seeded to prevent future erosion.

This alternative serves to meet the remedial goal of the reduction of PCB loading in surface water from the site and will be further evaluated.

13.4.1.4 Alternative 3 – Capping of Sediments in Existing Drainage Ditches and Excavation of Bank Soils Greater than 50 mg/kg PCBs

In Alternative 3, all sediments would be capped in place (using the AquaBlok® technology, refer to Section 13.2.2) and the excavation of bank soils with PCB concentrations equal to or greater than 50 mg/kg. Soils with PCB concentrations greater than 50 mg/kg would be disposed off-site at an appropriately licensed land disposal facility.

In this alternative, sediments within the existing drainage ditches with PCBs would be isolated. Perimeter swales would be constructed along the eastern boundary of the Site to prevent the migration of storm water from adjacent properties from draining onto the Site. The conceptual layout of this alternative is shown on **Figure 13-5**.

The general scope of work for implementation of this alternative is described below:

- The placement of a six-inch AquaBlok® layer over the existing drainage ditch sediments, and a six-inch thick sand cushion layer over the AquaBlok® layer. The AquaBlok® layer is comprised of number 10 gravel coated with bentonite. The upper portions of the ditch side slopes would be seeded to prevent future erosion.

- Cap approximately 1,200 lineal feet of the drainage ditch north of the Eastern Drainage Ditch (north of Railcar Avenue) using the AquaBlok® technology. For purposes of this evaluation, it is assumed the ditch cross section is 20 feet wide by 8 feet deep with a 1 on 1 side slope;

- Cap approximately 2,300 lineal feet of the Eastern Drainage Ditch (south of Railcar Avenue) using the AquaBlok® technology. For purposes of this evaluation, it is assumed the ditch cross section is 120 feet wide by 8 feet deep with a 1 on 1 side slope;

- Cap approximately 2,200 lineal feet of the West Ditch using the AquaBlok® technology. For purposes of this evaluation, it is assumed the ditch cross section is 20 feet wide by 6 feet deep with a 1 on 1 side slope;

- Cap approximately 90 lineal feet of the Confluence Area using the AquaBlok. For purposes of this evaluation, the cross section of the Confluence Area is assumed to be 150 feet wide by 12 feet deep;

- Ditch bank soils with PCB concentrations greater than 50 mg/kg would be excavated and disposed at an appropriately licensed facility. These areas would be backfilled with material generated from re-shaping the channels (approximately 1,000 cubic yards) and clean fill, and would be covered with clean fill, and

- Construction of approximately 2,800 lineal feet of a perimeter swale to prevent storm waters from adjacent properties from impacting the Site.

This alternative serves to meet the remedial goal of the reduction of PCB loading in surface water from the site by eliminating contact with sediments. This alternative will be retained.

13.4.1.5 Alternative 4 - Construction of Sedimentation Basins within the Footprint of the Existing Drainage Ditches

Alternative 4 consists of constructing sedimentation basins upstream of existing dams in the Eastern

Drainage Ditch (Dam B), the Western Drainage Ditch (Dam C), and the confluence area (12th Street Dam) and upstream of the railroad bridge over the lower portion of the Eastern Drainage Ditch as shown on **Figure 13-6**. The sedimentation basins would be constructed to a depth of approximately 10 feet. A five foot high clay berm would be constructed around the perimeter of the sedimentation basins to prevent storm water runoff from directly entering the basins. The berms would be seeded to establish a vegetative cover. The sedimentation basins would be approximately 40 feet in diameter to facilitate periodic removal of accumulated sediments using a drag line or a long reach hydraulic excavator. Splash pads consisting of rock revetment would be constructed at the inlets to each of the basins. In addition, new overflow structures and splash pads would be constructed at the outfalls of each of the sedimentation basins.

The estimated quantities associated with completion of Alternative 4 are summarized below:

- Excavation and regrading of approximately 10,000 cubic yards of soil and sediment to construct the new sedimentation basins;

- Placement of approximately 5,100 cubic yards of fill material to construct the basin liners and the berms around the sedimentation basins;

- Placement of approximately 600 cubic yards of rock revetment to line the bottom of the sedimentation basins and to construct the splash pads;

- Off-site disposal of approximately 3,300 cubic yards of sediment assumed to be greater than 50 mg/kg PCBs (Dam B, railroad bridge area and Confluence Area) and approximately 610 cubic yards of sediments assumed to be less than 50 mg/kg PCBs (Dam C area); and

- Placing a geotextile and one-foot compacted soil cover over bank soils with PCB concentrations greater than 50 mg/kg (approximately 3,500 square yards).

The sedimentation basins would be operated in a manner that reduces the amount of suspended solids and serves to meet the remedial goal of the reduction of PCB loading in surface water from the site. The alternative can be reasonably implemented and is relatively cost effective. This alternative will be retained for further consideration.

13.4.1.6 Alternative 5 – Sediment Control Systems (Sedimentation Basins Draining to Constructed Wetlands) and Sediment Stabilization and Encapsulation

Alternative 5 would consist of components from Alternatives 1 and 4. Alternative 5 would consist of five major components: 1) construction of a new drainage channel on the AMTRAK property to the east of Eastern Drainage Ditch in order to re-route the current Eastern Drainage Ditch (reach extending from approximately Railcar Avenue to the confluence area); 2) stabilize sediments in the drainage ditch north of the Eastern Drainage Ditch, the Western Drainage Ditch, and Confluence Area, and re-create the drainage ditches with geotextile and stone revetment on top of the stabilized material; 3) construct sediment control systems upstream of the railroad bridge over the lower portion of the current Eastern Drainage Ditch and in the confluence area, which consist of a sedimentation basin draining to a constructed wetland system 4) capping/covering bank soils with PCB concentrations greater or equal to 50 mg/kg with geotextile and a one-foot earthen cap, the cap would then be seeded; and 5) construction of perimeter swales on the AMTRAK property to the east of the Eastern Drainage to prevent storm water from adjacent properties from running on to the site. The conceptual layout of this alternative is shown on **Figure 13-7.**

A new drainage channel would be constructed to the east of the current Eastern Drainage Ditch. The flow in the current Eastern Drainage Ditch would be significantly reduced by re-routing: 1) flow from Outfall 007; 2) the drainage to the north of the Eastern Drainage Ditch (NED); 3) and stormwater runoff from the eastern half of the Former Fueling Facility (to the extent practical) to the new drainage channel. The water level in the current Eastern Drainage Ditch would decline to the prevailing groundwater elevation in the area. The reduction of flow from the current Eastern Drainage would reduce sediment transport and PCB loading. A sedimentation basin draining to a constructed wetland would further reduce PCB loading. The sedimentation would act as the forebay component of the constructed wetland. The sedimentation basin would allow sediment and other solids to settle out before entering the wetland. The basins would be installed so that accumulating sediment can be periodically removed and disposed off-site. Water would drain from the sedimentation basin to a marsh zone where further “polishing” of the water would occur. Water from the marsh area would then collect in a micropool near the outlet. The micropool allows the collection of all water from the marsh zone prior to the outlet structure.

Two sediment control systems described above would be installed. One would be installed in the lower portion of the current Eastern Drainage Ditch. The second would be installed in the current general confluence area. This second system would reduce sediment transport from the new drainage channel and from water draining from the sediment control system to be installed in the lower portion of the current Eastern Drainage Ditch.

The proposed sediment control systems are consistent to the PMP approach to reduce PCB loadings through the use of sediment control BMPs. The systems use the same general approach that has been implemented at the site based on the recommendations of Woodward-Clyde, Inc. and relayed to USEPA during the 1980's. This alternative would also minimize disturbance of established wetlands and create new wetland area. The details of the constructed wetland would be developed during a design phase.

Flow from the new Eastern Drainage Ditch and the existing drainage ditch would be monitored at Outfall 006. Sediments in the drainage ditch north of Eastern Drainage Ditch, the Western Drainage Ditch, and in the confluence area would be stabilized and covered with geotextile and rock revetment. Bank soils with PCB concentrations greater than 50 mg/kg would be capped.

The general scope of work and additional discussion of this alternative is provided below:

- Construction of approximately 2,400 linear feet of new channel for the Eastern Drainage Ditch on the AMTRAK property to the east of the current Eastern Drainage Ditch. For purposes of this evaluation, it is assumed that the proposed ditch cross section is 20 feet wide by 8 feet deep with a 1 on 1 side slope. This new drainage ditch would be lined with a geotextile fabric and one foot of rock revetment would be placed on the bottom of the ditch.

- Stabilization of sediments (to the top of the clay substrate) in the drainage ditch north of the Eastern Drainage Ditch, in the Western Drainage Ditch, and the Confluence Area. Sediments would be stabilized with cement kiln dust at a 70% mix ratio (refer to Section 13.2.1 for the treatability study). The reagent would be mixed into the site sediments using an excavator with a rotary mix head. The stabilized sediment would be covered with a geotextile fabric and one foot of revetment would be placed on top of the geotextile fabric.

- Construction of two sediment control systems each consisting of a sedimentation basins draining to constructed wetlands. Sediment control systems would be placed in the lower portion of the Eastern Drainage Ditch, just upstream of the railroad bridge, and in the confluence area (12th Street Dam) (refer to **Figure 13-7**). As described above each sediment control system would consist of a sedimentation basin/forebay area, marsh zone, micropool, and outlet structure. The sedimentation basins would be constructed to a depth of approximately 10 feet, which would require the removal of approximately 1,100 cubic yards of sediment from each area (these sediments would be disposed off-site at a TSCA-approved facility). The sediment from the confluence area would be removed to deepen the area in order to construct the sedimentation basin. As noted, the remaining sediments in the confluence area would be stabilized. A five foot high clay berm would be constructed around the perimeter of the sedimentation basins to prevent storm water runoff from directly entering the basins. The berms would be seeded to establish a vegetative cover. The sedimentation basins would be approximately 40 feet in diameter to facilitate periodic removal of accumulated sediments using a drag line or a long reach hydraulic excavator. Splash pads consisting of rock revetment would be constructed at the inlets to each of the basins. In addition, new overflow structures and splash pads would be constructed near the outfalls of each of the sedimentation basins before drainage enters the marsh zone. Basins would be constructed as described in Section 13.4.1.5.

- Placing a geotextile and one-foot compacted soil cover over bank soils with PCB concentrations greater than 50 mg/kg (approximately 3,500 square yards). The soil cover would be seeded.

- Construction of approximately 2,800 linear feet of perimeter swale to the east of the new Eastern Drainage Ditch to prevent storm water from adjacent properties from running on to the site.

This alternative serves to meet the remedial goal of the reduction PCB loading in surface water from the site and will be further evaluated.

13.4.2 Soils

As discussed, separate designations were made when evaluating soils: site-wide soils and the former roundhouse area soils. Remedial investigation activities have identified the former roundhouse area as having higher PCB concentrations in soils within a defined geographic area, as compared to the remaining upland portions of the Site. Therefore, this area is addressed separately within this FFS.

13.4.2.1 Site-wide Soils

Site-wide soils include those upland surface soils within the study area which are outside of the former Roundhouse Area. As described in Section 10.0, the human health risk assessment concluded that the risks posed by these soils are below the DNREC target criteria. Therefore, these soils will be evaluated to reduce the potential PCB loading in storm water runoff from site soils to the site ditches in order to reduce the overall loading from the site to the Delaware River Estuary.

Section 3.3 includes a description of the erosion control and sediment reduction measures implemented in the Outfall 004 drainage area. These controls resulted in a reduction of PCB concentrations in storm water by over 90%. As was described, during the implementation of these controls, Former Fueling Facility upland soil (subdrainage) Areas 2, 3, and 4 were covered by filter fabric and stone (Area 2) or a bioretention cap (Areas 3 and 4). Therefore, these areas will not be evaluated further.

Three remedial alternatives will be screened to determine viable methods to address site-wide soils. These alternatives are summarized below:

- Maintain Existing Sediment Controls
- Alternative 6: Storm Water and Erosion Control Best Management Practices (BMPs); and
- Alternative 7: Cover and Cap.

13.4.2.2 Maintain Existing Sediment Controls

Site-wide soils can be eroded during storm events and transported via anthropogenic effects (i.e. vehicles, etc.). As mentioned, erosion control and sediment reduction measures were effective in reducing PCB concentrations in storm water in the Outfall 004 drainage area. However, because this alternative does not result in the additional reduction in the PCB loading in surface water from the site, this alternative will not be evaluated any further.

13.4.2.3 Alternative 6 - Storm Water and Erosion Control BMPs

Alternative 6 would result in the implementation of upland storm water and erosion control BMPs. These erosion controls and sediment reduction measures would reduce soil erosion and PCB loading to the site ditches. These BMPs include the installation of bio-retention caps/strips, drainage swales, geotextile/stone surface cover, surface water control berms, and an upgrade of vegetation including the placement of six inches of top soil to prevent the migration of PCB in storm water into the drainage ditches. A conceptual layout of this alternative is presented as **Figure 13-8**.

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The general scope of work for implementation of this alternative is described below:

Placement of approximately 5,200 linear feet of 30 foot wide bioretention strips adjacent to site drainage features,

- Re-grading of approximately 5,800 cubic yards of soil along the Eastern and Western Drainage Ditches and Confluence Area to facilitate construction of the bio-retention areas;

- Placement of approximately 17,500 square yards of geotextile to prevent damage from rainfall and runoff in the bio-retention areas;

- Placement of approximately 3,000 cubic yards of top soil on top of geotextile, then seeding and placement of erosion control fabric over a surface area of approximately 17,500 square yards to facilitate construction of the bio-retention areas;

- Placement of approximately 4,000 square yards of geotextile fabric and 700 cubic yards of stone revetment in areas (approximately 1200 linear feet and 30 feet wide) along the Eastern and Western Drainage Ditches and Confluence Area to construct stone drainage swales in the preferential storm water flow pathways to reduce storm water velocity and prevent erosion;

- Placement of approximately 44,000 square yards of geotextile and 7,300 cubic yards of stone (6-inch thick stone cover geotextile) to protect soils in the upland track area between the Eastern and Western Drainage Ditches and along the Western Drainage Ditch and Confluence Area.

- Allowance for approximately 5,000 square yards of porous pavement to be used for access roads and equipment/material storage areas.

- To prevent runoff from entering the channel north of the Eastern Drainage Ditch, grading to construct two (one on either side of channel) 1,100 lineal foot long surface water control berms on the channel banks (2 feet high by 2 feet wide with a 1 on 1 side slope); and

- Placement of approximately 18,500 square yards of geotextile and approximately 3,100 cubic yards of top soil, and seeding of approximately 18,500 square yards of surface area to upgrade the vegetative cover along the western side of the Eastern Drainage Ditch.

Storm water and erosion control BMPs have proven successful in reducing PCB migration as described for the Outfall 004 area project. This alternative would result in the further reduction in PCB loading from the site. This option is also cost-effective. Therefore, this alternative was deemed viable and would be further evaluated.

13.4.2.4 Alternative 7 - Cover and Cap

This alternative would consist of a geotextile and one foot earthen cap over the up portion of the Site to serve as an isolation barrier to prevent future erosion of impacted soils into the drainage ditches. For alternative 7, the existing railroad track would have to be removed and a portion replaced to implement this alternative.. This option also includes installation of berms to prevent run-off from entering the ditch north of the Eastern Drainage Ditch and an upgrade of the vegetative cover on the AMTRAK property to the east of the Eastern Drainage Ditch. The AMTRAK property to the east of the Eastern Drainage Ditch is covered with dense vegetation and other areas are sparsely vegetated. Additional top soil and vegetative cover would be placed in the sparsely vegetated areas to further reduce existing soil erosion. The conceptual layout of this alternative is shown on **Figure 13-9**.

The general scope of work for implementation of this alternative is described below:

- Removal of approximately 14,500 lineal feet of railroad track,
- Placement of approximately 83,000 square yards of geotextile (after surface regarding),
- Import, placement, and compaction of approximately 28,000 cubic yards of cover material to construct up to a one-foot thick cap in the Former Fueling Facility;
- Replacement of approximately 6,500 lineal feet of railroad track;
- Seeding of approximately 83,000 square yards of surface area to prevent erosion of the cap;
- Placement of approximately 15,000 cubic yards of top soil and seeding of approximately 0,000 square yards of surface area to upgrade vegetative cover along the property to the east of the Eastern Drainage Ditch; and
- To prevent runoff from entering the channel, grading to construct two (one on either side of

the channel) approximately 1,100 lineal foot long surface water control berms on the channel banks (2 feet high by 2 feet wide with a 1 on 1 side slope).

Capping the site-wide soils would provide an effective barrier to isolate and prevent contact with soils. Implementation issues exist with the presence of rail track and other structures. This alternative was deemed viable and will be further evaluated.

13.4.3 Roundhouse Area

Soils containing PCBs at concentrations higher than in site-wide soils were identified in the former roundhouse area. Therefore, in addition to reducing PCB loadings from the site, the remedial alternative for former roundhouse area will be further protective of human health.

Three remedial alternatives will be evaluated to determine viable methods to evaluate soils in the Roundhouse Area. These alternatives are summarized below:

- Maintain Existing Sediment Controls
- Alternative 8: Cover and Cap; and
- Alternative 9: Excavation and Disposal

Each of these alternatives will be reviewed in more detail in the following sections.

13.4.3.1 Maintain Existing Sediment Controls

Currently, soils with PCBs are within a secured fenced area. No current operations are being performed within the fenced area. Silt fencing and filter berms were placed along the portions of the perimeter of the roundhouse area at downgradient surface drainage locations to reduce sediment transport to the Eastern and Western Drainage Ditches as part of the Outfall 004 project.

This alternative does not result in the further reduction in the PCB loading in surface water from the site and does not provide any further protection of human health. Therefore, this alternative would not be evaluated any further.

13.4.3.2 Alternative 8 - Cover and Cap

Alternative 8 would consist of re-grading soil in the roundhouse area and the installation of a geotextile and one-foot thick earthen cap over the soils to eliminate the direct contact exposure pathway and prevent erosion of the soils containing PCBs. The conceptual layout of this alternative is presented on **Figure 13-10**.

The general scope of work for implementation of this alternative is described below:

- Regrade area and place approximately 17,500 square yards of geotextile;
- Import of approximately 5,900 cubic yards of cover material to be used to construct the one foot thick cap;
- Placement and compaction of 5,900 cubic yards of imported cover material to construct the one foot thick cap; and
- Seeding of approximately 17,500 square yards of surface area to prevent erosion of the cap.

Capping the roundhouse area soils would provide an effective barrier to isolate and prevent contact with the soils with PCBs. This alternative would result in a reduction of PCB loadings from the site and would be further protective on human health. This option was also cost effective. This alternative has been retained and will be further evaluated.

13.4.3.3 Alternative 9 - Excavation and Disposal of Soils with PCB Concentrations Greater than 50 mg/kg

Alternative 9 is an excavation and off-site disposal alternative. Soils with PCB concentrations equal to or greater than 50 mg/kg would be excavated and disposed off-site at a TSCA Land Disposal facility. The anticipated area of excavation is shown in **Figure 13-11**.

The general scope of work for implementation of this alternative is described below:

- Based on soil data, excavation of approximately 4,900 tons of soils with PCB concentrations greater or equal to 50 mg/kg.

- Placement and compaction of approximately 4,900 tons of imported clean fill material;

- Seeding of approximately 17,500 square yards of surface area to cover the Roundhouse Area; and

- Off-site transportation and disposal of 4,900 tons of PCB impacted soils at a licensed TSCA Land Disposal facility.

This alternative would eliminate soils with PCB concentrations equal to or greater than 50 mg/kg in the former roundhouse area. This alternative would result in a reduction of PCB loadings from the site and would provide additional human health protection. This alternative was retained and will be further evaluated.

13.4.4 LNAPL on the Water Table Surface/Groundwater

The occurrence of light non-aqueous phase liquid (LNAPL) comprised of weathered diesel fuel containing PCBs was described in Section 3.2. As described, in Section 13.1.7, remedial action objectives for LNAPL include reducing the quantity and mobility of LNAPL in the subsurface and prevention or limiting of PCBs in LNAPL in the subsurface from impacting site sediments in the restored site drainage channels. As was also described in Section 13,1.7, once remedial action objectives are met for LNAPL, the monitoring of groundwater for natural attenuation processes for dissolved organics would be performed.

As described in Section 3.1, interim remedial measures to address LNAPL began in 1998. These measures were implemented to characterize PCBs in product, initiate product recovery, and further control/contain the surface occurrence of product in the Eastern and Western Drainage Ditches. As described in Section 3.2, AMTRAK and APU proactively developed the Diesel Fuel Remedial Work Plan to increase diesel fuel recovery and reduce the mobility of the diesel fuel. The oil recovery system described in the Diesel Fuel Remedial Work Plan was installed during the period September to December 2000. The system was installed to address liquid phase diesel-fuel occurrence in the Former Fueling Facility. The on-going operation of the diesel fuel recovery system has been documented in progress reports submitted to DNREC.

Based on our understanding of site subsurface conditions, and two alternatives will be evaluated to address LNAPL on the water table surface, as listed below:

- Alternative 10 – Continue operation of the current diesel fuel remedial program, and
- Alternative 11 – Installation of perimeter interceptor/recovery trenches and continue operation of the diesel fuel remedial program.

These alternatives are described in detail below.

13.4.4.1.1 Alternative 10 - Continue Operation of the Diesel Fuel Recovery Systems

As mentioned above, the diesel fuel remedial program described in the Diesel Fuel Remedial Work Plan was installed during the period September to December 2000. The components of this program were described in Section 3.2 and are summarized below:

- Installation and operation of oil recovery systems.
- Bioremediation of surface soils in the vicinity of the Eastern Drainage Ditch,
- Test trenching and closure/removal of preferential pathways,
- Review of NPDES surface water sampling results in order to monitor potential impact of groundwater on surface water quality,
- Groundwater monitoring to verify natural attenuation of dissolved organics, and
- Continuation of the sorbent boom maintenance program to control LNAPL occurrence on site drainage features.

The layout of the diesel fuel recovery system is presented on **Figure 13-12**. Major components of the oil recovery systems include the following:

- Approximately 1200 feet of recovery trenches (four trenches), 9 feet deep, were installed for active product skimming during 2000.
- A total of five 30-inch diameter recovery wells (RW-1, 2, 3, 4 and 5) and nine 8-inch diameter standpipes (SP-1 through 9) were installed within the active product skimming trenches during

2000. Oil recovery pumps were installed in five recovery well locations. Oil is routed from these to the 1,000 gallon above-ground storage tank.

- A total of 11 oil collection and monitoring sumps were installed in the vicinity of the Eastern and Western Drainage Ditches. The sumps consist of 12-inch diameter PVC well screen placed to depths from 5 to 7 feet, backfilled with pea gravel and covered with site fill material. As indicated on **Figure 3-12**, the lateral extent of the pea gravel at each location varies and is dependent on the extent of oil observed in the subsurface observed during excavation.

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- Six sumps were installed in the vicinity of the Eastern Drainage Ditch (ED-1 through ED-6). As indicated on **Figure 3-12**, ED-3 and ED-4 were installed in a "passive" recovery trench approximately 100 feet in length.

- Five sumps were installed in the vicinity of the Western Drainage Ditch (WD-A, WD-B, WD-D, WD-E and WD-F).

- A compressed gas powered product skimming system was installed to recover product from recovery sumps adjacent to the Western Drainage Ditch. The recovered oil is routed to a 100 gallon doubled-walled recovery tank adjacent to the recovery location. This system can be relocated to other wells/sumps based on observed apparent product thicknesses and product recovery rates.

- Manual product recovery on a regular basis from site sumps, wells, and standpipes.

- A water pumping system was installed during 2001 in order to increase oil recovery from the active oil-skimming recovery trenches. Water accumulated in the trenches, is routed through granular activated carbon and the treated water is drained to the ground surface in the immediate track area.

- During April 2007, an additional recovery trench was installed. This recovery trench is approximately 70 feet long and extends in a general east-west direction to the south of the previously existing recovery trench system (refer to **Figure 13-12**). The trench construction was similar to that of the existing trenches (approximately nine feet deep, and three feet wide filled with pea gravel), although the trench was excavated to a depth of 12 feet in the vicinity of the 30-inch diameter recovery well (RW-6). Product recovery and water pumps were placed in RW-6. Water and product conveyance conduits were connected to existing liquids management systems. RW-6 is a 30-inch diameter PVC recovery well with 10 feet of 40 slot well screen and two feet of PVC (0.627 inch thickness) riser (solid) pipe.

As described in the Diesel Fuel Remedial Work Plan, the product recovery system was intended to be a component of the overall site remedy. The layout and design of the system considers the extent of LNAPL on the water table surface and the heterogeneous nature of the subsurface materials. The five-year review of the system is presented as **Appendix X**.

As described in Section 3.2, over 15,200 gallons of diesel fuel has been recovered through December 2006. This program has been effective in reducing the quantity and mobility of LNAPL in the subsurface and reducing the occurrence of LNAPL in site drainage features. Therefore, this option will be retained.

13.4.4.2 Alternative 11 - Installation of Perimeter Interceptor/Recovery Trenches and Continue Operation of the Diesel Fuel Recovery Systems

In addition to the current operation described above, LNAPL interceptor/recovery trenches would be installed immediately east of the Western Drainage Ditch and immediately west of the Eastern Drainage Ditches as part of this alternative. These trenches would be parallel to these drainage features and would be installed to further reduce migration of LNAPL to these drainage features. These trenches would protect the restored drainage channels from potential impacts related to LNAPL migration. The trench locations are depicted on **Figure 13-13**.

The trenches would be installed to a depth of approximately nine-feet below the ground surface and would be approximately 3-feet wide. Trench boxes would be utilized to excavate soils within the footprint of the trench. The trench would be backfilled with pea gravel to within 2-feet of the ground surface. A geotextile fabric would be placed on top of the pea gravel and then the remaining two feet would be backfilled and compacted with clean fill material. Based on previous soil sampling, it is assumed that soils would be disposed off-site at a non-hazardous waste landfill (pending the results of pre-excavation soil characterization results).

This alternative would involve the installation of multiple large-diameter recovery wells with LNAPL recovery and water pump systems in each trench. The product recovery and water pumps placed in each recovery well would be connected to the existing fluid management systems.

The following quantities would apply to the additional interceptor/recovery trench installation:

- Installation of 550 lineal feet of trench adjacent to the Western Drainage Ditch;
- Installation of three sumps, each equipped with product recovery and water pumps, in the western trench,
- Installation of 880 lineal feet of trench adjacent to the Eastern Drainage Ditch;
- Installation of six sumps each equipped with product recovery and water pump, in the eastern trench; and
- Off-site disposal of approximately 1,430 cubic yards of non-hazardous soil.

This alternative is similar to Alternative 10 with the additional perimeter trenches to protect the restored drainage features from potential LNAPL migration. Therefore, this alternative will be retained for further evaluation.

13.5 Detailed Analysis of Remedial Action Alternatives

Remedial action alternatives were evaluated to address site drainage ditch sediments, site surface soils, and LNAPL on the water table surface. This section of the FFS provides a detailed analysis of the alternatives retained from the preliminary screening (Section 13.4).

The objective of the detailed analysis of remedial action alternatives is to evaluate each alternative against a set of criteria that DNREC uses to make the selection of the preferred alternative. Each alternative is discussed briefly in relation to the criteria, and then the alternatives are compared to each other against each of the criteria. The relative advantages and disadvantages of the various remedial alternatives are therefore identified. The criteria by which the alternatives are evaluated are identified and discussed below:

Protection of Public Health, Welfare and the Environment This evaluation criterion assures that the remedial alternative provides adequate protection of human health and the environment. The overall assessment of protection considers the evaluation of other criteria, including chiefly the long-term effectiveness, permanence, short-term effectiveness, and compliance with applicable regulations. The evaluation of an alternative should describe how the site risks are eliminated, reduced, or otherwise controlled.

Compliance with Applicable Laws and Regulations Chemical specific, location specific, and action specific laws and regulations were reviewed and identified for the site and the remedial alternatives. This evaluation criterion is used to determine how an alternative would meet all of its applicable laws and regulations.

This evaluation is presented as a general discussion of applicable regulations. Efforts to meet the requirements of the regulations are identified. Where specific regulations cannot be met, the regulation is identified and discussed in more detail.

Community Acceptance The potential concerns of the community are evaluated under this criterion.

Compliance Monitoring Requirements This criterion evaluates how an alternative is monitored to assure that it is conducted in accordance with the Remedial Action Plan. The requirements for compliance monitoring, as well as exposure pathways that cannot be monitored should be identified in this evaluation.

Permanence This criterion evaluates the degree to which the treatment is reversible. In addition, this criterion determines the contaminants remaining after the alternative is implemented and the associated risk from the contaminants.

Technical Practicability This criterion is an evaluation of the alternative with respect to performance, reliability and implementability. The likelihood that technologies would meet performance specifications (the specific remediation goals) is evaluated. The ability to construct and implement the alternative and the ease of undertaking additional remedial actions if needed is also discussed.

Restoration Timeframe This criterion evaluates the timeframe to implement the alternative and meet the remedial action objectives.

Reduction of Toxicity, Mobility and Volume of Contamination This criterion evaluates the extent to which the toxicity, mobility, and volume of contaminants are reduced through the implementation of an alternative. This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element.

Long-term Effectiveness This criterion evaluates the results of a remedial action in terms of the risk associated with contaminants remaining onsite after implementation of an alternative. In addition, the type and effort related to the long-term management of a site after a remedial action is implemented is reviewed.

Short-term Effectiveness This criterion evaluates the effectiveness of an alternative at protecting human health and the environment during implementation. Factors such as cross-media impacts, the need to transport material through populated areas and the protection of workers during implementation are evaluated.

The capital (implementation) costs of each alternative are then compared for the alternatives that equally satisfy these criteria. The estimated costs included in this FFS were developed to be accurate within +50 percent to -30 percent. The costs of each alternative will then be used to establish a preference for the proposed remedial action for the site. The estimated net present value for operation and maintenance costs are presented as appropriate.

13.5.1 Site Drainage Ditch Sediments and Bank Soils with PCB Concentrations Greater Than or Equal to 50 mg/kg PCBs

There are four primary drainage ditches that have been identified on the Site. These drainage ditches are defined as the drainage ditch north of the Eastern Drainage Ditch, the Eastern Drainage Ditch, Western Drainage Ditch, and the confluence area (merging of the Eastern and Western Drainage Ditches). As described, bank soil total PCB concentrations equal to or greater than 50 mg/kg have been detected adjacent to portions of the drainage ditch north of the Eastern Drainage Ditch (adjacent to sediment sample locations NED-13, NED-14, and NED-15). Those soils will be addressed with site sediment. Four alternatives are being considered to address sediments present in the site drainage ditches and adjacent bank soils to the top of the clay substrate with PCB concentrations greater than or equal to 50 mg/kg. These alternatives, which were previously discussed in Section 13.4 of this FFS, are listed below:

- Alternative 1 – Stabilization of ditch sediments and encapsulation of existing drainage ditch sediments and adjacent bank soils with PCB concentrations greater than or equal to 50 mg/kg and reconstruction of new drainage ditches;

- Alternative 2 – Removal and off-site disposal of all sediments from existing drainage ditches and bank soils with PCB concentrations greater than or equal to 50 mg/kg and lining the existing ditches with stone revetment to prevent future erosion of the ditches;

- Alternative 3 – Capping sediments associated with the drainage ditches and lining the existing ditches with stone revetment to prevent future erosion of the ditches and excavating bank soils with PCB concentrations greater than 50 mg/kg; and

- Alternative 4 – Construction of sedimentation basins within the existing drainage ditches to facilitate removal of PCB containing suspended solids conveyed in the storm water and capping bank soils with PCB concentrations greater than 50 mg/kg.

- Alternative 5 – Re-routing the Eastern Drainage Ditch; stabilization of sediments in the drainage ditch north of the Eastern Drainage Ditch, the Western Drainage Ditch, and the Confluence Area; construction of two sediment control systems (lower Eastern Drainage Ditch and confluence area), and capping bank soils with PCB concentrations greater than 50 mg/kg.

The detailed analysis is summarized in the remaining portions of Section 13.5.1. The detailed analysis is summarized on **Table 13-2**.

13.5.1.1 Alternative 1

Alternative 1 consists of encapsulating the existing drainage ditches and bank soils with PCBs greater than 50 mg/kg PCBs and constructing new drainage ditches. As a result, these soils and sediments would be prevented from coming into contact with storm water and the potential for future erosion and/or transport would be eliminated. New drainage ditches would be constructed and lined with a stone revetment.

13.5.1.1.1 Protection of Public Health, Welfare and the Environment

Alternative 1 eliminates the direct contact and potential for future erosion and transport by this alternative encapsulating bank soils and sediments in the existing drainage ditches. The existing ecosystems in the site ditches would be eliminated.

13.5.1.1.2 Compliance with Applicable Laws and Regulations

This alternative meets the remedial action objectives reducing PCB loading from the site and eliminates exposure of ecological receptors to site sediments.

Alternative 1 would be implemented in accordance with the State of Delaware requirements for Voluntary Cleanup Program (VCP). The VCP allows the implementation of risk-based remedial action approaches provided the footprint of existing contamination is not increased and work activities are conducted in accordance with agency approved work plans. Encapsulation of bank soils and sediments is a risk-based technology allowable under the VCP. In addition, encapsulation of ditch soils and sediments does not increase the footprint of existing contamination and as a result does not trigger other regulatory requirements that would pertain to landfill construction.

40CFR Part 761.61 also allows for risk-based closures to address sediments and soils with PCBs. The provisions within this part of 40CFR allow for the petition of alternate clean-up levels (i.e., PCB soil concentrations in excess of 100 mg/kg) provided a demonstration is made that the remedy is protective of human health and the environment. Implementation of such a remedy would require approval of the United States Environmental Protection Agency (USEPA) in addition to the State of Delaware to ensure compliance with TSCA regulations.

Some of the areas in and around the drainage ditches are wetlands. Disturbance of wetlands should be minimized to the extent practicable. Wetland disturbance must be mitigated in accordance with state and federal requirements.

13.5.1.1.3 Community Acceptance

Alternative 1 would reduce the loading of PCBs from the site. Accordingly, community acceptance for this type of remediation would be high. On-site management of soils with PCBs would not be opposed by the community since the property is zoned for industrial use. The local community would support the continued use of the property as industrial property to maintain jobs in the area. Encapsulation of soils and sediment on-site would eliminate the need to transport soil and sediment off-site for disposal.

13.5.1.1.4 Compliance Monitoring Requirement

The effectiveness of Alternative 1 depends upon the ability to construct and maintain a viable encapsulation system. However, the Eastern Drainage Ditch would be re-routed, therefore there would not be contact with sediments in the existing Eastern Drainage Ditch after it is re-routed. Once the encapsulation activities are completed, the former ditches would have to be inspected on a routine basis to ensure that the integrity of the encapsulation system was being maintained.

The Site has a Pollution Minimization Plan (PMP) for PCBs, as required by the Delaware River Basin Commission (DRBC). The PMP and NPDES permit require routine sampling of PCBs in site surface water including Outfall 006 which is representative of surface water leaving the site. These samples are collected and analyzed to monitor PCB and other parameter concentrations in waters leaving the Site in accordance with DRBC (reduction of PCB loading from the site) and NPDES requirements.

The PMP and NPDES permit requirements could serve to meet the monitoring requirements for this remedial action.

A detailed zoning review would also need to be conducted routinely. This review would ensure that the Site would maintain its industrial use classification which would preclude residential or commercial development on the property. Restricting land use to industrial reduces potential complete human receptor pathways.

13.5.1.1.5 Permanence

Encapsulation of the impacted drainage ditches is a permanent remedy provided that the encapsulation system is maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the encapsulation system is inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. As a result, Alternative 1 would be a permanent solution provided that encapsulation system was properly maintained.

13.5.1.1.6 Technical Practicality

Alternative 1 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where the new Eastern Drainage Ditch would be constructed followed by the encapsulation of existing Eastern Drainage Ditch. Once the new ditches have been constructed, the sediments in existing ditches would be isolated from storm water flow that would leave the site. The existing ditches would be encapsulated after isolation of sediments from storm water.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this

equipment and qualified operators are readily available in the area. Engineering controls would be needed to reduce potential dust issues with handling and mixing the reagent into sediments.
Other materials that would be required to complete the construction activities would be a source of stabilizing reagent, clean fill, geotextile fabric, and erosion control fabric. Geotextile fabric would be used to placed over existing stabilized ditch sediment to allow for efficient encapsulation. Clean fill and stone revetment would be used to backfill and encapsulate the existing drainage ditches. Erosion control fabric would be used to secure the encapsulated drainage ditches until a vegetative cover can be established over them. Clean fill, geotextile fabric and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the encapsulation system would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the encapsulation systems.

13.5.1.1.7 Restoration Timeframes

Alternative 1 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

13.5.1.1.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 1 is an encapsulation remedy. The encapsulation remedy would not result in any volume reduction of PCBs. The mobility of PCBs would be eliminated since capped bank soils and sediment would no longer come into contact with surface water. As a result, PCBs within existing ditch sediments would not migrate off-site.

13.5.1.1.9 Long-Term Effectiveness

Since Alternative 1 eliminates sediment direct contact with surface water and aquatic ecosystems it would be effective long term. As with any risk-based remedial action, the effectiveness of the system is dependent upon a well defined and executed maintenance plan.

Alternative 1 ultimately results in the elimination of sediment contact with surface water that would leave the site. As a result, the concentrations of PCBs in surface water leaving the site, would decrease over time.

13.5.1.1.10 Short-Term Effectiveness

Alternative 1 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, sediment direct contact with surface water and aquatic ecosystems would be eliminated. As a result, the concentrations of PCBs in surface water leaving the site would decrease over time.

By re-routing the Eastern Drainage Ditch, this remedy can be implemented such that it is considered effective in the short-term.

13.5.1.11 Costs

The estimated cost to complete Alternative 1 is summarized in **Table 13-3**. The estimated capital cost for Alternative 1 is approximately $10,500,000. Including the net present value (NPV) of annual inspections over 30 years, the total cost for this alternative is approximately $10,600,000.

13.5.1.2 Alternative 2

Alternative 2 consists of the excavation and off-site disposal of site sediments and bank soils with PCB concentrations in excess of 50 mg/kg. These excavated soils and sediments would be disposed off-site at an appropriately licensed land disposal facility. As a result, soils and sediments containing PCBs would be prevented from coming into contact with storm water. The restored drainage ditches would be lined with stone revetment to reduce potential erosion of the underlying clay substrate and side slopes.

13.5.1.2.1 Protection of Public Health, Welfare and the Environment

Alternative 2 eliminates the direct contact and future erosion of bank soils in certain areas and sediment and transport by removal of bank soils and sediments from the existing drainage ditches. The existing ecosystems in the site drainage ditches would be eliminated.

13.5.1.2.2 Compliance with Applicable Laws and Regulations

Alternative 2 follows the defined TSCA regulations for Bulk Remediation Wastes in Low Occupancy Areas. Bulk remediation wastes are soils and sediments having PCB concentrations in excess of 25 mg/kg. Industrial properties are considered to be Low Occupancy Areas.

TSCA regulations define the following requirements for management of Bulk Remediation Wastes in Low Occupancy Areas:

- PCB concentrations less than 25 mg/kg are not subjected to any special restrictions;
- PCB concentrations between 25 mg/kg and 50 mg/kg can be managed on-site if appropriate institutional controls are in place; and
- PCB concentrations in excess of 50 mg/kg require engineering controls to prevent direct contact exposure.

Alternative 2 would result in the excavation and off-site disposal of bank soils with PCB concentrations in excess of 50 mg/kg and sediments from the drainage ditches. The excavated soils and sediments with PCB concentrations greater or equal to 50 mg/kg would be disposed of off-site at a chemical waste landfill as approved by USEPA in accordance with 40CFR 761.75, or at hazardous waste landfill that has been licensed by USEPA under Section 3004 of RCRA or by a State Authority under Section 3006 of RCRA.

Some of the areas in and around the drainage ditches are wetlands. Disturbance of wetlands should be minimized to the extent practicable. Wetland disturbance must be mitigated in accordance with state and federal requirements.

13.5.1.2.3 Community Acceptance

Alternative 2 would reduce the loading of PCBs from the site. Accordingly, the community acceptance for this type of remediation would be high. Off-site disposal of PCB impacted soils would not be opposed by the community from an environmental standpoint, but could face some resistance due to concerns with high traffic volumes moving through local neighborhoods during construction. This type of community resistance is difficult to assess until the final scope of work is prepared. Some communities prefer to minimize short term exposure risks from increased traffic volumes by using on-site engineering controls that would eliminate the need to transport excavated soils off-site for disposal. Trucks could also be routed directly to Railcar Avenue (bounded by other industrial properties) and on the Interstate 495 in order to alleviate concerns with traffic through local neighborhoods.

13.5.1.2.4 Compliance Monitoring Requirement

The Site has a PMP for PCBs, as required by DRBC. The PMP and NPDES permit require routine sampling of PCBs in Site surface water including Outfall 006 which is representative of surface water leaving the site. These samples are collected and analyzed to monitor PCB and other parameter concentrations in waters leaving the Site in accordance with DRBC (reduction in PCB loading from

the site) and NPDES requirements. The PMP requirements could serve to meet the monitoring requirements for this remedial action.

13.5.1.2.5 Permanence

Removal and off-site disposal of soils and sediments provides a permanent solution. The excavated soils would be disposed in an appropriately licensed land disposal facility which would require long term monitoring and maintenance.

Potential future PCB contributions from the site from other media (soil and LNAPL) would be addressed using the selected alternative for those media.

13.5.1.2.6 Technical Practicality

Alternative 2 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where impacted soil and sediments would be removed and disposed of at an appropriately licensed land disposal facility. Following excavation, drainage channels would be re-constructed with fill and stone revetment.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this equipment and qualified operators are readily available in the area. Since the sediments would be wet and have a high hydrocarbon content, engineering controls would be needed to minimize site impacts associated with the handling of excavated sediment and soil.

Other materials that would be required to complete the construction activities would be a source of clean fill, geotextile fabric and erosion control fabric. Clean fill and stone revetment would be used to backfill and encapsulate the existing drainage ditches after soil and sediment excavation. Geotextile fabric would be placed over existing ditch sediment to allow for efficient placement of stone revetment to prevent the construction equipment from getting stuck in the soft sediment. Erosion control fabric would be used to prevent erosion in the drainage ditches until a vegetative cover can be established over them. Clean fill, geotextile fabric and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the engineering controls would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the engineering controls.

13.5.1.2.7 Restoration Timeframes

Alternative 2 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

13.5.1.2.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 2 is a removal remedy. The site volume of PCBs would be reduced although they would be managed off-site in a landfill. The mobility of PCBs in the targeted bank soils and sediments would be eliminated since these soils and sediment would no longer come into contact with surface water.

13.5.1.2.9 Long-Term Effectiveness

Since Alternative 2 removes target bank soils and sediments from the site, it would be effective long-term.

13.5.1.2.10 Short-Term Effectiveness

Alternative 2 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, a potential source of PCBs to surface water leaving the site would be removed. As a result, the concentrations of PCBs in surface water leaving the site would decrease over time.

As this remedy requires the removal of all soils with PCB concentrations greater than 50 mg/kg, there is an increased opportunity for migration of PCBs during the implementation of the remedy. PCBs can become mobile as sediments are disrupted and soils are excavated. Controls would need to be implemented to control PCB migration during remedy implementation. In addition, disposal of the PCBs would require that PCB contaminated media be transported through adjacent and distant properties, thereby increase the potential for PCB migration during the implementation of this remedy.

This remedy is not considered effective in the short-term.

13.5.1.2.11 Costs

The estimated cost to complete Alternative 2 is summarized in **Table 13-4**. The estimated cost for Alternative 2 is approximately $26,000,000. Since this is a removal option, no operation and maintenance costs are assumed.

13.5.1.3 Alternative 3

Alternative 3 consists of excavating PCB impacted ditch bank soils with concentrations in excess of 50 mg/kg and disposing of these soils at an appropriately licensed landfill. Following soil excavation and capping, the existing ditch sediments would be encapsulated using the AquaBlok® capping technology. As a result, these soils and sediments would be prevented from coming into contact with storm water.

13.5.1.3.1 Protection of Public Health, Welfare and the Environment

Alternative 3 eliminates the direct contact and potential for future erosion and transportation by excavating target bank soils and capping sediments in the existing drainage ditches using the AquaBlok® technology. The soil excavation and AquaBlok® system prevents soils and sediments with PCBs contact with ecological receptors and surface water. This alternative would disrupt the existing ecosystems in the site ditches.

13.5.1.3.2 Compliance with Applicable Laws and Regulations

This alternative meets the remedial action objective of reducing PCB loading from the site and eliminates exposure of ecological receptors to site sediments.

Alternative 3 would be implemented in accordance with DNREC requirements for the VCP. This VCP allows the implementation of risk-based remedial action approaches provided that the footprint of existing contamination is not increased and work activities are conducted in accordance with agency approved work plans. Encapsulation of ditch sediments that have detectable PCB concentrations is a risk-based technology allowable under the VCP.

40CFR Part 761.61 also allows for risk-based closures to address PCB impacted sediments and soils.

The provisions of this part of 40CFR allow for the petition of alternate clean-up levels provided a demonstration is made that the remedy is protective of human health and the environment. Implementation of such a remedy would require the approval of USEPA in addition to ensure compliance with TSCA regulations.

Alternative 3 would result in the excavation and off-site disposal of soils with PCB concentrations in excess of 50 mg/kg. The excavated soils would be disposed off-site at a PCB waste landfill as approved by USEPA in accordance with 40CFR 761.75, or at a hazardous waste landfill that has been licensed by USEPA under Section 3004 of RCRA or by a State Authority under Section 3006 of RCRA.

Some of the areas in and around the drainage ditches are wetlands. Disturbance of wetlands should be minimized to the extent practicable. Wetland disturbance must be mitigated in accordance with state and federal requirements.

13.5.1.3.3 Community Acceptance

Alternative 3 would reduce the PCB loadings from the site. Accordingly, the community acceptance for this type of remediation would be high. On-site management soils and sediments would not be opposed by the community since the property is zoned for industrial use. The local community would support the continued use of the property as industrial property to maintain jobs in the area.

Encapsulation of impacted sediments on-site would eliminate the need to transport sediments off-site for disposal. As a result, there would be less truck traffic to and from the site transporting sediments to the approved disposal facilities. However, there would be some increased traffic due to the off-site disposal of target bank soils.

13.5.1.3.4 Compliance Monitoring Requirement

The effectiveness of Alternative 3 depends upon the ability to construct and maintain a viable encapsulation system for sediments. The construction phase of the capping and encapsulation project would need to be closely monitored to ensure construction activities are not causing the additional release sediments through Outfall 006. Once the capping and encapsulation activities are completed, the existing ditches would have to be inspected on a routine basis to ensure the integrity of the capping and encapsulation system are being maintained.

The Site has a PMP for PCBs, as required by the DRBC. The PMP and NPDES permit require routine sampling of PCBs in Site surface water including Outfall 006. These samples are collected and analyzed to monitor PCB and other parameter concentrations in waters leaving the Site in accordance with DRBC (reduction in PCB loading from the site) and NPDES requirements. The PMP requirements could serve to meet the monitoring requirements for this remedial action.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property.

13.5.1.3.5 Permanence

Removal of bank soils and encapsulation of the impacted drainage ditches is a permanent remedy provided the encapsulation system is maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the encapsulation system is inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. As a result, Alternative 3 would be a permanent solution to provide the capping and encapsulation system are properly maintained and reduce PCB loading from the site.

13.5.1.3.6 Technical Practicality

Alternative 3 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where bank soils would be excavated and disposed off-site, followed by the installation of the AquaBlok® encapsulation system over the ditch sediments.

The AquaBlok® encapsulation system is a patented process that places bentonite around a gravel core. AquaBlok® materials are placed upon sediments and then covered with a sand cushion layer and stone revetment. Field-scale testing of the Aquablok® technology may be required before full-scale implementation.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this equipment and qualified operators are readily available in the area.

Maintenance of the capping and encapsulation systems would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the encapsulation systems.

13.5.1.3.7 Restoration Timeframes

Alternative 3 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

13.5.1.3.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 3 is a combined excavation, capping and encapsulation remedy. The on-site volume of PCBs would be reduced through the excavation and off-site disposal of target bank soils. The mobility of PCBs in sediments would be eliminated since sediment would no longer come into contact with surface water. The toxicity of PCBs would also be reduced through pathway elimination.

13.5.1.3.9 Long-Term Effectiveness

Since Alternative 3 eliminates sediment contact with surface water and aquatic receptors, it would be effective long term. As with any similar remedial action, the effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.1.3.10 Short-Term Effectiveness

Alternative 3 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, sediment contact with surface water and ecological receptors would be eliminated. As a result, PCB loading from the site would decrease over time.

As this remedy requires the removal of bank soils with PCB concentrations greater than 50 mg/kg, there is an increased opportunity for migration of PCBs to adjacent areas during the implementation of the remedy. PCBs can become mobile as sediments are disrupted and soils are excavated.

13.5.1.3.11 Costs

The estimated cost to complete Alternative 3 is summarized in **Table 13-5**. The estimated capital cost for Alternative 3 is approximately $8,500,000. Including the NPV of annual inspections over 30 years, the total cost for this alternative is approximately $8,600,000.

13.5.1.4 Alternative 4

Alternative 4 consists of installing sedimentations basins within the existing drainage network to settle out suspended solids prior to storm water being conveyed to off-site. Suspended solids that settle out in the sedimentation basins would need to be periodically removed and disposed off-site at an appropriately licensed landfill. Also, some sediment excavation and off-site disposal would be required to deepen existing drainage features for basin installation. Bank soils exceeding 50 mg/kg PCBs would be covered with geotextile and one-foot of compacted soils and then stabilized with vegetation.

13.5.1.4.1 Protection of Public Health, Welfare and the Environment

Alternative 4 reduces suspended solids (and associated PCB transport) in surface water conveyed off-site. As discussed in the Draft PCB TMDL Development for the Schuylkill River, Pennsylvania dams, which work in a similar manner to sediment basins, create barriers to sediment transport and impede the movement of fish (Tetra Tech, Inc., 2007), and work to effectively mitigate PCB migration from sediments. This alternative would only cause localized disruption to the existing ecosystems in site drainage ditches.

13.5.1.4.2 Compliance with Applicable Laws and Regulations

The remedial objective of reducing PCB loading would be met. Alternative 4 would be implemented in accordance with DNREC requirements for the VCP. The VCP allows the implementation of risk-based remedial action approaches provided that the footprint of existing contamination is not increased and work activities are conducted in accordance with agency approved work plans. Construction of sedimentation basins would settle PCB-containing suspended solids prior to their discharge to Brandywine Creek. The PCB concentrations in the sedimentation basins would likely need to be maintained at concentrations less than 50 mg/kg to comply with the storage and disposal requirements as defined by 40 CFR 761.65.

Alternative 4 would result in the periodic excavation and off-site disposal of settled suspended solids excavated from the sedimentation basins. The excavated sediment would be disposed off-site at a chemical waste landfill as approved by USEPA in accordance with 40CFR 761.75, or at a hazardous waste landfill that has been licensed by USEPA under Section 3004 of RCRA or by a State Authority under Section 3006 of RCRA if the PCB concentrations in the sediment exceed 50 mg/kg. If PCB concentrations are less than 50 mg/kg, the excavated material can be disposed in an appropriately licensed non-hazardous waste land disposal facility.

This approach is consistent with the Draft PCB TMDL Development for the Schuylkill River, Pennsylvania as described previously.

Some of the areas in and around the drainage ditches may be considered wetlands. Disturbance of wetlands should be minimized to the extent practicable. Wetland disturbance must be mitigated in accordance with state and federal requirements. Alternative 4 would likely not create a disturbance of a significant area of wetlands.

13.5.1.4.3 Community Acceptance

Alternative 4 would reduce PCB loadings from the site. Accordingly, the community acceptance for this type of remediation would be high. On-site management of sediments with PCBs may be opposed by the community since direct contact with aquatic ecosystems is possible within the property boundaries of the Site. However there would only be localized disruption of the existing ecosystems.

There would be the need to initially and periodically excavate and dispose of sediments off-site. However, there would not be high volumes of truck traffic running through the local neighborhoods transporting impacted soils to the approved disposal facilities. Although, there would be some increased traffic.

13.5.1.4.4 Compliance Monitoring Requirement

The effectiveness of Alternative 4 depends upon the ability to construct and maintain a viable settling system. PCBs are typically bound to the finer grained suspended solids with higher organic content and as a result require more settling time for removal. A detailed compliance monitoring program would need to be developed and implemented to ensure effective suspended solids removal in the sedimentation basins is occurring. The construction phase of the project would need to be closely monitored to ensure construction activities are not releasing soils or sediments with PCBs.

The Site has a PMP for PCBs, as required by the DRBC. The PMP and NPDES permit require routine sampling of PCBs in Site surface water. These samples are collected and analyzed to monitor PCB concentrations in waters leaving the Site meet DRBC (reduction in PCB loading from the site) and NPDES requirements. The PMP requirements could serve to meet the monitoring requirements for this remedial action.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property.

13.5.1.4.5 Permanence

Alternative 4 would reduce the loading of PCBs from the Site, but the effectiveness would be highly dependant on the performance of the settling basins over a wide range of storm water flow conditions. Basins would have to be inspected and accumulating sediments removed.

13.5.1.4.6 Technical Practicality

Alternative 4 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where new dams would be constructed followed by construction of the sedimentation basins.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks dozers and compactors. All of this equipment and qualified operators are readily available in the area.

Other materials that would be required to complete the construction activities would be a source of clean fill, geotextile fabric and erosion control fabric. Clean fill and stone revetment would be used to construct the liner system for the sedimentation basins. Geotextile fabric would be placed over existing ditch sediment to allow for efficient construction of the liner and to prevent the construction equipment from getting stuck in the soft sediment. Erosion control fabric would be used to secure the side slopes of the sedimentation basins until a vegetative cover can be established over them. Clean fill, geotextile fabric and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the sedimentation basin would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the sedimentation basins.

13.5.1.4.7 Restoration Timeframes

Alternative 4 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

Additional accumulating sediment removal activities at the Site would be ongoing. The Operation and Maintenance plan developed for the Site would need to determine the appropriate monitoring and sediment removal requirements for the sediment basins. Sediment removal and disposal can be expected to occur every one to seven years.

13.5.1.4.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 4 is a sedimentation remedy. The sedimentation basins would not result in any volume reduction of PCBs other than the on-site sediment volume reduction associated with the removal of sediments prior to installation of the sedimentation basins. The mobility of PCBs associated with the capped bank soils would be eliminated and the mobility of PCBs associated with sediments would be reduced and off-site transport of PCBs would be reduced. Sediment direct contact with ecologic receptors and surface water would still be complete.

13.5.1.4.9 Long-Term Effectiveness

This alternative would result in a reduction of PCB loading from the site. However, the long-term effectiveness is dependent on the efficiency of the basins in reducing suspended solids and removal of accumulating sediments. Sediment direct contact with surface water and ecologic receptors would not be eliminated. PCB loading from the site would decrease over time

13.5.1.4.10 Short-Term Effectiveness

Alternative 4 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, PCB loading from the site would be reduced. However, sediments would be disturbed during installation. Controls would be implemented to reduce sediment re-suspension during installation.

13.5.1.4.11 Costs

The estimated cost to complete Alternative 4 is summarized in **Table 13-6**. The estimated capital cost for Alternative 4 is approximately $2,400,000. Operation and maintenance costs include annual inspections, maintenance of sorbent booms placed in the drainage features, and removal and disposal of up to 40 tons of accumulated sediment in the sedimentation basins every five years. The operation and maintenance NPV is estimated to be approximately $500,000 over a 30 year period. Therefore, the total cost of this alternative is approximately $2,900,000.

13.5.1.5 Alternative 5

Alternative 5 consists of re-routing the Eastern Drainage Ditch, stabilizing sediments and re-constructing the other drainage features, covering bank soils with PCB concentrations greater than 50 mg/kg with geotextile and one foot of compacted soil, and constructing sediment control systems, each consisting of a sedimentation basin draining to a constructed wetland (in the lower Eastern Drainage Ditch and the confluence area). As indicated, this alternative includes components of Alternatives 1 and 4.

13.5.1.5.1 Protection of Public Health, Welfare and the Environment

Alternative 5 reduces suspended solids (and associated PCB transport) in surface water conveyed off-site. As discussed in the Draft PCB TMDL Development for the Schuylkill River, Pennsylvania dams, which work in a similar manner to sediment basins, create barriers to sediment transport and impeded the movement of fish (Tetra Tech, Inc., 2007), and work to effectively mitigate PCB migration from sediments. This alternative would only cause localized disruption to the existing ecosystems in the Eastern Drainage Ditch and would result in additional wetland area.

13.5.1.5.2 Compliance with Applicable Laws and Regulations

The remedial objective of reducing PCB loading would be met. Alternative 5 would be implemented in accordance with DNREC requirements for the VCP. The VCP allows the implementation of risk-based remedial action approaches provided that the footprint of existing contamination is not increased and work activities are conducted in accordance with agency approved work plans. Encapsulation of bank soils and sediments is a risk-based technology allowable under the VCP. Construction of sediment control systems would settle PCB-containing suspended solids prior to their discharge to Brandywine Creek. The PCB concentrations in the sedimentation basins would likely need to be maintained at concentrations less than 50 mg/kg to comply with the storage and disposal requirements as defined by 40 CFR 761.65.

Alternative 5 would result in the periodic excavation and off-site disposal of settled suspended solids excavated from the sedimentation basins. The excavated sediment would be disposed off-site at a chemical waste landfill as approved by USEPA in accordance with 40 CFR 761.75, or at a hazardous waste landfill that has been licensed by USEPA under Section 3004 to RCRA or by a State Authority under Section 3006 of RCRA if the PCB concentrations in the sediment exceed 50 mg/kg. If PCB concentrations are less than 50 mg/kg, the excavated material can be disposed in an appropriately licensed non-hazardous waste land disposal facility.

This approach is consistent with the Draft PCB TMDL Development for the Schuylkill River, Pennsylvania as described previously.

Some of the areas in and around the drainage ditches are wetlands. Disturbance of wetlands should be minimized to the extent practicable. Wetland disturbance must be mitigated in accordance with state and federal requirements. Alternative 5 would not likely disturb a significant area of wetlands.

13.5.1.5.3 Community Acceptance

Alternative 5 would reduce PCB loadings from the site. Accordingly, the community acceptance for this type of remediation would be high. On-site management of sediments with PCBs may allow direct contact with some aquatic ecosystems with sediments within the property boundaries of the site. However there would only be localized disruption of the existing ecosystems in Eastern Drainage Ditch and additional wetland area would be created.

There would be the need to initially and periodically excavate and dispose of sediments off-site. However, there would not be high volumes of truck traffic running through the local neighborhoods transporting impacted soils to the approved disposal facilities. Although, there would be some increased traffic.

13.5.1.5.4 Compliance Monitoring Requirement

The effectiveness of Alternative 5 depends upon the ability to construct and maintain viable encapsulation and settling systems. PCBs are typically bound to the finer grained suspended solids with higher organic content and as a result require more settling time for removal. A detailed compliance monitoring program would need to be developed and implemented to ensure effective suspended removal in the sedimentation basins is occurring. The construction phase of the project would need to be closely monitored to ensure construction activities are not releasing soils or sediments with PCBs.

The Site has a PMP for PCBs, as required by DRBC. The PMP and NPDES permit requires routine sampling of PCBs in Site surface water. These samples are collected and analyzed to monitor PCB concentrations in waters leaving the Site in accordance with DRBC (reduction in PCB loading from the site) and NPDES requirements. The PMP requirements could serve to meet the monitoring requirements for this remedial action.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property.

13.5.1.5.5 Permanence

Alternative 5 would reduce the loading of PCBs from the Site, but the effectiveness would be highly dependent on the performance of the sediment control systems. However, the flow to these systems would be greatly reduced by re-routing the Eastern Drainage Ditch. Basins would have to be inspected and accumulating sediments removed. The encapsulation systems would also need to be inspected on a routine basins.

13.5.1.5.6 Technical Practicality

Alternative 5 is technically practical to construction and maintain. Construction activities would be completed in a phased approach.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this equipment and qualified operators readily available in the area.

Other materials that would be required to complete the construction activities would be a source of the stabilizing reagent, clean fill, geotextile fabric, wetland vegetation, and erosion control fabric. Clean fill and stone revetment would be used to construct the liner system for the sedimentation basins and re-constructed drainage ditches. Geotextile fabric would be placed over existing ditch sediment to allow for efficient construction of the liner and to prevent the construction equipment from getting stuck in the soft sediment. Erosion control fabric would be used to secure the areas to be vegetated until a vegetative cover can be established. Clean fill geotextile fabric and erosion control fabric are also readily available in the vicinity of the site.

Maintenance of the sedimentation basin and installation of the encapsulation system would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the implementation and maintenance of this alternative.

13.5.1.5.7 Restoration Timeframes

Alternative 5 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

Additional accumulating sediment removal activities at the Site would be ongoing. The Operation and Maintenance plan developed for the site would need to determine the appropriate monitoring and sediment removal requirements for the sediment basins. Sediment removal and disposal can be expected to occur every one to seven years.

13.5.1.5.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 5 is an encapsulation and sedimentation remedy. The sediment control systems would not result in any volume reduction of PCBs other than the on-site sediment volume reduction associated with the removal of sediments prior to installation of the sedimentation basins and periodic removal sediments accumulating in the sedimentation basins. The mobility of PCBs associated with the capped bank soils and stabilized sediments would be eliminated and the mobility of PCBs associated with sediments in the existing Eastern Drainage Ditch would be reduced. Off-site transport of PCBs would also be reduced.

13.5.1.5.9 Long-Term Effectiveness

This alternative would result in a reduction of PCB loading from the site. However, the long-term effectiveness is dependent on the efficiency of the encapsulation systems and basins in reducing suspended solids as well as removal of accumulating sediments. Sediment direct contact with surface water and ecologic receptors would not be eliminated. PCB loading from the site would decrease over time.

13.5.1.5.10 Short-Term Effectiveness

Alternative 5 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, PCB loading from the site would be reduced. However, sediments would be disturbed during installation. Controls would be implemented to reduce sediment re-suspension during installation.

13.5.1.4.11 Costs

The estimated costs to complete Alternative 5 is summarized in **Table 13-7**. The estimated capital cost for Alternative 5 is approximately $4,300,000. Operation and maintenance includes annual inspections, maintenance of sorbent basin in drainage features that are not stabilized, and removal and disposal of up to 20 tons of sediment every 5 years. The operation and maintenance NPV is estimated to be approximately $500,000 over the next 30 years. Therefore, the total cost of this alternative is approximately $4,800,000. Operation and maintenance costs would be dependent on the rate of sediment accumulation in sedimentation basins as well as sediment removal and off-site disposal costs.

13.5.2 PCB Impacted Soil (Site-wide)

Site-wide soils will be addressed to reduce the potential for soils containing PCBs from being washed into site drainage features after implementation of the sediment selected remedy. As described previously, site soils do not pose unacceptable human health risk. Two alternatives were considered to address site-wide soils. These alternatives, previously discussed in Section 13.4.2 of this FFS, include the following:

- Alternative 6 – BMP’s to prevent erosion of soils containing PCBs; and
- Alternative 7 – Capping of soils to prevent erosion containing PCBs

A summary of the detailed evaluation of alternatives for site-wide soils is presented in **Table 13-8**.

13.5.2.1 Alternative 6

Alternative 6 consists of implementing BMPs to prevent erosion of soils and the potential to wash soils containing PCBs into site drainage ditches. The BMPs include the installation of bio-retention caps/strips, drainage swales, surface water control berms, and placing additional top soil and upgrading the vegetative cover.

13.5.2.1.1 Protection of Public Health, Welfare and the Environment

Based on the human health risk assessment, site-wide soils do not pose an unacceptable human health risk. Implementation of this alternative would provide additional protection and reduce PCB loading to drainage ditches via storm water runoff.

13.5.2.1.2 Compliance with Applicable Laws and Regulations

Alternative 6 would be implemented in accordance with DNREC requirements for the VCP. This VCP allows the implementation of risk-based remedial action approaches provided the footprint of existing impact is not increased and work activities are conducted in accordance with agency approved work plans. The implementation of additional BMPs to prevent erosion of soils containing PCB is consistent with measures previously implemented as part of the PMP program for the site.

13.5.2.1.3 Community Acceptance

Alternative 6 would result in the reduction of PCB loading from the site. This remedy would have minimal impact on the surrounding community, other than some increased truck traffic to and from the site during implementation. Accordingly, the community acceptance for this type of remediation would be high. On-site use of BMPs for the soils would not be opposed by the community since the property is zoned for industrial use. The local community would support the continued use of the property as industrial property to maintain jobs in the area.

Implementing BMPs would also eliminate the need to transport PCB impacted soils off-site for disposal. This would eliminate the high volume of truck traffic, which could be a nuisance for the community. In addition, the elimination of off-site disposal would result in less energy consumption for transportation of impacted soils to the disposal facility and lower carbon dioxide emissions to the atmosphere.

13.5.2.1.4 Compliance Monitoring Requirement

The effectiveness of Alternative 6 depends upon the ability to construct and maintain the erosion control measures (bio-retention strips, drainage swales, surface water control berms, and vegetative cover). A detailed compliance monitoring program would need to be developed and implemented to ensure the integrity of the BMPs is maintained.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property. Restricting land use to industrial reduces the number of potential complete human receptor pathways and is consistent with the risk-based approach used for the development of the alternative.

13.5.2.1.5 Permanence

The establishment of erosion controls (BMPs) to address impacted Site-wide soils is a permanent remedy provided the BMPs are maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the erosion control measures are inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. As a result, Alternative 6 would be a permanent solution to reduce PCB loadings from the site, provided the BMPs are properly maintained.

13.5.2.1.6 Technical Practicality

Alternative 6 is technically practical to construct and maintain. The BMPs are similar to sediment reduction and erosion control measures already implemented at the site. Construction activities would be completed in a phased approach where the bio-retention areas are constructed, then the stone drainage swales, followed by the surface water control berms, establishment of vegetative cover along the Eastern Drainage Ditch, and finally placement of geotextile fabric and stone in the upland areas to protect soils.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this equipment and qualified operators are readily available in the area.

Other materials that would be required to complete the construction activities would be a source of clean topsoil, stone revetment, geotextile fabric, seed, fertilizer, mulch and erosion control fabric. Erosion control fabric would be used to secure sloped surfaces until a vegetative cover can be established over them. Clean topsoil, stone revetment, geotextile fabric, seed, fertilizer, mulch and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the erosion control measures would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the BMPs.

13.5.2.1.7 Restoration Timeframes

Alternative 6 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

13.5.2.1.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 6 is a sediment reduction and erosion control BMP remedy. The establishment of erosion control measures would not result in any volume reduction of PCBs. The mobility of PCBs would be greatly reduced by either covering soils or implementing controls to reduce suspended solids (which may contain PCBs) in storm water.

13.5.2.1.9 Long-Term Effectiveness

Since Alternative 6 would reduce PCB loading from the Site, it would be effective long term. The long-term effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.2.1.10 Short-Term Effectiveness

Alternative 6 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, PCB loading from the site would be reduced.

13.5.2.1.11 Costs

The estimated cost to implement Alternative 6 is summarized in **Table 13-9**. The estimated capital cost for Alternative 6 is approximately $1,000,000. Operation and maintenance costs are estimated to be on the order of $20,000 per year and include inspections, maintenance of vegetated areas, and upkeep of erosion controls. The NPV of operation and maintenance over 30 years is approximately $500,000. Therefore, the total cost of this alternative is approximately $1,500,000.

13.5.2.2 Alternative 7

Alternative 7 consists of capping PCB soils across the Former Fueling Facility (refer to **Figure 13-9**). This alternative involves the installation of a geotextile and one-foot earthen cap over soils to serve as an isolation barrier to prevent future erosion of soils which may contain PCBs into the drainage ditches. The existing railroad track, approximately 14,500 linear feet, would have to be removed and a portion replaced, approximately 6,500 linear feet, to implement this remedy. This option also includes installation of two run-on control berms (approximately 1,100 linear feet) along the drainage ditch north of the Eastern Drainage Ditch and an upgrade of the vegetative cover on the AMTRAK property to the east of the Eastern Drainage Ditch to prevent erosion of soils (which may contain PCBs) via storm water into the site ditches.

13.5.2.2.1 Protection of Public Health, Welfare and the Environment

Based on the results of the human health risk assessment, site-wide soils do not pose an unacceptable human health risk. Implementation of this alternative would provide further protection and reduce PCB loading to drainage ditches via storm water runoff.

13.5.2.2.2 Compliance with Applicable Laws and Regulations

Alternative 7 would be implemented in accordance with DNREC requirements for the VCP. This VCP allows the implementation of risk-based remedial action approaches provided that the footprint of existing impact is not increased and that work activities are conducted in accordance with agency approved work plans. Encapsulation of site soils having detectable PCB concentrations is a risk-based technology that is allowable under the VCP. In addition, encapsulation of impacted site soils does not increase the footprint of existing contamination.

13.5.2.2.3 Community Acceptance

Alternative 7 would result in the reduction of PCB loading from the Site. Accordingly, the community acceptance for this type of remediation would be high. On-site management of soils would not be opposed by the community since the property is zoned for industrial use. The local community would support the continued use of the property as industrial property to maintain jobs in the area. Encapsulation, versus excavation, would also minimize the amount of PCB carried off-site via fugitive dust emissions during construction activities, increasing community acceptance.

Encapsulation of impacted soils on-site would eliminate the need to transport PCB impacted soils off-site for disposal. However, approximately 28,000 cubic yards of clean fill would be transported to the Site for construction of the earthen cap, contributing to high volumes of truck traffic, which could be a nuisance for the local community.

13.5.2.2.4 Compliance Monitoring Requirement

The effectiveness of Alternative 7 depends upon the ability to construct and maintain a viable encapsulation system. The construction phase of the encapsulation project would need to be closely monitored to ensure that construction activities are not mobilizing soils. Once the encapsulation activities were completed, the capped areas would have to be inspected on a routine basis to ensure the integrity of the encapsulation system was being maintained.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property. Restricting land use to industrial reduces the number of potential complete human receptor pathways and is consistent with the risk-based approach used for the development of the alternative.

13.5.2.2.5 Permanence

Encapsulation of the impacted Site-wide soils is a permanent remedy provided the encapsulation system is maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the encapsulation system is inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. As a result, Alternative 6 would be a permanent solution to reduce PCB loadings from the site provided the encapsulation system is properly maintained.

13.5.2.2.6 Technical Practicality

Alternative 7 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where existing railroad tracks are removed, followed by capping of site soils, construction of surface water control berms, establishment of a vegetative cover, and replacement of the railroad track. During all phases, adequate erosion control measures would be maintained.

Some disruption to facility operations would occur since equipment currently staged on track would need to be removed. Track would not be available for facility use during implementation.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump trucks, dozers and compactors. All of this equipment and qualified operators are readily available in the area.

Other materials that would be required to complete the construction activities would be a source of clean fill and topsoil, railroad materials, seed, and erosion control fabric. Erosion control fabric would be placed on sloped surfaces, such as the berms, to secure the placed soil until a vegetative cover can be established over them. Clean fill, topsoil, railroad materials, seed, and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the encapsulation system would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the encapsulation system.

13.5.2.2.7 Restoration Timeframes

Alternative 7 can be implemented within a 12 to 24 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and six to twelve months for actual construction.

13.5.2.2.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 7 is an encapsulation remedy. The encapsulation remedy would not result in any volume reduction of PCBs. The mobility of PCBs in capped soils would be eliminated.

13.5.2.2.9 Long-Term Effectiveness

Since Alternative 7 would reduce PCB loading from the site, it would be effective long term. The long-term effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.2.2.10 Short-Term Effectiveness

Alternative 7 can be implemented in a 12 to 24 month time frame. Once the remedy is implemented, PCB loading from the site would be reduced.

13.5.2.2.11 Costs

The estimated cost to complete Alternative 7 is summarized in **Table 13-10**. The estimated capital cost for Alternative 7 is approximately $4,250,000. Operation and maintenance costs include inspection and maintenance of vegetated areas (as needed). An allowance of $10,000 per year over 30 years is assumed, with a NPV of approximately $250,000. Therefore, the total cost of this alternative is approximately $4,500,000.

13.5.3 PCB Impacted Soil (Roundhouse Area)

Soil within the roundhouse area will be addressed separately from site-wide soils. Remedial investigation activities have identified the roundhouse area as having higher PCB concentrations in soils within a concentrated area, as compared to the rest of the site. The human health risk assessment demonstrated that former roundhouse area soils pose an unacceptable human health risk to theoretical commercial workers. Therefore, this area is addressed separately within this FFS. Two alternatives were considered to address these impacts. These alternatives, previously discussed in Section 13.4.3 of this study, include the following:

- Alternative 8 – Capping of all soils within the roundhouse area to prevent erosion and direct contact; and
- Alternative 9 – Excavation and off-site disposal of all soils with PCB concentrations equal to or exceeding 50 mg/kg.

A summary of the detailed evaluation of Alternatives for roundhouse area soils is presented on **Table 13-11**.

13.5.3.1 Alternative 8

Alternative 8 consists of capping soils across the approximately 3.6 acre roundhouse area. This alternative involves the placing a geotextile material and a one-foot earthen cap over soils to serve as an isolation barrier to prevent future erosion of soils and to prevent direct contact.

13.5.3.1.1 Protection of Public Health, Welfare and the Environment

Alternative 8 eliminates the direct contact exposure pathway by encapsulating impacted soils with an earthen cap. The earthen cap prevents contact with human and storm water contact with the soils and as a result, eliminates the direct contact pathway and eliminates storm water run-off from existing exposed soils.

13.5.3.1.2 Compliance with Applicable Laws and Regulations

Alternative 8 would be implemented in accordance with the DNREC requirements for the VCP. This VCP allows the implementation of risk-based remedial action approaches provided that the footprint of existing impact is not increased and that work activities are conducted in accordance with agency approved work plans. Encapsulation of roundhouse area soils having detectable PCB concentrations is a risk-based technology that is allowable under the VCP. In addition, encapsulation of impacted soils does not increase the footprint of existing contamination and as a result does not trigger other regulatory requirements that would pertain to landfill construction.

40 CFR Part 761.61 also allows for risk-based closures to address PCB impacted soils. The provisions of this part of 40 CFR allow for the petition of alternate clean-up levels provided a demonstration is made that the remedy is protective of human health and the environment. Implementation of such a remedy would require the approval of the USEPA in addition to DNREC approval to ensure compliance with TSCA regulations.

13.5.3.1.3 Community Acceptance

Alternative 8 would result in the reduction of PCB loading from the site. Accordingly, the community acceptance for this type of remediation would be high. On-site management of soils would not be opposed by the community since the property is zoned for industrial use. The local community would support the continued use of the property as industrial property to maintain jobs in the area. Encapsulation, versus excavation, would also minimize the amount of PCB carried off-site via fugitive dust emissions during construction activities, increasing community acceptance.

Encapsulation of impacted soils on-site would eliminate the need to transport PCB impacted soils off-site for disposal. However, approximately 6,000 cubic yards of clean fill would be transported to the Site for construction of the earthen cap, contributing to increased volumes of truck traffic, which could be a nuisance for the local community.

13.5.3.1.4 Compliance Monitoring Requirement

The effectiveness of Alternative 8 depends upon the ability to construct and maintain a viable encapsulation system. The construction phase of the encapsulation project would need to be closely monitored to ensure that construction activities are not mobilizing soils. Once the encapsulation activities were completed, the capped areas would have to be inspected on a routine basis to ensure the integrity of the encapsulation system was being maintained.

A detailed zoning review would also need to be conducted every five years. This review would ensure the Site would maintain its industrial use classification which would preclude residential or commercial development on the property. Restricting land use to industrial reduces the number of potential complete human receptor pathways and is consistent with the risk-based approach used for the development of the alternative.

13.5.3.1.5 Permanence

Encapsulation of the impacted roundhouse area soils is a permanent remedy provided the encapsulation system is maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the encapsulation system is inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. As a result, Alternative 8 would be a permanent solution to reduce PCB loadings from the roundhouse area to drainage ditches provided the encapsulation system is properly maintained.

13.5.3.1.6 Technical Practicality

Alternative 8 is technically practical to construct and maintain. The existing ground surface would be graded, geotextile placed, and then imported cover material would be placed to construct the one-foot cap followed by topsoil and seeding to establish the vegetative cover over the 3.6 acre area. During all phases, adequate erosion control measures would be maintained.

All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump truck, dozers and compactors. All of this equipment and qualified operators are readily available in the area.

Other materials that would be required to complete the construction activities would be a source of clean fill and topsoil, seed, and erosion control fabric. Erosion control fabric would be placed on sloped surfaces to secure the placed soil until a vegetative cover can be established over them. Geotextile, clean fill, topsoil, seed, and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the encapsulation system would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the encapsulation system.

13.5.3.1.7 Restoration Timeframes

Alternative 8 can be implemented within a 9 to 18 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months for contractor and material procurement, and three to six months for actual construction.

13.5.3.1.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 8 is an encapsulation remedy. The encapsulation remedy would not result in any volume reduction of PCBs. The mobility of PCBs in soils would be eliminated since roundhouse area soils would no longer come into contact with surface water.

13.5.3.1.9 Long-Term Effectiveness

Since Alternative 8 eliminates the direct contact with soils (human and surface water) and would reduce PCB loading from the site long-term. As with any risk-based remedial action, the long-term effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.3.1.10 Short-Term Effectiveness

Alternative 8 can be implemented in a 9 to 18 month time frame. Once the remedy is implemented, PCB loading to site ditches would be reduced and human exposure to roundhouse soils eliminated. Therefore, this alternative is considered effective in the short-term.

13.5.3.1.11 Costs

The estimated cost to complete Alternative 8 is summarized in **Table 13-12**. The estimated capital cost for Alternative 8 is approximately $290,000. An allowance of $5,000 per year for 30 years is included for inspections and maintenance of the vegetated area (NPV of approximately $130,000). Therefore, the total cost of this alternative is approximately $420,000.

13.5.3.2 Alternative 9

Alternative 9 consists of excavation and off-site disposal of all soils within the roundhouse area having PCB concentrations in excess of 50 mg/kg. The estimated 4,900 tons of PCB impacted soil would be disposed of at an approved TSCA land disposal facility. The excavated areas would be backfilled with clean fill material. The entire roundhouse area would then be seeded.

13.5.3.2.1 Protection of Public Health, Welfare and the Environment

Alternative 9 minimizes the direct contact exposure pathway by excavating the most highly impacted soils (> 50 mg/kg PCB) from the roundhouse area and transporting them off-site for disposal. In addition, the entire 3.6 acre roundhouse area would be re-vegetated to prevent erosion of soils left in place (with PCB concentrations less than 50 mg/kg). Removal of soils containing PCB concentrations greater than 50 mg/kg would significantly reduce the risk to human health and would reduce PCB loading to site drainage ditches from storm water run-off.

13.5.3.2.2 Compliance with Applicable Laws and Regulations

Alternative 9 follows the defined TSCA regulations for Bulk Remediation Wastes in Low Occupancy Areas. Bulk remediation wastes are soils having PCB concentrations in excess of 25 mg/kg. Industrial properties are considered to be Low Occupancy Areas.

TSCA regulations define the following requirements for management of Bulk Remediation Wastes in Low Occupancy Areas;

- PCB concentrations less than 25 mg/kg are not subjected to any special restrictions;
- PCB concentrations between 25 mg/kg and 50 mg/kg can be managed on-site if appropriate institutional controls are in place; and
- PCB concentrations in excess of 50 mg/kg require engineering controls to prevent direct contact exposure.

Alternative 9 would result in the excavation and off-site disposal of all PCB impacted soils from the roundhouse area with concentrations in excess of 50 mg/kg. The excavated soils would either be disposed of off-site at a chemical waste landfill as approved by the USEPA in accordance with 40CFR 761.75, or a hazardous waste landfill that has been licensed by USEPA under Section 3004 of RCRA or by a State Authority under Section 3006 of RCRA.

Excavation and off-site disposal of roundhouse area soils having PCB concentrations in excess of 50 mg/kg, and establishment of a vegetative cover for soils left in place with PCB concentrations less than 50 mg/kg is a risk-based technology that is allowable under the VCP. In addition, Alternative 8 does not increase the footprint of existing contamination and as a result does not trigger other regulatory requirements that would pertain to landfill construction.

13.5.3.2.3 Community Acceptance

Alternative 9 would reduce PCB loadings from the site. Accordingly, the community acceptance for this type of remediation would be high. Off-site disposal of PCB impacted soils would not be opposed by the community from an environmental standpoint, but could face some resistance due to concerns with high traffic volumes moving through the local community during construction. This type of community resistance is difficult to assess until the final scope of work is prepared. In addition, an excavation alternative, as compared to a capping alternative, could potentially increase the off-site migration of PCBs via fugitive dust emissions during construction activities.

13.5.3.2.4 Compliance Monitoring Requirement

The effectiveness of Alternative 9 depends upon the ability to construct and maintain a viable vegetative cover since PCB concentrations less than 50 mg/kg would remain in place. The construction phase of the vegetative cover placement would need to be closely monitored to ensure that construction activities are not mobilizing soils. Once the vegetative cover is completed, the 3.6 acre Roundhouse Area would have to be inspected on a routine basis to ensure that the integrity of the engineering controls is being maintained.

A detailed zoning review would also need to be conducted every five years. This review would ensure that the Site would maintain its industrial use classification which would preclude residential or commercial development on the property. Restricting land use to industrial reduces the number of potential complete human receptor pathways and is consistent with the risk-based approach used for the development of the alternative.

13.5.3.2.5 Permanence

Excavation and off-site disposal of PCB impacted soils with concentrations in excess of 50 mg/kg provides a permanent solution. The excavated soils would be disposed of in an appropriately licensed land disposal facility which would require long term monitoring and maintenance.

Establishing a vegetative cover over the PCB impacted soils with concentrations less than 50 mg/kg is a permanent remedy to reduce PCB loading to site drainage ditches provided that the engineering controls are maintained and the property is zoned for industrial usage. An Operation and Maintenance Plan would be developed to ensure the engineering controls are inspected on a routine basis. Any deficiencies identified during the inspections would be corrected. Alternative 9 would be a permanent solution to reduce PCB loadings from the roundhouse area to on-site drainage ditches, provided the encapsulation system was properly maintained into the future.

13.5.3.2.6 Technical Practicality

Alternative 9 is technically practical to construct and maintain. Construction activities would be completed in a phased approach where impacted soil (PCB concentrations in excess of 50 mg/kg) would be removed and disposed of at an appropriately licensed off-site land disposal facility. The excavated areas would then be backfilled with clean overburden material. Following excavation and backfill, a vegetative cover would be placed over soils with PCB concentrations less than 50 mg/kg. All construction activities would be completed using conventional construction equipment including hydraulic excavators, front end loaders, off-road dump truck, dozers and compactors. All of this equipment and qualified operators are readily available in the area.

PCB impacted soil would be hauled off-site for disposal using on-road transport trucks that are readily available in the vicinity of the Site. In addition, there is a licensed land disposal facility that can accept the PCB impacted soils.

Other materials that would be required to complete the construction activities would be a source of seed, fertilizer, mulch, and erosion control fabric. Erosion control fabric would be used to prevent erosion in sloping areas until a vegetative cover can be established over them. Seed, fertilizer, mulch, and erosion control fabric are also readily available in the vicinity of the Site.

Maintenance of the engineering controls would become one of the standard operation functions of the operating industrial facility. As a result, there are no technical barriers preventing the proper maintenance of the engineering controls.

13.5.3.2.7 Restoration Timeframes

Alternative 9 can be implemented within a 9 to 18 month time frame. The implementation timeframe would include three to six months for work plan development and approval, three to six months to for contractor and material procurement, and three to six months for actual construction.

13.5.3.2.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 9 would result in the on-site reduction of the volume of soil with PCBs. However, the excavated soils would be managed in an off-site landfill. Mobility associated with soils containing PCB concentrations greater than 50 mg/kg would be eliminated since they would be removed from the site. The mobility of soils with PCB concentrations less than 50 mg/kg would be reduced by the vegetative cover.

13.5.3.2.9 Long-Term Effectiveness

Since Alternative 9 eliminates the direct contact for soils with PCB concentrations greater than 50 mg/kg pathway it would be effective long term. As with any risk-based remedial action the effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.3.2.10 Short-Term Effectiveness

Alternative 9 can be implemented in a 9 to 18 month time frame. Once the remedy is implemented, the PCB loading from the former roundhouse area would be reduced.

13.5.3.2.11 Costs

The estimated cost to complete Alternative 9 is summarized in **Table 13-13**. The estimated capital cost for Alternative 9 is approximately $1,600,000. Note that this estimate does not include costs to sample or dispose of concrete. The area may contain concrete that has been in contact containing soils with PCBs. An allowance of $5,000 per year for 30 years is included for maintenance of the vegetated area (NPV approximately $130,000). Therefore, the total costs of this alternative is approximately $1,700,000.

13.5.4 Light Non-Aqueous Phase Liquids (LNAPL)

LNAPL present on the water table in the former fueling area between the Eastern and Western Ditches contains PCBs (approximately 10 to 20 mg/kg). There is the potential for the LNAPL to seep into the adjacent drainage ditches and subsequently be released to Brandywine Creek.

Two alternatives were retained to address LNAPL on the water table surface. These alternatives previously described in Section 13.4.4, include the following:

- Alternative 10 – Continue operation of the current diesel fuel recovery systems, and
- Alternative 11 – Installation of perimeter interceptor/recovery trenches and continue operation of the diesel fuel recovery systems.

As described in Section 13.4.4, components of both alternatives include groundwater monitoring for natural attenuation parameters in perimeter monitoring wells once the remedial action objectives for LNAPL have been met.

A summary of the detailed evaluation of Alternatives for LNAPL is presented on **Table 13-13**.

13.5.4.1 Alternative 10

Alternative 10 consists of the continued operation of the current diesel fuel recovery systems. Components of the current diesel fuel remedial program were described in Section 13.4.4.1 and include the operation of approximately 1,300 feet of LNAPL recovery trenches.

13.5.4.1.1 Protection of Public Health, Welfare and the Environment

Collection of LNAPL hydrocarbons prior to their discharge to the Eastern and Western Drainage Ditches would reduce the PCB mass loading and therefore would have long-term positive benefits to public health, welfare and the environment.

13.5.4.1.2 Compliance with Applicable Laws and Regulations

This alternative was proposed in the Diesel Fuel Remedial Work Plan dated March 2000 and was subsequently approved by DNREC.

Any recovered product would be appropriately managed in accordance with TSCA regulations. If the PCB concentrations in the recovered separate phase hydrocarbon exceed 50 mg/kg, the liquids would have to be incinerated in accordance with Section 761.70 of TSCA. Currently, all recovered product is shipped off-site for incineration at a TSCA facility.

13.5.4.1.3 Community Acceptance

Alternative 10 is currently on-going with no disruption to the community. Accordingly, the community acceptance for this type of remediation is high.

13.5.4.1.4 Compliance Monitoring Requirement

The continued effectiveness of Alternative 10 depends upon the ability to maintain a viable collection and recovery system. Because of the fluctuating water table conditions at the site, the product and water pumps need to be closely monitored to ensure that the LNAPL is being efficiently recovered. Recovered product would continue to be sampled and analyzed for PCB content prior to each off-site shipment.

13.5.4.1.5 Permanence

Alternative 10 would not provide a permanent solution to prevent the migration of LNAPL into discharge to the East and West Drainage Ditches. Localized LNAPL seeps have been observed in the drainage ditches and LNAPL has been detected in site wells and standpipes between existing trenches and site ditches.

13.5.4.1.6 Technical Practicality

Alternative 10 is already in-place, therefore it is technically practical to construct and maintain.

13.5.4.1.7 Restoration Timeframes

Alternative 10 is ongoing. The timeframe to meet LNAPL remedial action objectives is dependent on the rate of LNAPL recovery. The rate of LNAPL recovery increases when the trenches are kept dewatered. However, as a result of heavy precipitation events, the water pumping system must be periodically deactivated because of standing water on the ground surface in the track area. Also, the water pumping system is deactivated in the winter due to freezing conditions. Water management options would be discussed with DNREC outside of this FFS.

13.5.4.1.8 Reduction of Toxicity, Mobility and Volume of Contamination

The remedy has already removed approximately 15,200 gallons of LNAPL from the subsurface. Visual observations have indicated that LNAPL seepage (LNAPL mobility) to the drainage ditches has been greatly reduced since implementation of this remedy.

13.5.4.1.9 Long-Term Effectiveness

Alternative 10 would continue to recover LNAPL and reduce LNAPL seepage to site ditches. Therefore, it would be effective long term.

13.5.4.1.10 Short-Term Effectiveness

Alternative 10 has already been implemented, therefore it is effective in the short-term.

13.5.4.1.11 Costs

Alternative 10 has already been implemented. Costs associated with this remedy are related to operation, maintenance, GAC vessel re-filling, disposal of spent GAC, and recovered LNAPL disposal. Operation and maintenance costs are expected to be on the order of $100,000 per year for the first 5 years. Costs and operation duration would depend on the rate of LNAPL recovery and the time frame to reach remedial action objectives. Operation and maintenance costs are anticipated to be on the order of $60,000 per year for years 6 through 15, based on a decreased rate of LNAPL recovery (and disposal costs), decreased GAC usage, and decreased frequency of site visits as well as the transition from active product recovery to natural attenuation monitoring. The NPV for operation and maintenance is approximately $1,000,000.

13.5.4.2 Alternative 11

Alternative 11 consists of the installation of perimeter LNAPL interceptor/recovery trenches adjacent to the Western Drainage Ditch and Eastern Drainage Ditch. The liquid conveyance systems would be connected to the current product recovery system, and operation of the current recovery system would continue. The additional recovery trenches would provide a zone of higher permeability which would allow for the efficient recovery of LNAPL prior to its discharge to the Eastern and Western Drainage Ditches.

13.5.4.2.1 Protection of Public Health, Welfare and the Environment

Collection of LNAPL prior to discharge to the Eastern and Western Drainage Ditches would reduce the PCB mass loading to from the site and therefore would have long term positive benefits to public health, welfare and the environment.

13.5.4.2.2 Compliance with Applicable Laws and Regulations

This alternative is an expansion of the current recovery system approved by DNREC. Recovered product would continue to be managed in accordance with TSCA regulations.

13.5.4.2.3 Community Acceptance

Alternative 11 would result in the containment and removal of a potential source of PCBs to site drainage features under a Voluntary Action with minimal disturbance to the community. Accordingly, the community acceptance for this type of remediation would be high.

13.5.4.2.4 Compliance Monitoring Requirement

The effectiveness of Alternative 11 depends upon the ability to construct and continue to maintain a viable collection and recovery system. The construction phase of the project would need to be closely monitored to ensure that construction activities are not mobilizing soils containing PCBs. Once the collection system is installed, the LNAPL and water need to be closely maintained to ensure that the LNAPL is being efficiently recovered. Recovered product would be sampled and analyzed for PCB content prior to each off-site shipment.

13.5.4.2.5 Permanence

Alternative 11 would provide a permanent solution to recover LNAPL and prevent to discharge to the Eastern and Western Drainage Ditches. This alternative would effectively prevent the migration of PCBs in LNAPL to site drainage features.

13.5.4.2.6 Technical Practicality

Alternative 11 is technically practical to construct and maintain. Recovery trenches have already been installed at the site. SECOR provides on-going operation and maintenance of the current recovery system. The status of these operations is reported to DNREC in progress reports.

13.5.4.2.7 Restoration Timeframes

Alternative 11 can be implemented within a 6 to 12 month time frame. The implementation timeframe would include one to two months for work plan development and approval, two to four months for contractor and material procurement, and three to six months for actual construction.

As described for Alternative 10, the timeframe to meet LNAPL remedial action objectives is dependent on the rate of LNAPL recovery. The rate of LNAPL recovery increases when the trenches are kept dewatered. However, as a result of heavy precipitation events, the water system must be periodically deactivated because of standing water on the ground surface in the track area. Also, the water pumping system is deactivated in the winter due to freezing conditions. Water management options would be discussed with DNREC outside of this FFS.

13.5.4.2.8 Reduction of Toxicity, Mobility and Volume of Contamination

Alternative 11 is a source control and removal remedy. The existing recovery system has already removed approximately 15,200 gallons of LNAPL. The mobility of PCBs in LNAPL would be eliminated since LNAPL would no longer come into contact with surface water.

13.5.4.2.9 Long-Term Effectiveness

Since Alternative 11 would continue to recover LNAPL and eliminate seepage to site ditches, therefore it would be effective long term. The effectiveness of the system is dependent upon a well defined and executed maintenance plan.

13.5.4.2.10 Short-Term Effectiveness

Alternative 11 can be fully implemented in a six to twelve month time frame, and includes continued operation of the current recovery systems. Therefore, the remedy would be effective short-term.

13.5.4.2.11 Costs

The estimated cost to complete Alternative 11 is summarized in **Table 13-15**. The estimated cost for implementation of Alternative 11 is approximately $1,100,000. Operation and maintenance costs include GAC vessel re-filling, disposal of spent GAC, and disposal of recovered LNAPL. Operation and maintenance costs are on the order of $120,000 per year for the first 5 years. Operation and maintenance costs are anticipated to be on the order of $70,000 for year 6 through 15, based on a decreased rate of LNAPL recovery, decreased GAC usage, and a decreased frequency of site visits as well as the transition from active product recovery to natural attenuation monitoring. The NPV for operation and maintenance is approximately $1,200,000. Additional costs for this alternative as compared to Alternative 10 are included for additional GAC management and equipment repairs/upkeep. Costs and operation duration would depend on the rate of LNAPL recovery and the time frame to reach remedial action objectives. The total cost of this alternative is approximately $2,300,000.

13.6 Comparative Analyses of Remedial Alternatives

The remedial alternatives considered for site sediments, site-wide soil, roundhouse area soil, and LNAPL are compared in **Table 13-16**. The following criteria were given a ranking ranging from 1 to 3 for each remedial alternative:

- Protection of Public Health, Welfare and the Environment;
- Compliance with Applicable Laws and Regulations;
- Community Acceptance;
- Compliance Monitoring Alternatives;
- Permanence;
- Technical Practicability;
- Restoration Timeframe;
- Reduction of Toxicity, Mobility and Volume of Contamination;
- Long Term Effectiveness; and
- Short Term Effectiveness.

Each alternative was also ranked according to cost, with the lowest cost equal to 1. The total score was calculated by adding the sum of the evaluation criteria and cost ranking, and the lower the score the more favorable the alternative.

13.6.1 Sediments

All of the alternatives compared similarly (within one point in **Table 13-16**) with respect to Protection of Public Health, Welfare and the Environment; Compliance with Applicable Laws and Regulations; Community Acceptance; Compliance Monitoring Alternatives; Permanence; Technical Practicability; Restoration Timeframe; Reduction of Toxicity, Mobility and Volume of Contamination; and Long Term Effectiveness. Alternatives 2 and 3, which both include removal of some of the contaminated media, do not compare favorably to other alternatives 1 in Short Term Effectiveness. Alternatives 2 and 3 have an elevated risk of exposure during implementation when compared to the implementation of Alternatives 1, 4 and 5. Alternative 4, while similar to the other alternative with respect to these categories, is less protective of human health and the environment and is least effective in the long term. However, Alternatives 4 and 5 cause the least disruption to existing ecosystems in the site ditches.

Alternatives 4 and 5 proved to be the most cost effective alternatives. Alternatives 1 and 3 are similar alternatives with respect to cost. Alternative 2 is the most costly alternative.

13.6.2 Site-wide Soil

Alternatives 6 and 7 compare similarly (within one point in **Table 13-16**) with respect to Protection of Public Health, Welfare and the Environment; Compliance with Applicable Laws and Regulations; Community Acceptance; Compliance Monitoring Alternatives; Permanence; Technical Practicability; Restoration Timeframe; Reduction of Toxicity, Mobility and Volume of Contamination; Long Term Effectiveness; and Short Term Effectiveness. Alternative 6 causes less disruption to facility operations, is more cost effective than Alternative 7 and BMPs have already been demonstrated to be effective at this site.

13.6.3 Roundhouse Area Soil

Alternatives 8 and 9 compare similarly (within one point in **Table 13-16**) with respect to Protection of Public Health, Welfare and the Environment; Compliance with Applicable Laws and Regulations; Community Acceptance; Compliance Monitoring Alternatives; Permanence; Technical Practicability; Restoration Timeframe; Reduction of Toxicity, Mobility and Volume of Contamination; Long Term Effectiveness; and Short Term Effectiveness. Alternative 8 is more effective in the short term and provide pathway elimination with direct contact to all existing soils.

Alternative 8 is more cost effective than Alternative 9 and provides additional protection against run-off of soils containing PCBs since it covers the entire area with a geotextile and one foot thick earthen cap.

13.6.4 LNAPL Recovery

Alternatives 10 and 11 are similar and compare similarly (within one point) on all evaluation criteria (refer to **Table 13-16**). However, although more costly, Alternative 11 provides additional protection of the site drainage ditches from LNAPL seepage.

13.7 Preferred Alternatives and Justification

As described in Section 13.4, a component of the selected remedial actions for the site will include the closure of the abandoned sewer that is connected to the former lift station. As mentioned previously, if constructed, the CETC building constructed would be incorporated into the site remedy. It is also assumed that the tide gate at the Brandywine Creek will be fixed and maintained by the appropriate government agency.

13.7.1 Sediments

As Alternative 5 is protective of the environment, meets the remedial action objectives of reducing PCB loading from the site and is more cost effective than Alternatives 1, 2 and 3. While Alternatives 4 and 5 are the most cost effective alternatives, Alternative 4 is not as protective of human health and the environment and would not be as effective as other alternatives in the long term. Alternative 5 is also consistent with BMP approach to reduce PCB loadings from the facility. Based on this comparative analysis, Alternative 5 is selected.

13.7.2 Site-wide Soil

Both Alternatives 6 and 7 protect human health and the environment and meet the goal of reducing the PCB loading from stormwaterrun-off to site ditches. As Alterative 6 is as effective as Alternative 7, but is more cost effective, causes less disruption to facility operations, and has been proven to be effective at the site. Alternative 6 is selected as the preferred alternative.

13.7.3 Roundhouse Area Soil

Both Alternatives 8 and 9 protect human health and the environment and meet the goal of reducing the impact of PCB impacted soils on sediments in the future. As Alterative 8 is more effective in protecting from potential stormwaterrunoff of soils containing PCBs is more protective of human health (eliminates direct contact with existing soils) than Alternative 9. Also, Alternative 8 is more cost effective and provides for the least adverse impact in the short term, Alternative 8 is selected as the preferred alternative.

13.7.4 LNAPL Recovery

Alternative 11 provides additional protection from potential LNAPL seepage to site drainage features. Although Alternative 11 is more costly, Alternative 11 is selected as the preferred alternative.

13.7.5 Summary

As summarized on **Table 13-17**, the recommended alternatives are:

- Sediments and bank soils with PCB concentrations greater than 50 mg/kg – Alternative 5,
- Site-wide soils – Alternative 6,
- Former roundhouse area soils – Alternative 8, and
- LNAPL – Alternative 11.

Table 13-17 also presents a summary of implementation costs and discussion of other costs related to the operation and maintenance of the selected remedies.

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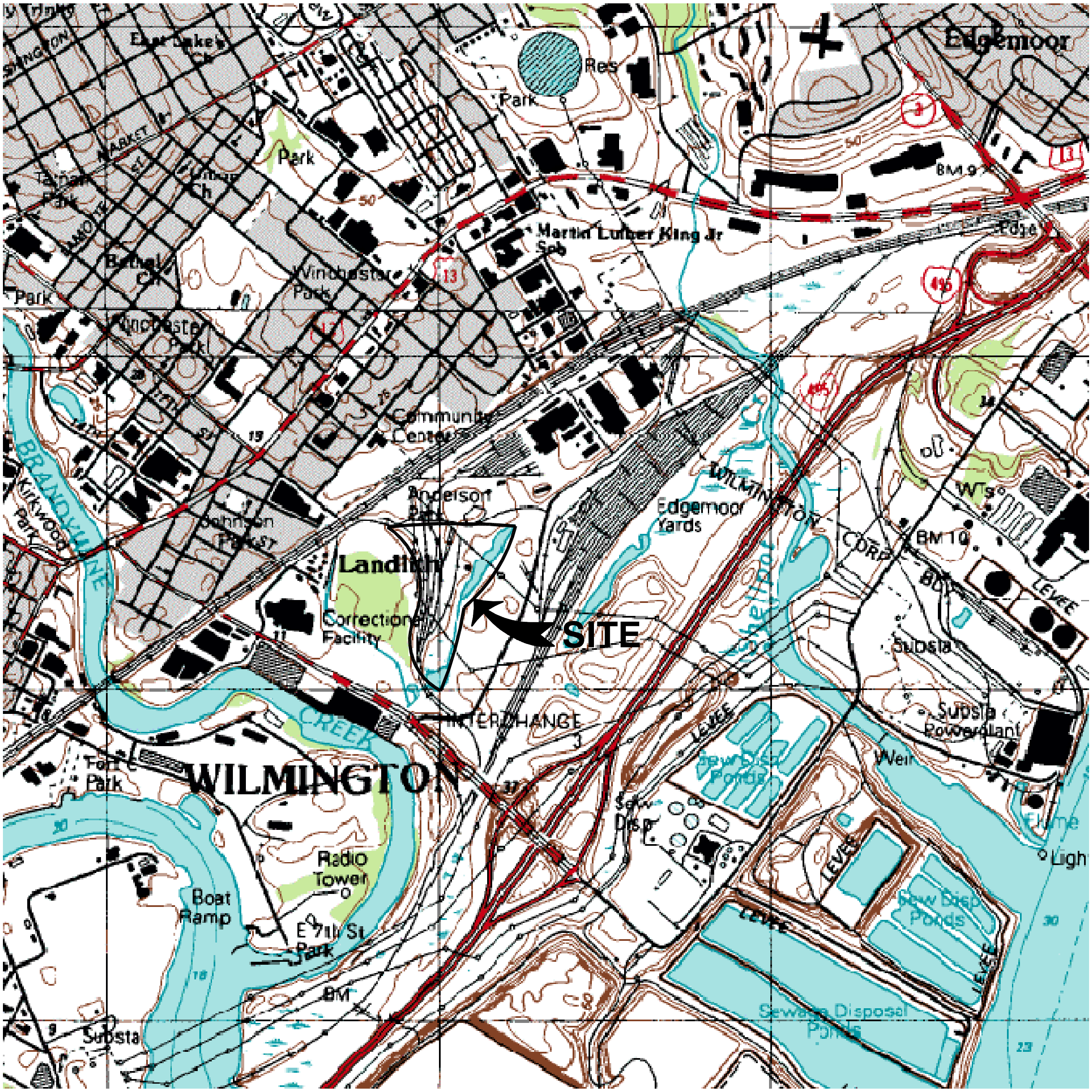
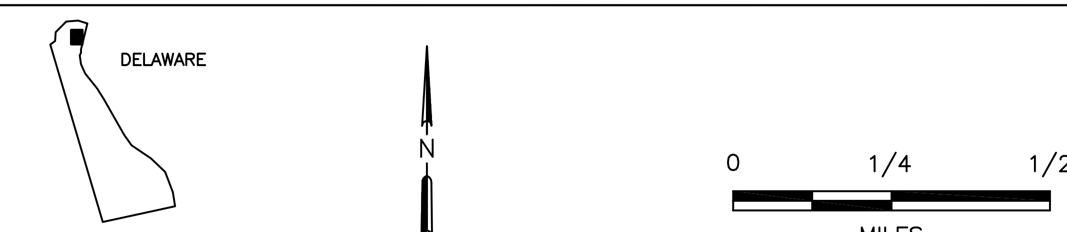
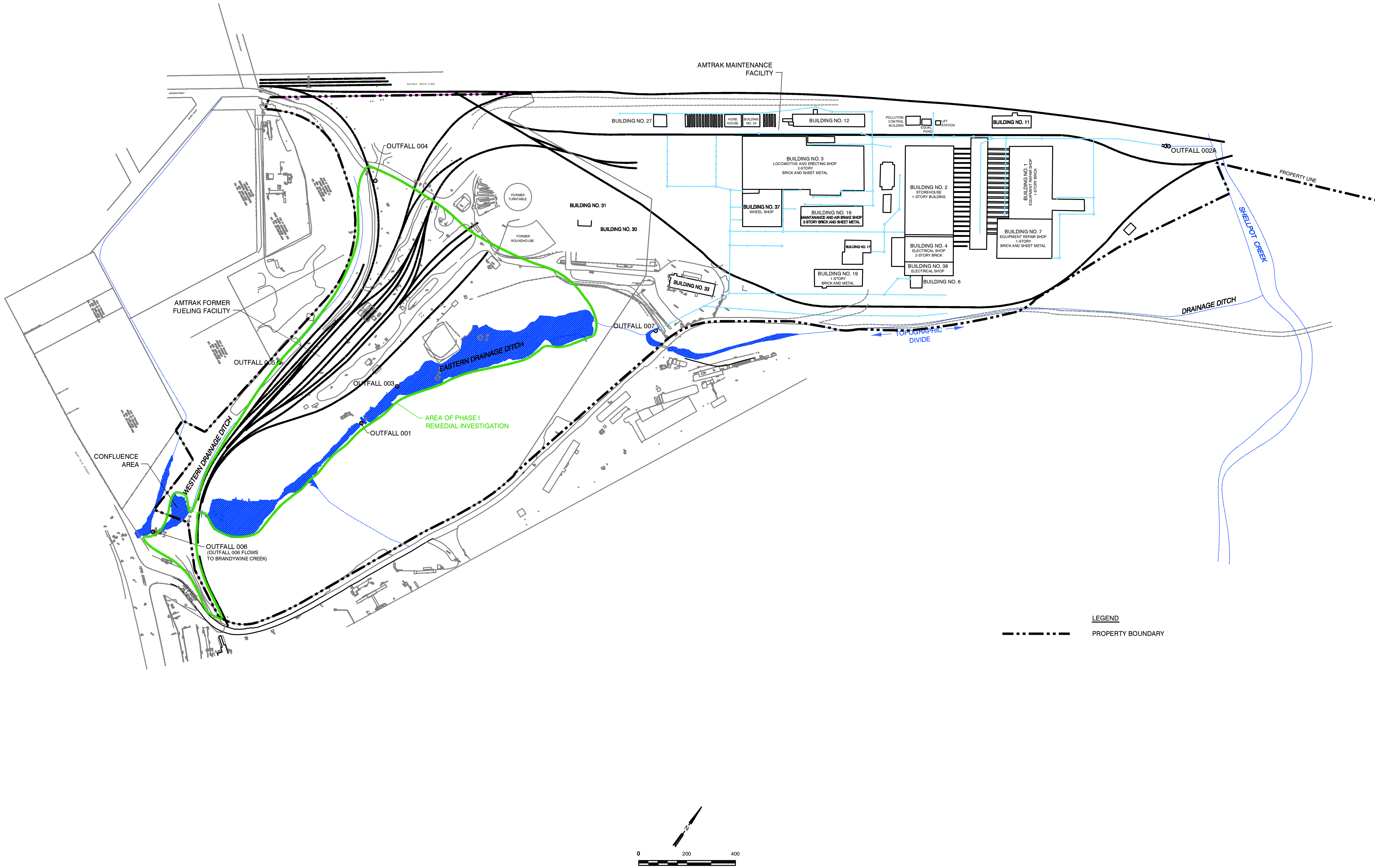




REFERENCE: USGS 7.5 MINUTE QUADRANGLE; WILMINGTON SOUTH, DELAWARE/PENNSYLVANIA , 1997

SECOR 102 PICKERING WAY, SUITE 200 EXTON, PENNSYLVANIA PHONE: (484) 875-3075/875-9286 (FAX)	FOR: AMTRAK FORMER FUELING FACILITY 4001 VANDEVER AVENUE WILMINGTON, DELAWARE		SITE LOCATION MAP	FIGURE: 1-1
	JOB NUMBER:	DRAWN BY: KEF	CHECKED BY: SB	APPROVED BY:	DATE: 04/25/2007



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FOR: AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE		SITE PLAN		PLATE: 1-2
JOB NUMBER: 62OT-01057	DRAWN BY: KEF	CHECKED BY: SB	APPROVED BY:	DATE: 04/27/2007

62OT-1057-1-2.DWG

The color digital ortho-photo (1 ft resolution) present in this map was created September 1, 2005.

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FOR: AMTRAK FOMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DE		SITE VICINITY		FIGURE: 1-3
JOB NUMBER: 62OT.01057.04	DRAWN BY: TFB	CHECKED BY:	APPROVED BY:	DATE: 9/29/05

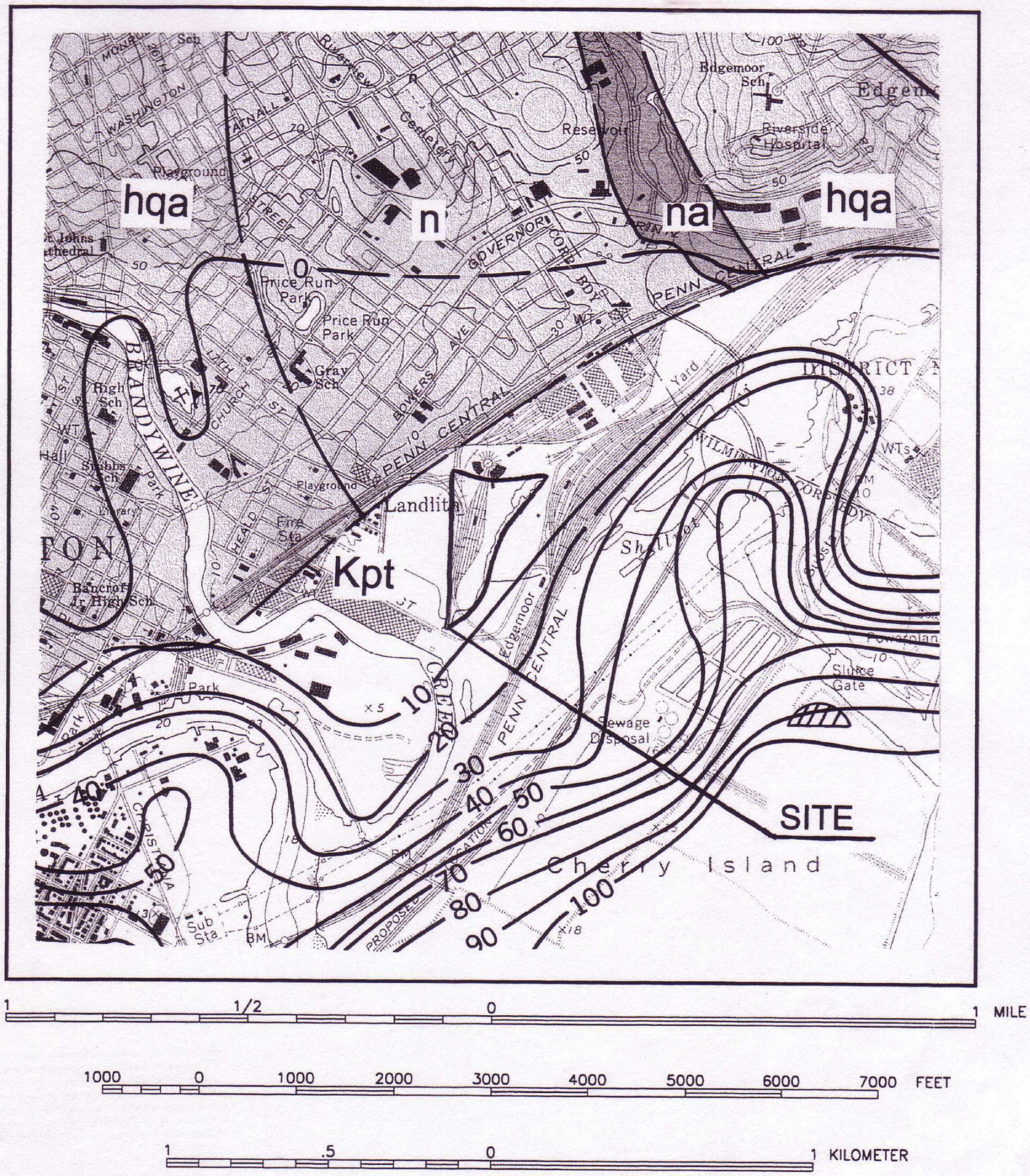

FIGURE 2–1

GEOLOGIC MAP

FOMER FUELING FACILITY AMTRAK WILMINGTON SHOPS

VANDEVER AVENUE
WILMINGTON, DE

Kpt POTOMAC FORMATION – VARIEGATED, FREQUENTLY LIGNITIC SILTS AND CLAYS

n WILMINGTON COMPLEX – NORITE

na WILMINGTON COMPLEX – NORITIC ANORTHOSITE

hqa WILMINGTON COMPLEX – HYPERSTHENE–QUARTZ–ANDESINE GNEISS

10— QUATERNARY SEDIMENTS ISOPACH

N

SOURCE: GEOLOGY OF THE WILMINGTON AREA, DELAWARE:
K.D. WOODRUFF AND A.M. THOMPSON
DELAWARE GEOLOGICAL SURVEY, 1975

01303–0177

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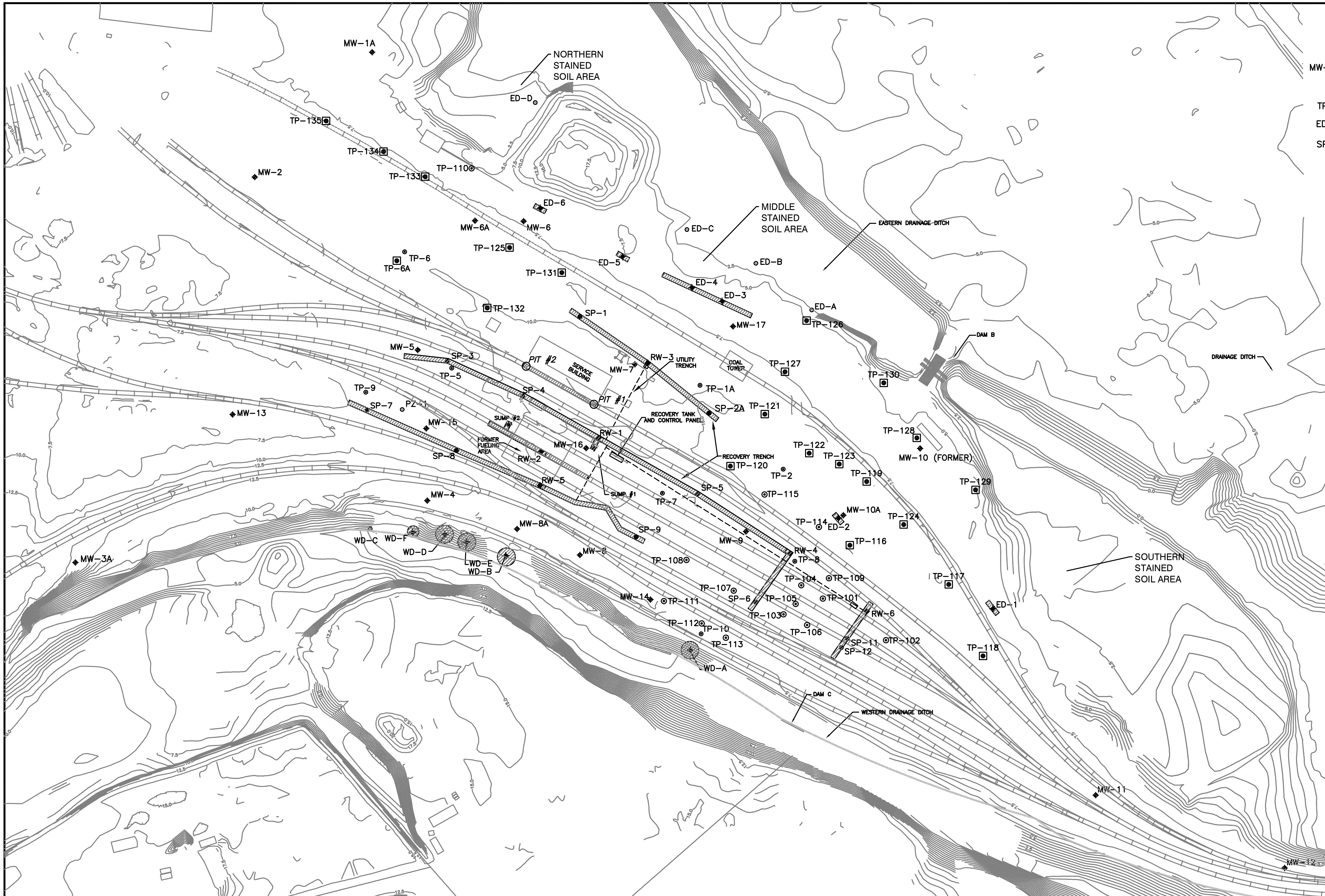
FOR:		GEOLOGIC MAP		FIGURE:
AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE				2-1
JOB NUMBER: 62OT.01057	DRAWN BY: KEF	CHECKED BY: SB	APPROVED BY:	DATE: 04/26/2007



LEGEND

- RECOVERY WELL
- MW-11 MONITORING WELL
- RECOVERY SUMP LOCATIONS
- TP-2 TEST PIT STAND PIPE
- ED-2 OBSERVATION STAND PIPES
- SP-4 RECOVERY TRENCH STANDPIPES
- TEST PIT STAND PIPE – APPROXIMATE (INSTALLED JULY 2005)
- TEST PIT STAND PIPE – APPROXIMATE (INSTALLED JANUARY 2007)

NOTE:
THE LOCATIONS OF WELLS MW-1A, MW-3A, SP-2A AND TP-1A ARE APPROXIMATE.

0 110 220
SCALE IN FEET

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FOR:
AMTRAK FORMER FUELING FACILITY
4001 VANDEVER AVENUE
WILMINGTON, DELAWARE

MONITORING WELL AND TEST PIT STANDPIPE LOCATIONS

FIGURE: 2-2

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
62OT.01057	KEF	SB		04/27/2007

FILEPATH: PHASE II RI REPORT - 2007

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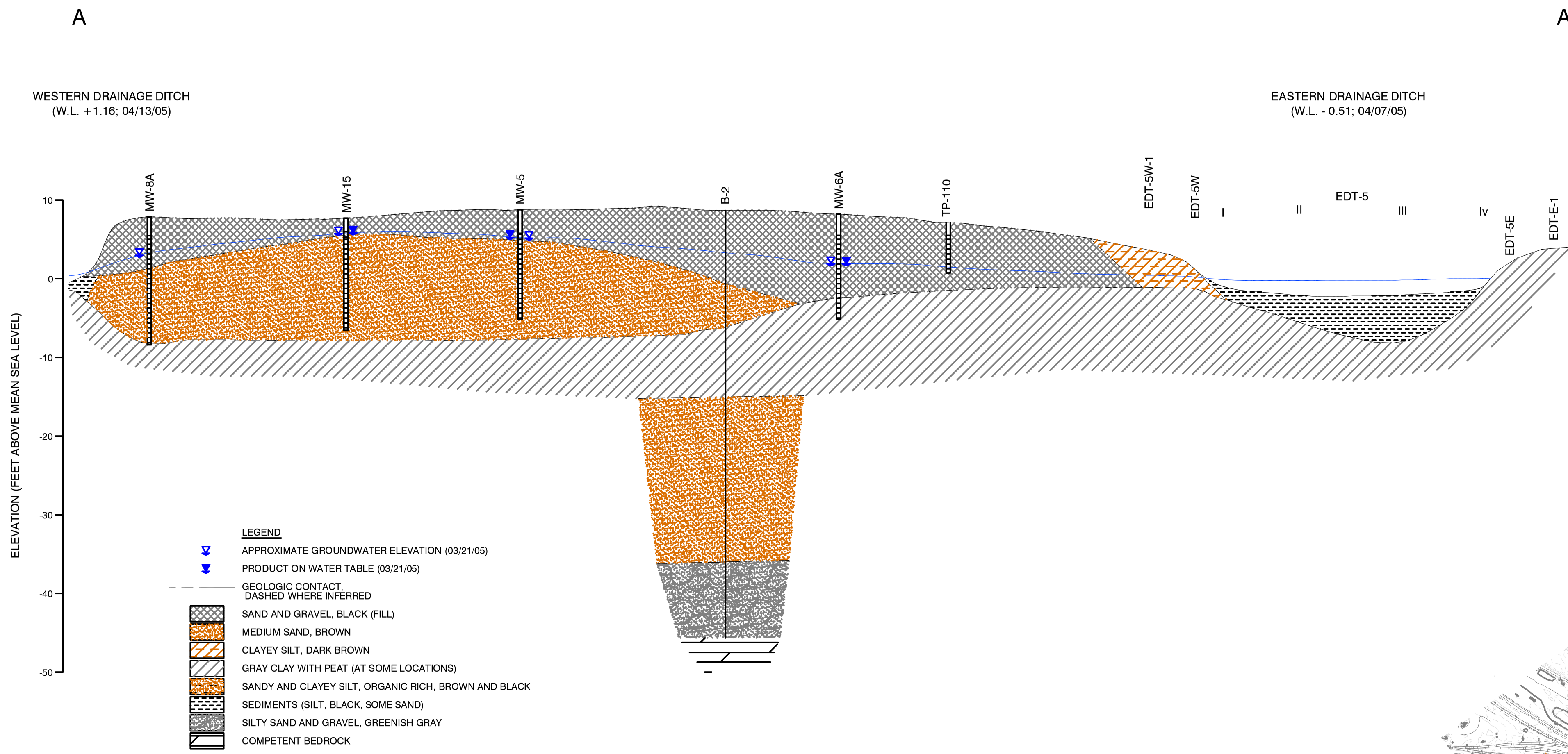

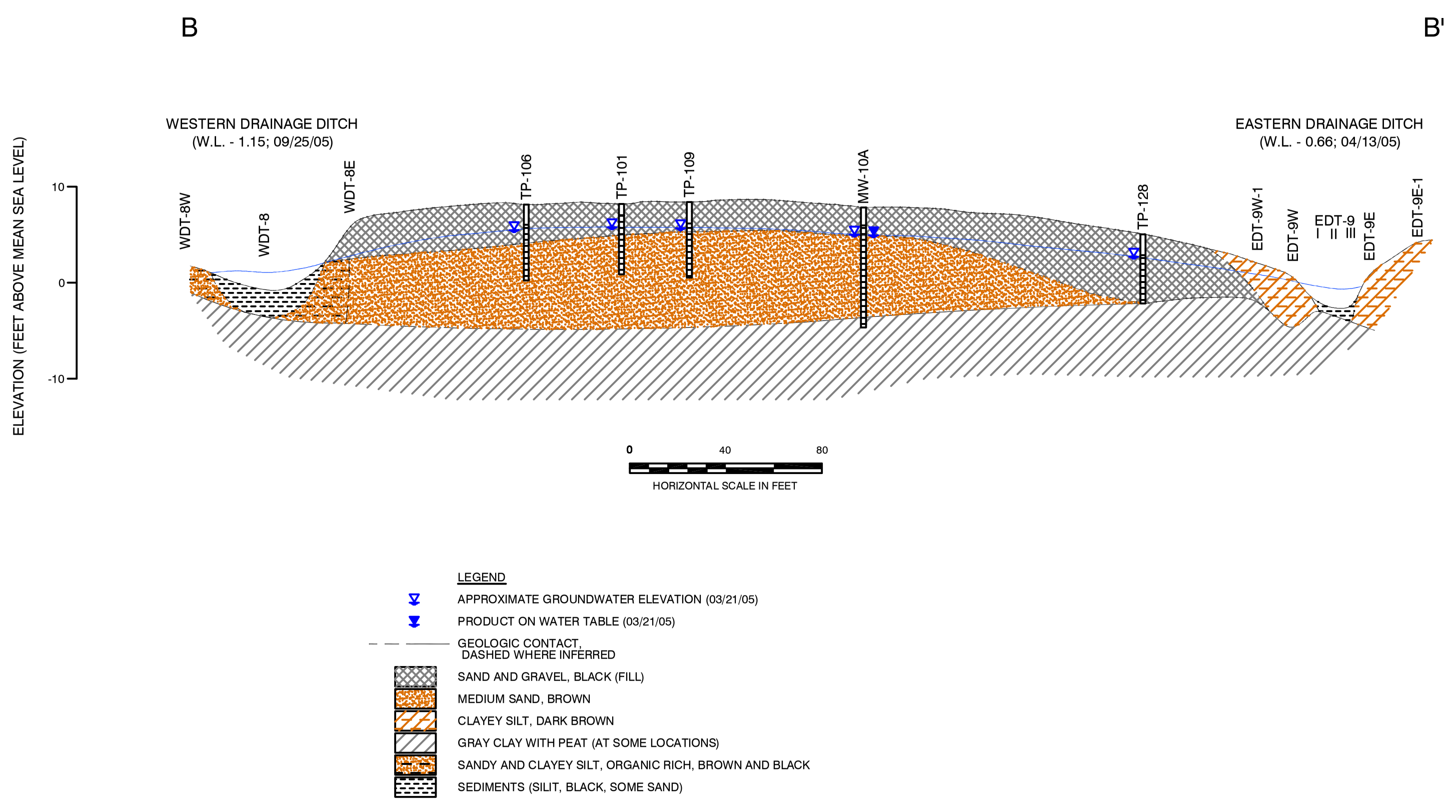

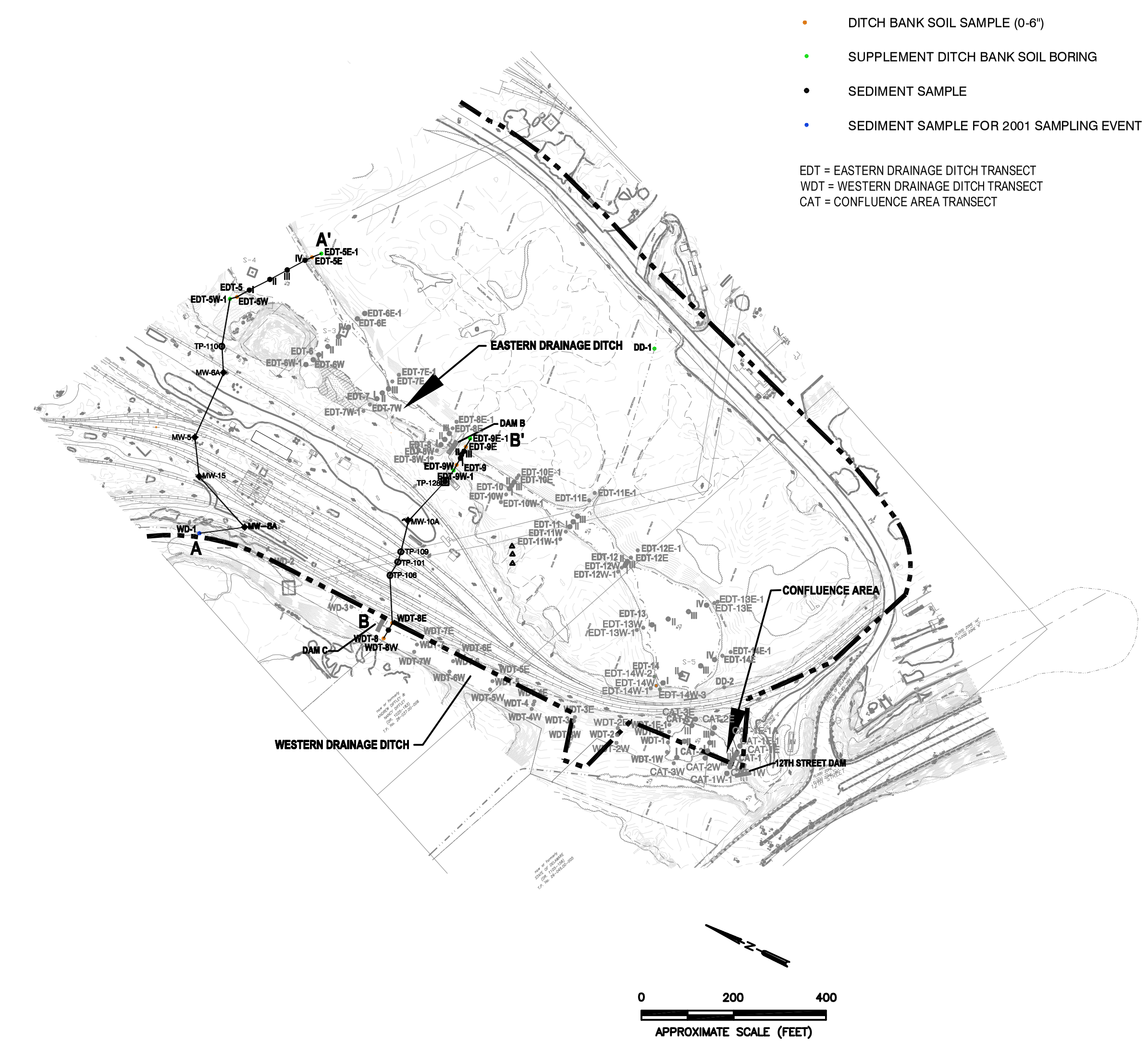

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FOR:		GENERALIZED HYDROGEOLOGIC PROFILES		FIGURE: 2-3
AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE				
JOB NUMBER: 01OT.01057	DRAWN BY: KEF	CHECKED BY: SB	APPROVED BY:	DATE: 04/30/2007

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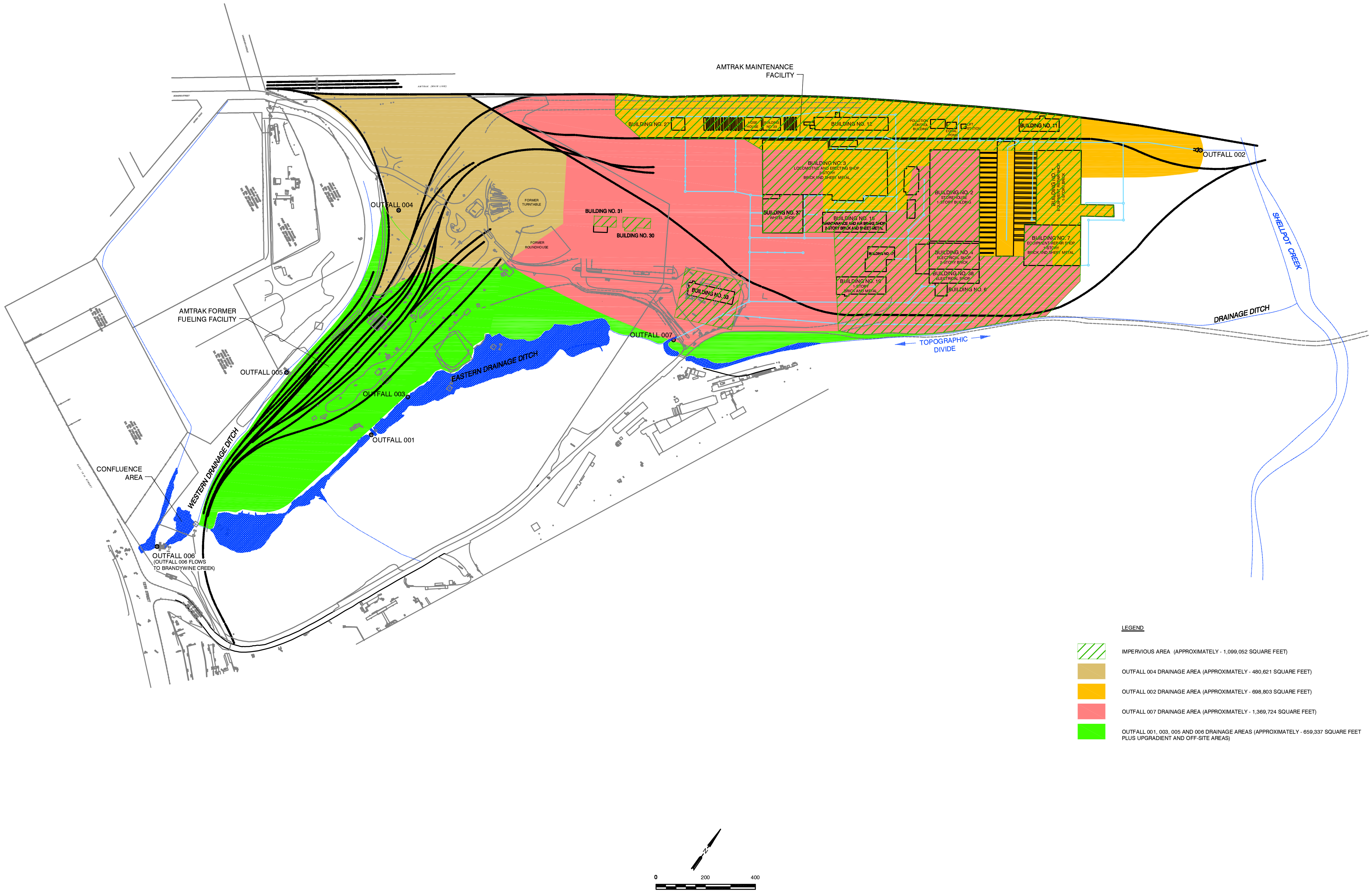

LEGEND

- IMPERVIOUS AREA (APPROXIMATELY - 1,099,052 SQUARE FEET)
- OUTFALL 004 DRAINAGE AREA (APPROXIMATELY - 480,621 SQUARE FEET)
- OUTFALL 002 DRAINAGE AREA (APPROXIMATELY - 698,803 SQUARE FEET)
- OUTFALL 007 DRAINAGE AREA (APPROXIMATELY - 1,369,724 SQUARE FEET)
- OUTFALL 001, 003, 005 AND 006 DRAINAGE AREAS (APPROXIMATELY - 659,337 SQUARE FEET PLUS UPGRADIENT AND OFF-SITE AREAS)

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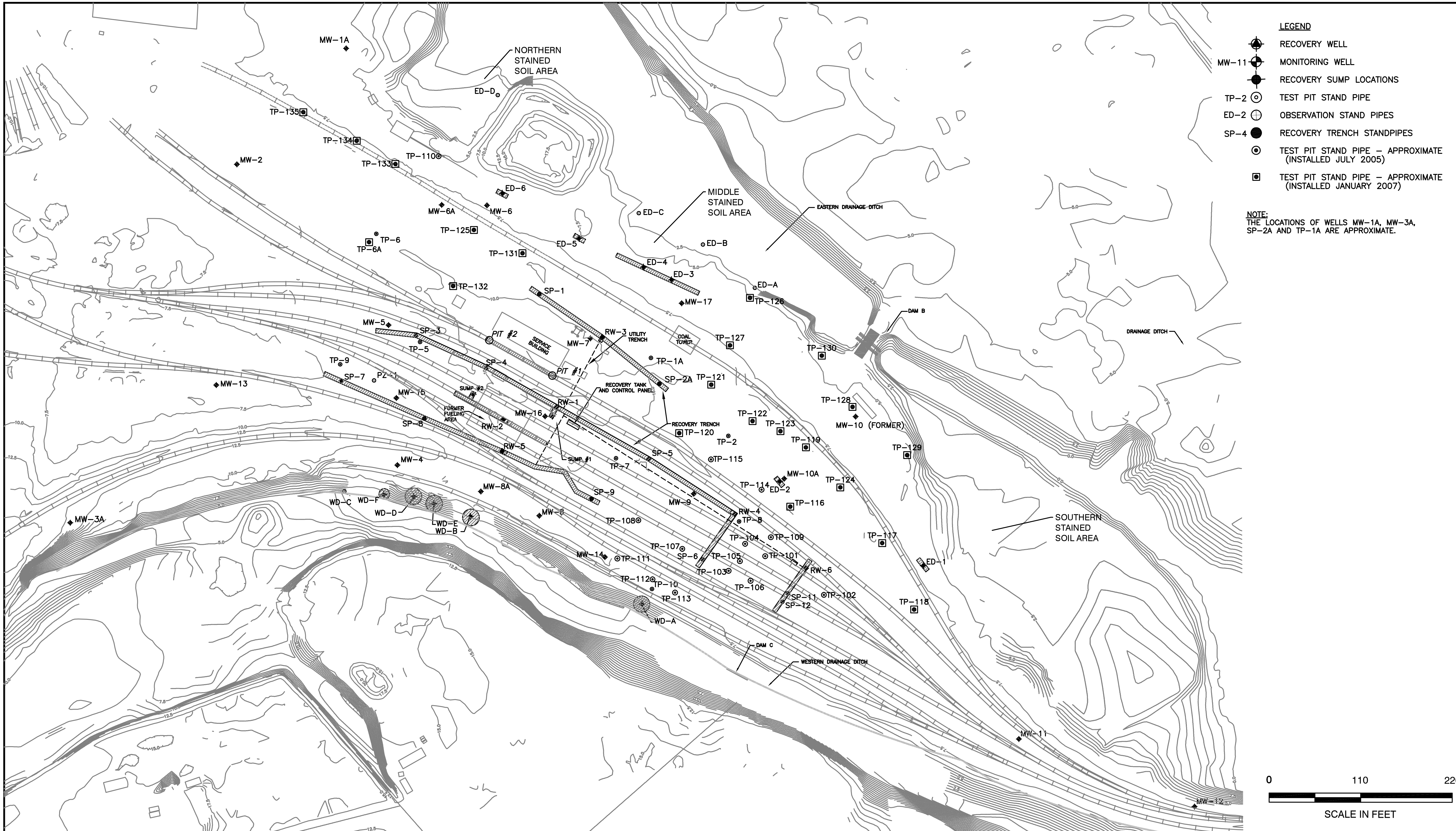
FOR:		SITE OUTFALL LOCATIONS AND ON FACILITY DRAINAGE AREAS		PLATE: 2-4
AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE				
JOB NUMBER: 62OT-01057	DRAWN BY: KEF	CHECKED BY: SB	APPROVED BY:	DATE: 04/27/2

FILEPATH: PHASE II RI REPORT - 2007

62OT-1057-2-4.DWG

NOTE:
006 DRAINAGE AREA = 5,160,407 SQUARE FEET

SECOR 102 PICKERING WAY, SUITE 200	FOR: AMTRAK FORMER FUELING FACILITY VANDEVER AVENUE WILMINGTON, DELAWARE	OUTFALL 006 DRAINAGE AREA	PLATE: 2-5



SECOR
102 PICKERING WAY, SUITE 200
EXTON, PENNSYLVANIA
PHONE: (484) 875-3075/875-9286 (FAX)

FOR:
AMTRAK FORMER FUELING FACILITY
4001 VANDEVER AVENUE
WILMINGTON, DELAWARE

LAYOUT OF REMEDIAL SYSTEM

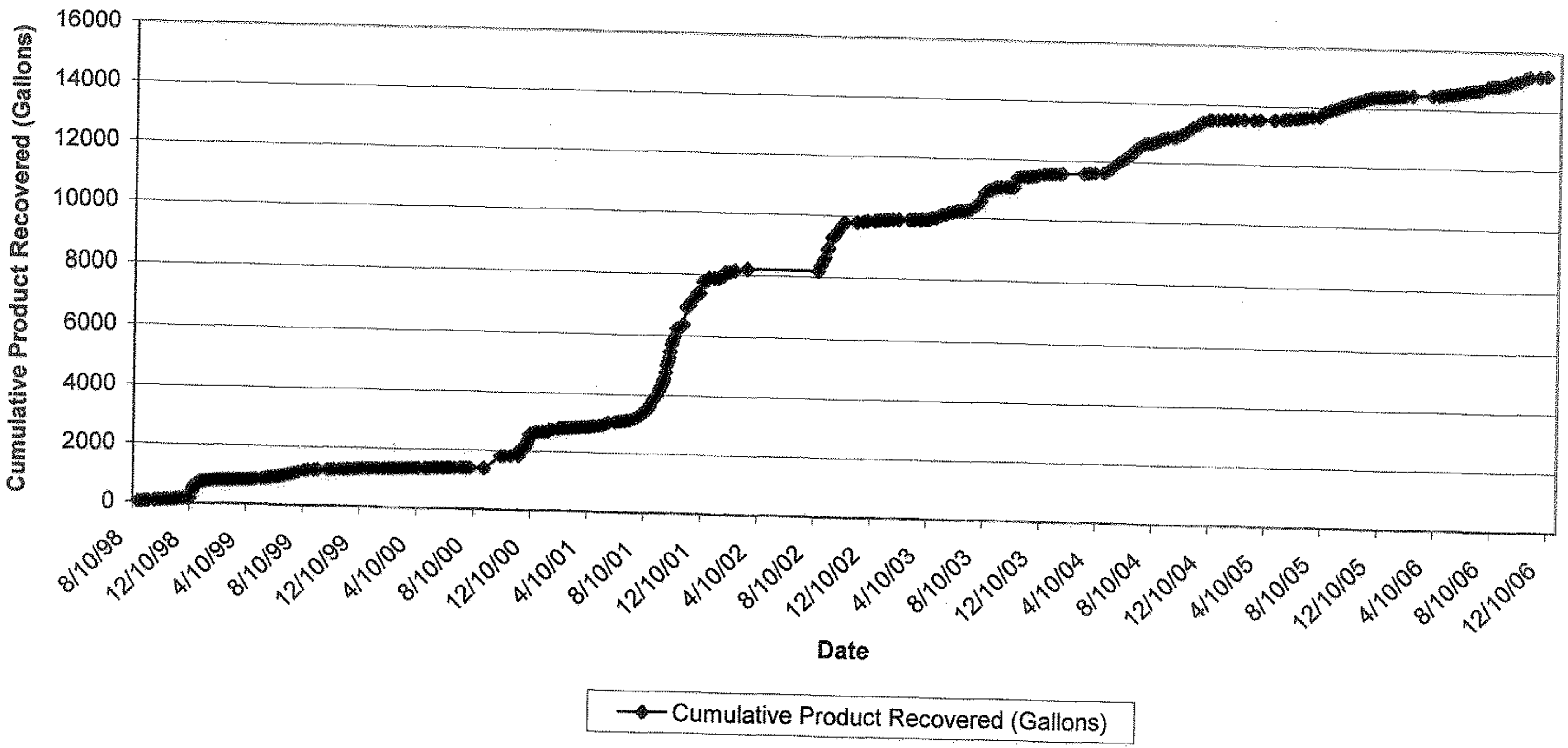
FIGURE: **3-1**

JOB NUMBER:	DRAWN BY:	CHECKED BY:	APPROVED BY:	DATE:
62OT.01057	KEF	SB		04/27/2007

FILEPATH: PHASE II RI REPORT - 2007

62OT-1057-3-1.DWG

FIGURE 3-2
Cumulative Product Recovered
Manual Recovery, Sump #1 (IRM), Trench Recovery Wells, Construction Dewatering and Compressed Gas System
Through December 2006
Amtrak Former Fueling Facility
4001 Vandever Avenue, Wilmington, Delaware



S:/Clients/Amtrak-APU/LPH/Product Recovery tables through January 2007.xls/total rec chart

FIGURE 3-3
Cumulative Product Recovered
Sump #1 (IRM), Trench Recovery Wells and Construction Dewatering
Through December 2006
Amtrak Former Fueling Facility
4001 Vandever Avenue, Wilmington, Delaware

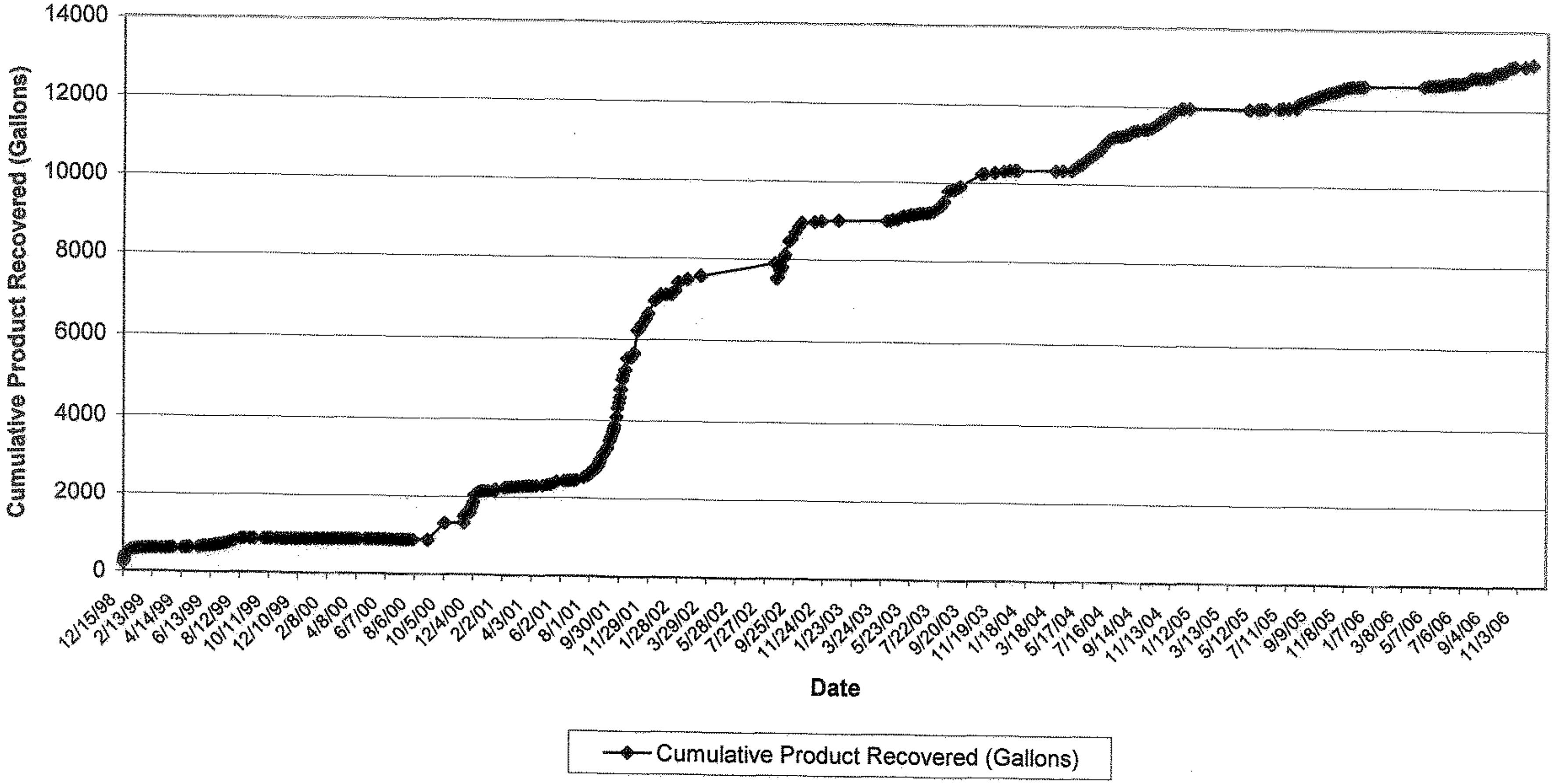
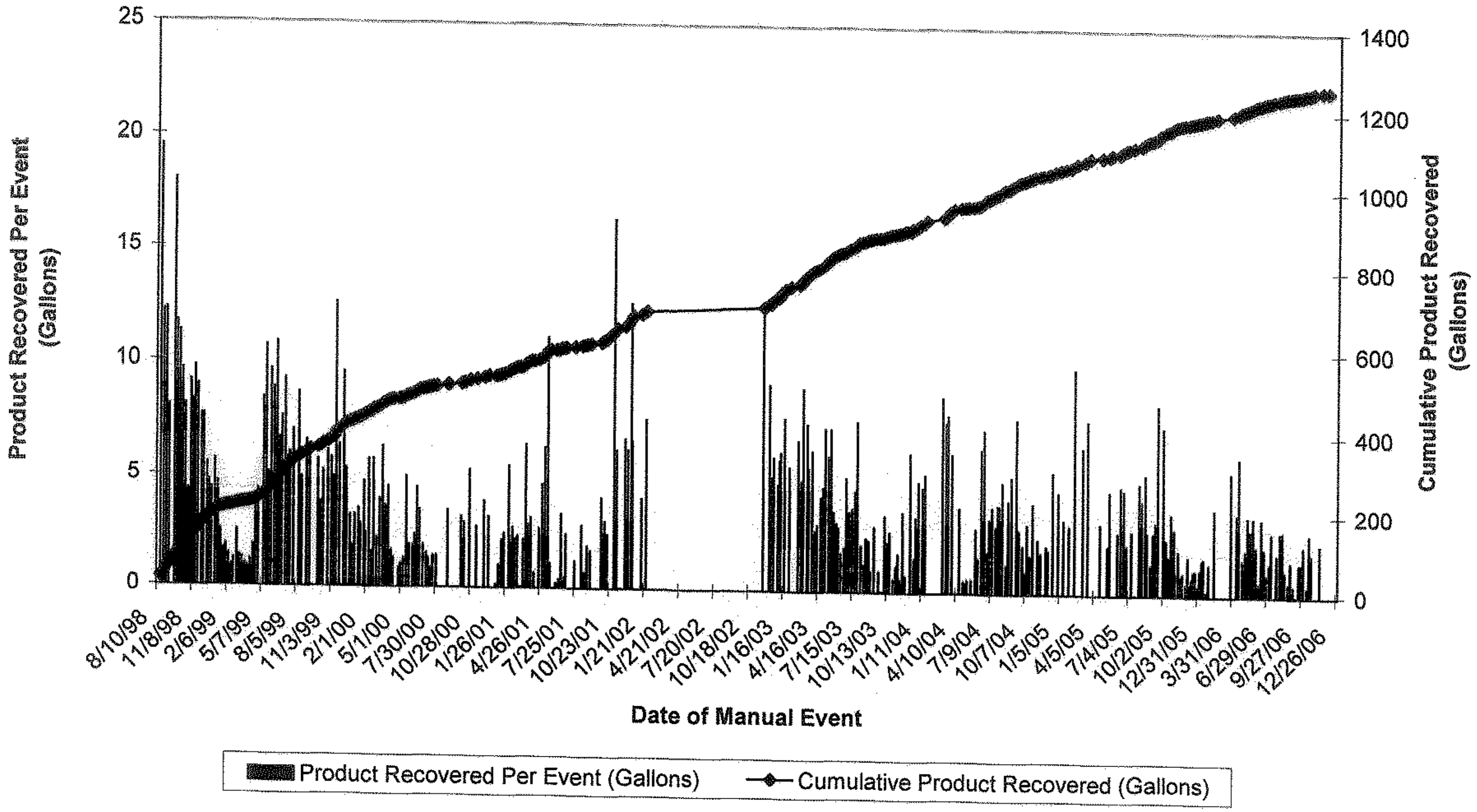
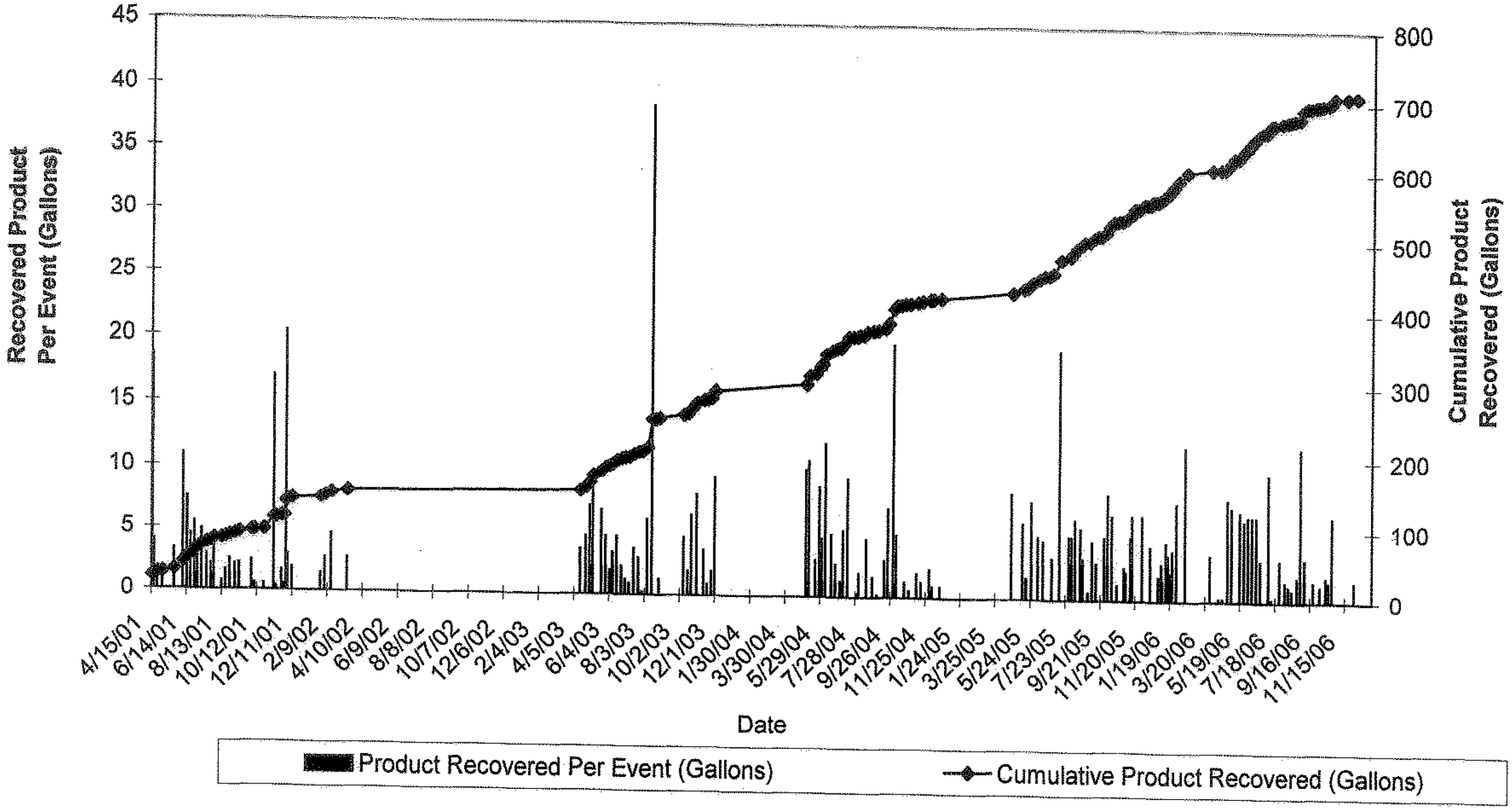


FIGURE 3-4
Product Recovered Per Event and Cumulative Product Recovered
Manual Recovery
Through December 2006
Amtrak Former Fueling Facility
4001 Vandever Avenue, Wilmington, Delaware



S:/Clients/Amtrak-APU/LPH/Product Recovery tables through december 2006 r.xls/man rec chart

FIGURE 3-5
Product Recovered Per Event and Cumulative Product Recovered
Compressed Gas System
Through Decmber 2007
Amtrak Former Fueling Facility
4001 Vandever Avenue, Wilmington, Delaware



S:/Clients/Amtrak-APU/LPH/Product Recovery tables through december 2006 r.xls/Xitech Cht