SITE CHARACTERIZATION REPORT

POPLAR POINT

WASHINGTON, D.C.

Poplar Point in 1973

PREPARED FOR THE

DISTRICT OF COLUMBIA

AND THE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

RIDOLFI Inc.

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Prepared for the

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Prepared by

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EXECUTIVE SUMMARY

ES-1 BACKGROUND

The Poplar Point site is located in Washington, D.C., on the south bank of the Anacostia River, just upstream of the confluence with the Potomac River. The site, which is owned by the U.S. National Park Service, was historically used as a plant nursery, including facilities known as the D.C. Lanham Tree Nursery and the Architect of the Capitol (AOC) Nursery. The U.S. Navy operated a Naval Receiving Station on an adjacent property. Together these areas encompass about 44 acres.

The District of Columbia (D.C.) and the National Oceanic and Atmospheric Administration (NOAA) have developed a coordinated strategy to evaluate environmental conditions at the Poplar Point site. The D.C. and NOAA have signed an Interagency Agreement to investigate, clean up, restore, and enhance habitat at Poplar Point.

NOAA retained Ridolfi Inc. (Ridolfi) to complete a site characterization of the Poplar Point site. As part of this effort, Ridolfi reviewed and evaluated information generated during previous investigations and conducted new field activities to gather the data necessary for characterizing environmental conditions at the site.

Past practices at the Poplar Point site led to the release of contaminants to the environment. These practices included fueling and heating, application of pesticides, and undocumented dumping of materials that may have contained chemicals. In addition, releases from adjacent facilities may have impacted some areas of the site.

Between 1986 and 2002, six separate field investigations were conducted at the Poplar Point site to characterize environmental conditions. This report briefly summarizes previous investigations, describes Ridolfi's 2002 field activities and collection of environmental samples, and integrates results from the new and previous investigations to develop a geological and hydrogeological model for the site. In addition, the current and historical chemical results for soil, ground water, and surface water samples are compared to available screening levels that are intended to be protective of human and ecological receptors. This comparison identifies the chemicals of concern by medium and portions of the site where these chemicals are found.

ES-2 SUMMARY OF PHYSICAL SITE CHARACTERISTICS

The Poplar Point site is quite flat. Since active nursery operations ceased, wetlands have developed in several areas because stormwater that was once pumped off site now collects in topographically low areas. Stickfoot Sewer runs under the eastern portion of the site and conveys both stormwater and Stickfoot Creek from areas south of the site to the Anacostia River.

Near-surface material at the site consists of fill that was placed beginning about 100 years ago both to reclaim "swamp" land and as a means of disposing of sediment dredged from the Anacostia River to deepen a navigational channel. The fill consists of 1 foot to 20 feet of dredged sand and silt, as well as miscellaneous debris. Underlying the fill in most areas of the site is a thick layer of soft gray Holocene clay. The clay is up to 40 feet thick near the river and thins moving away from the river to the south, pinching out near the southern portion of the site. There are a few discontinuous pockets of sand lying on top of the Holocene clay.

A fine wet sand interbedded with a sandy rounded gravel (called the middle permeable unit in this report) underlies the Holocene clay or fill in the southern portion of the site. Farther north, where the Holocene clay is considerably thicker, a unit with sand and sandy gravel lithology (called the lower permeable unit in this report) is encountered below the Holocene clay. One boring drilled in the south-central portion of the site encountered neither the middle nor the lower permeable unit, which suggests that the two permeable units are not physically connected, although the potential exists that they are connected at other areas at or near the site.

Water level measurements in the fill suggest that ground water flow is controlled by the topography of the underlying Holocene clay and presumably by localized areas with preferential recharge. However, water level patterns are erratic, suggesting that there is no consistent direction of ground water flow in the fill material.

In the vicinity of the site, the Anacostia River is tidally influenced, with about 2 feet of tidal variation per day. Previous reports suggest that there may be a tidal influence in the water levels in several monitoring wells. However, it appears from the cross sections prepared during this study that only the lower permeable unit is possibly connected hydraulically to the Anacostia River.

ES-2.1 Summary of Nature and Extent of Contamination

Areas with significantly elevated concentrations of one or more chemicals are summarized below, although this discussion is not intended to represent all of the site risks or to indicate areas that require remedial actions. For each chemical in each medium, the lowest applicable screening level was used for comparison purposes. Comparisons to other screening levels are also presented in this report to provide some sense of the magnitude of the issues associated with a given chemical or to identify

patterns or hotspots. It is important to note that not all the screening levels discussed in this report are intended to be used for cleanup purposes.

ES-2.1.1 Soil

Benzo(a)pyrene was detected above a screening level in seven samples from the former AOC Area. Three samples from Wetland 1 in the D.C. Lanham Area, all located near the fence line adjacent to the AOC Area, also contained elevated concentrations of benzo(a)pyrene, as did two samples from background locations north of Anacostia Drive.

The pesticide 4,4'-DDT was detected above a screening level in a sample collected near the southern greenhouses and in a storm drain sample from the AOC Area. In addition, 4,4'-DDT was detected at elevated concentrations in four samples from the southern portion of Wetland 1, one sample from the north-central portion of Wetland 1, and one sample from the southern portion of the D.C. Lanham Area.

Arsenic was detected at concentrations exceeding a screening level in four samples from the AOC Area and in two samples from near the southern end of Wetland 1. Six additional locations in Wetland 1 had elevated arsenic concentrations in soil. Finally, two samples collected near the Green Fuel Oil property and one taken in the south-central portion of the D.C. Lanham Area have elevated arsenic concentrations.

Diesel was detected at an elevated concentration in a soil sample taken from the AOC Area near a former aboveground storage tank (AST), and motor oil was detected at an elevated concentration in a sample from the dog training area. Two samples collected in the D.C. Lanham Area, one from near the former burn pit and another from near the Green Fuel Oil property, had elevated concentrations of petroleum products.

ES-2.1.2 Ground Water

Diesel, motor oil, or fuel constituents have been detected at concentrations exceeding screening levels in some monitoring wells, most of which are near the location of former underground storage tanks (USTs) or ASTs. One such well is located near a former burn pit, suggesting that fuel used in burning activities has impacted ground water. Diesel-range organics were detected in a relatively shallow well in the north-central portion of the AOC Area at a concentration above the D.C. cleanup standard. This well is not adjacent to any known fuel storage facilities.

Methyl tertiary-butyl ether, a gasoline additive commonly known as MTBE, was detected in four monitoring wells at concentrations above the U.S. Environmental Protection Agency's (EPA) advisory level (based on taste and odor) for drinking water. The wells are all located near the former garage in the AOC Area. Vinyl chloride was detected above a screening level in one monitoring well north of the garage.

Benzene was detected at a concentration slightly above a screening level in a sample from a monitoring well screened in the lower permeable unit below a thick layer of clay. The benzene could be associated with gasoline impacts found near the garage.

Also detected in ground water were several inorganic and organic chemicals. The inorganic compounds are likely associated with the solids in turbid samples or with samples collected from shallow perched zones in the fill and are not widespread. Similarly, the miscellaneous organic compounds in ground water do not seem to indicate a pervasive problem in ground water.

ES-3 RECOMMENDATIONS

The surface soil contamination is relatively discontinuous. Several samples collected at the southern end of Wetland 1 contained a variety of chemicals at concentrations that exceed screening levels. Historically, Wetland 1 was a collection point for surface water runoff, and the concentrations of chemicals in the soil in the vicinity may reflect the cumulative effect of past practices throughout the D.C. Lanham Area.

Some contaminated material may be removed as a component of habitat restoration activities at the site. In other areas it may be prudent to perform limited removals or to place a clean cap to break the exposure pathway. It is possible to use rapid-turnaround laboratory results or field-screening instruments to guide remedial efforts.

Additional soil/sediment samples should be collected from Wetland 1 to better define the extent of contamination. These should include profiles across flow channels in the wetland and cores in selected locations to define the thickness of the contaminated sediment. Several sumps and storm drains have concentrations of chemicals that exceed screening levels. It would be prudent to remove sediment from these collection points to prevent migration through storm sewers or direct contact with these materials.

The AOC prepared a corrective action plan for the petroleum-related contamination associated with the former garage and submitted the report to the D.C. UST Division in 2003. The D.C. UST Division issued a conditional site closure letter dated July 2003. However, several other areas of the site have petroleum impacts. It is recommended that well DCMW009-02 be resampled for benzene, toluene, ethylbenzene, and xylenes and that wells MW-07 and DCMW012-02 be resampled for diesel-range organics. Remedial planning for the area adjacent to Green Fuel Oil property should also be

conducted. This may include installation of several monitoring wells adjacent to that facility.

Although previous studies have indicated that ground water at the site may be tidally influenced by a connection to the Anacostia River, data supporting this conclusion are very limited. It may be prudent to place pressure transducers in several monitoring wells near the river to record water level measurements for at least a few tidal cycles (several days). Additionally, it is appropriate to install monitoring wells between the site and the Anacostia River, to further evaluate the potential for off-site contaminant transport. Data from these wells would be used in conjunction with the results of the sediment sampling effort conducted by the Academy of Natural Sciences to study the connection between the site and the river.

Some restoration alternatives include "daylighting" of Stickfoot Sewer. Measurement of flow (discharge) and collection of water chemistry during various flow regimes should be conducted in Stickfoot Sewer to support restoration planning.

1.0 INTRODUCTION

The District of Columbia (D.C.) and National Oceanic and Atmospheric Administration (NOAA) have developed a coordinated strategy to evaluate environmental conditions at the Poplar Point site in Washington, D.C. The D.C. and NOAA have signed an Interagency Agreement to investigate, clean up, restore, and enhance habitat at Poplar Point.

The study was funded under a Congressional appropriation of 3.45 million dollars for environmental and infrastructure costs at the Poplar Point site. This included funding for an environmental assessment, site remediation, and wetlands restoration of the 11 acres under the jurisdiction of the D.C. The site is owned by the U.S. National Park Service.

NOAA retained Ridolfi Inc. (Ridolfi) to complete a site characterization of Poplar Point. As part of this effort, Ridolfi reviewed and evaluated existing site information and performed field activities that included:

- Assessment of ground water discharge/recharge in wetland areas;
- Geophysical investigation of portions of the site;
- Surface soil sampling;
- Completion of soil borings and subsurface soil sampling;
- Installation and sampling of piezometers and monitoring wells;
- A ground water investigation;
- Sampling of Stickfoot Sewer sediment and surface water; and
- A drum and debris survey.

This report presents the results of the site characterization work. Section 1 presents the project objectives and site background. Section 2 describes the procedures used in the field investigations. Section 3 summarizes the physical characteristics of the Poplar Point site, and Section 4 describes the nature and extent of contamination at the Poplar Point site. The results of the site characterization are summarized in Section 5. Sections 6 and 7 list the references cited and the acronyms used in this report, respectively.

1.1 Objectives of the Site Characterization

The principal objectives of the site characterization were to:

- Characterize existing site conditions by reviewing historical data and by collecting and analyzing surface soil, subsurface soil, sediment, and ground water samples.

- Complete a site characterization report that includes field data and the results of laboratory analyses.

- Complete a human health and ecological risk assessment using the newly generated and historical data; this task will be reported in a separate deliverable.

1.2 Site Background

1.2.1 Site Description

As defined in the Implementation Plan (Appendix A of the Interagency Agreement signed by the D.C. Department of Health and NOAA on July 31, 2001), the Poplar Point study area comprises two sections (Figure 1-1). Section One covers an area where

several environmental site investigations have been conducted and encompasses properties used previously for nursery operations. Section Two contains properties that are owned by or are under the jurisdiction of D.C. An additional area to the east of Section One was formerly operated by the U.S. Department of the Navy as a Naval Receiving Station (USNRS). The former USNRS area is not considered part of the Poplar Point study area for the purposes of this site characterization. The USNRS may be investigated under another program, such as the Defense Environmental Restoration Program (DERP) for Formerly Used Defense Sites (FUDS).

Section One

This site characterization report focuses on Section One, which is referred to as "the site" or "the Poplar Point site." Section One of the Poplar Point study area is located on the southern bank of the Anacostia River at 1900 Anacostia Drive S.E., Washington, D.C. The property is primarily bounded by Anacostia Drive to the north, by Howard Road and southbound Interstate 295 (I-295) to the south, by various government buildings to the east, and by South Capitol Street to the west. The former USNRS property forms the eastern boundary. The tunnel for the Washington Metropolitan Area Transit Authority Metrorail (METRO) Green Line runs through and beneath the eastern section of Poplar Point, and the Anacostia METRO Station is on the southeastern side of the property.

Section One can be further subdivided into three tracts:

1) A western nursery area known as the D.C. Lanham Tree Nursery;
2) A central portion, formerly operated by the Architect of the Capitol (AOC), that contains abandoned greenhouses, a garage building, a boiler room, offices, and other buildings; and

3) An eastern portion now owned by the National Park Service (NPS) that is undeveloped except for the underground METRO tunnel. The METRO tract was formerly operated by the U.S. Navy under an agreement made between the Secretary of the Navy and the Secretary of the Interior in 1942 (Dolph, 2001).

Although these areas have been under multiple jurisdictions and control, for ease of reference they will be referred to in this report as the D.C. Lanham Area, the AOC Area, and the USNRS Area. The three areas, numerous unnamed buildings (e.g., garage, greenhouse, boiler room), and other site features referred to in this report are shown on Figure 1-2.

Section Two

Section Two is an irregularly shaped zone bounded on the north by the property managed by the NPS and on the east by the 11th Street Bridge. The southern boundary of Section Two runs along southbound I-295 and Firth Sterling Avenue to the limits of the cloverleaf interchanges for I-295 and Suitland Parkway. South Capitol Street and the Anacostia River form the western boundaries of Section Two. Few environmental investigations have been conducted in this area. The area contains numerous private properties, some of which have been noted for posing potential hazardous substance issues, such as Green Fuel Oil, P&P Auto Body, and the Howard Street warehouse.

1.2.2 Site History

Prior to the early 1900s, the majority of the Poplar Point site consisted of tidally influenced mudflats submerged under 3 to 5 feet of water. From approximately 1910 through 1920, the site was filled with dredge spoils from the Anacostia River generated by operations undertaken to improve navigation in and around the lower Anacostia

and Potomac Rivers. Soil borings conducted during previous investigations verified the presence of fill materials ranging in thickness from 2.5 feet in the southwestern portion to 15 feet in the northeastern portion of the site (Environ, 2002; Buchman et al., 2002).

Figure 1-3 was prepared by overlaying a recent site features diagram (Figure 1-2) on an 1882 (pre-dredging, pre-filling) nautical map of the D.C. area, which shows the submerged, tidally influenced mudflats. The historical Anacostia riverbank ran through the area south of the southern greenhouses and extended through the southwestern portion of the site. Stickfoot Creek historically ran from southeast to southwest and drained into the Anacostia River southwest of the current site. It does not appear that the historical Stickfoot Creek ran through what is now the site.

The AOC Area of the site was used between 1927 and 1993 as a nursery for growing tropical and subtropical plants. During the same period, the west side of the site (D.C. Lanham Area) was used as the D.C. Lanham Tree Nursery. The U.S. Navy occupied the eastern portion of the greater site area from the 1940s through the 1960s. The site has been vacant since 1993 (Environ, 2002).

A drainage channel created in the fill material was transformed during the late 1940s into the current Stickfoot Sewer line. A pump house was built at that time to direct surface runoff to the sewer (Environ, 2002). Stickfoot Creek was realigned and placed in a culvert that flows into the Stickfoot Sewer line.

The METRO Green Line was constructed under the site during the late 1980s and early 1990s (Brown, 1999).

1.2.3 Previous Investigations

Several investigations have been completed at the Poplar Point site prior to the site characterization work completed in 2002 by Ridolfi. This section summarizes the scope of the previous investigations. The sampling locations where soil, ground water, surface water, and sediment samples were collected during the previous investigations are shown on Figure 1-2. Analytical results from the previous investigations have been merged with Ridolfi's analytical results, and the combined data set was used to characterize environmental site conditions (see Section 4.0).

Department of Transportation Investigations – 1981 (DeLeuw et al., 1981)

In 1981, the U.S. Department of Transportation (U.S. DOT) completed an Environmental Impact Statement (EIS) for construction of the Anacostia segment of the METRO Green Line (U.S. DOT, 1981). Geological data collected during construction were used to characterize stratigraphy and potential ground water flow characteristics. The EIS primarily focused on the impact of the rail line and did not identify areas for environmental investigation.

Wetlands Delineation – 1995 (GSI, 1995)

Wetland areas were delineated at the site in August 1995 by Geotechnical Services, Inc. (GSI). Four wetland areas were identified during the delineation; they are labeled as Wetlands 1 through 4 on Figure 1-2.

Phase I Environmental Site Assessment – 1995 (Volkert, 1995)

In December 1995, Volkert Environmental Group, Inc. (Volkert) completed a Phase I Environmental Site Assessment (ESA) of the site. Volkert's ESA identified a gasoline underground storage tank (UST), a fuel oil aboveground storage tank (AST), numerous 55-gallon drums, possible asbestos-containing materials (ACMs), possible polychlorinated biphenyls (PCBs), hazardous materials or chemicals, and historical activities that might have impacted the site.

Volkert recommended additional investigations near the waste pit, discarded 55-gallon drums, fuel oil AST, gasoline UST, and possible ACMs in the boiler room, offices, and greenhouses.

Emergency Response Activities – 1997

In March 1997, several federal and local agencies initiated emergency response activities at the site because of the presence of drums, compressed gas cylinders, and other evidence of potential contamination. After further inspection, the D.C. Fire Department de-escalated the site to non-emergency status. It was during the emergency response activities that D.C. was established as the primary authority at the site, and the D.C. Department of Environmental Health/Environmental Health Administration (DOH/EHA) was designated as the lead agency.

The emergency response activities motivated three phases of priority response, described below.

Priority Response, Phases I through III – 1997 (Brown, 1997a,b,c,d,e)

In March 1997, a three-phase priority response plan was developed for the site by Thomas L. Brown Associates (Brown). Phase I was to be conducted within 72 hours and included staging and removing 11 gas cylinders. Phase I work activities also included overpacking and appropriately storing laboratory kits containing ferrous oxide and potassium nitrate from the chemical storage building.

Phase II activities, which were to be conducted within two to three weeks, included overpacking 55-gallon and 25-gallon drums and excavating and stockpiling stained soils found beneath the drums. The overpacked drums and excavated soils were temporarily stockpiled on site, pending appropriate disposal.

Phase III activities included locating and removing the source of an oil leak in the boiler room; removing five ASTs and one UST; planning for the removal of drums located on the D.C. Lanham Area; and repairing the fence surrounding the site.

During the priority response activities, one 1,000-gallon UST was removed from the southern side of the garage building. A small hole was noted in the bottom of the UST, but no soil was removed. Three soil samples collected for analysis contained fuel-related compounds.

Brown also completed an asbestos survey of the site in 1997. This study analyzed 114 samples of floor tiles, roofing, ceiling tiles, pipe insulation, and other potential ACMs. Suspect material was observed in all but one building. Asbestos was found in floor tiles of the southern boiler room, office space of the northern nursery building, transite board in tables in greenhouses (confirmed in two, suspected in all others), insulation in

two of the northern greenhouses and the associated office building/boiler room, and material stored in trash bags in the southern boiler room (Brown, 1997b).

In March 1997, samples were collected from six drums and two bags of soil were collected from the drum area for laboratory analyses (Brown, 1997c). The drum contents were described as kerosene and lubrication oil. Only benzene, toluene, ethylbenzene, and xylenes (BTEX) and naphthalene were detected in the samples.

The Phase II priority response report provides data from the sampling of three tanks, two of which were reported as removed, plus some pails found near the garage (Brown, 1997d).

- A 300-gallon AST in a concrete vault near the southwest corner was found to contain water but no BTEX or petroleum hydrocarbons.

- A yellow, 275-gallon diesel AST near the southern fence was drained and removed.

- Four pails containing liquids were removed from north of the garage. Testing of the contents showed that the pails contained petroleum products and pesticides.

Phase II Investigations – 1997 and 1999 (Brown, 1999)

Based on findings from the three-phase priority response, regulatory authorities requested that additional environmental investigations be conducted at the site. Phase II investigations included:

- Completing a subsurface investigation, including soil borings and monitoring well installations;

- Collecting and analyzing surface and subsurface soil samples, wetland sediment samples, ground water samples, and surface water samples;

- Excavating test pits at various locations at the D.C. Lanham Area; and

- Locating, cataloging, sampling, and overpacking drums.

Soil/Planting Medium and Sediment Investigations – 1998 (E&E, 1999)

In August 1998, Ecology and Environment, Inc. (E&E) was retained by the NPS to collect samples of soil/planting medium and sediment at the site. Samples of soil/planting medium were collected from eight of the 14 greenhouses. Three soil samples were collected at the dog training area, and one sediment sample was collected from the southeast drain sump. In addition, three soil samples were collected from unidentified test pit locations. Samples were analyzed for chlorinated pesticides (by U.S. Environmental Protection Agency [U.S. EPA] Method 8081M), carbamates (by U.S. EPA Method 8318), and arsenic. No description of specific sampling methods (e.g., sampling depth) was provided in E&E's report on the test results. Results for some of the samples were determined to be unreliable; therefore, E&E resampled some locations in October 1998. The results are described in E&E's 1999 report. These data are not used in this report's discussion of the nature and extent of contamination (Section 4.0) because the samples do not represent a "natural" site medium.

Site Investigation Activities – 1999 (Environ, 2002)

In 1999, Environ Corporation (Environ) was retained by the AOC to complete an environmental investigation and prepare a comprehensive report regarding soil, sediment, ground water, and surface water conditions at the site. The investigation activities included:

- Collecting soil samples within greenhouse areas, former planting areas, wetland areas, and former drum storage areas for pesticide analysis;
- Collecting soil samples at the location of a reported former burn pit for dioxin analysis;
- Collecting soil samples from an off-site area north of Anacostia Drive for analysis of carcinogenic polycyclic aromatic hydrocarbons (PAHs) and arsenic to evaluate anthropogenic impacts;
- Collecting sediment samples from two storm drains in the vicinity of the southern greenhouses for pesticides analysis; and
- Resampling ground water from seven monitoring wells at which several metals had been reported by Brown at levels greater than their risk-based concentrations (RBCs).

Based on various site-specific exposure scenarios, risk-based screening levels (RBSLs) were developed for each chemical detected in the soil and water samples collected at the site. Of these, only arsenic in surface soil was calculated to exceed the RBSL. The elevated arsenic concentrations were thought to result from fill material dredged from the Anacostia River and placed at the site by the U.S. Army Corps of Engineers in the early 1900s (Environ, 2002).

Site Inspection – 2001 (RAI, 2001)

On behalf of the U.S. EPA, Resource Applications, Inc. (RAI) completed a site inspection in July and August 2001. The objectives were to determine the level of contamination in various media and develop a hazard ranking system preliminary ranking evaluation score (PREscore). During this investigation, the surface water migration pathway was evaluated, including potential ground water-to-surface water migration. In addition, samples of surface soil, wetland sediment, and surface water were collected and analyzed for organic and inorganic chemicals. The analytical results from this investigation are integrated with other analytical data in this report's discussion of the nature and extent of contamination (Section 4.0).

2.0 FIELD INVESTIGATIONS

Site characterization activities at Poplar Point included a geophysical survey, a ground water discharge/recharge assessment, a surface soil investigation, a subsurface soil investigation (which included completing soil borings and installing monitoring wells), a ground water investigation, and a wetland drum and debris survey. Samples of ground water, surface water from Stickfoot Sewer, sediment, surface soil, and subsurface soil were collected from the site during these investigations. Table 2-1 presents the sample information, including sample identification, location, and the analytical chemistry performed on each sample.

2.1 Geophysical Survey

As part of the site characterization activities at Poplar Point, a geophysical investigation was conducted at eight areas of interest as described in the Geophysical Investigation Report (Appendix A). This work was performed during July and August 2002, in accordance with the Ground Water Discharge/Recharge and Geophysical Assessment Work Plan (Ridolfi, 2002a).

The objective of the geophysical survey was to identify anomalous zones in the subsurface on the basis of variations in electromagnetic properties. Anomalies may be associated with buried metallic debris or contrasts in soil properties. The geophysical survey employed electromagnetic and ground-penetrating radar methods intended to locate buried objects that may be a source or conduit of contamination, such as buried tanks or drums (source) or buried pipes (conduit). The field methods and results of the geophysical survey are detailed in the Geophysical Investigation Report (Appendix A).

The findings of the geophysical investigation were used to guide the follow-up surface and subsurface soil sampling.

2.2 Ground Water Discharge/Recharge Assessment

Site characterization activities at Poplar Point included a ground water discharge/recharge assessment. During this assessment, staff gages, seepage meters, and piezometers were installed and monitored. This work was performed in several phases throughout 2002 in accordance with the Ground Water Discharge/Recharge and Geophysical Assessment Work Plan (Ridolfi, 2002a) and the Soil Boring and Monitoring Well Installation Work Plan (Ridolfi, 2002c).

2.2.1 Purpose of Ground Water Discharge/Recharge Assessment

The objective of the ground water discharge/recharge assessment was to assess the hydrology of the wetland surface water bodies at the site. Piezometers and staff gages were installed to determine the hydraulic head relationship between the surface water bodies and the surrounding shallow ground water. Seepage meters were installed in the surface water bodies to determine whether ground water is discharging into the surface water or whether surface water is recharging the ground water. The piezometers, staff gages, and seepage meters were monitored periodically throughout the course of the site characterization to assess variations caused by changing weather conditions, such as significant rain events or droughts.

2.2.2 Piezometer Installation

In July 2002, eight piezometers were installed at the site. The location of each piezometer (identified by the prefix PZ) is shown on Figure 1-2. Construction details for the piezometers are shown on the soil boring logs (Appendix B).

The piezometers were installed as outlined in the work plan with the following exceptions:

- A piezometer was not installed near the proposed location of PZ-9. Two hand auger borings were completed to 9.0 feet in this area, but no ground water was encountered.

- A piezometer was not installed near the proposed location of PZ-10 because sandy coarse gravel and cobble obstructions were encountered while hand augering in the near-surface soil at this location.

Soils encountered while installing the piezometers were described in accordance with the Unified Soil Classification System (USCS). Soil descriptions and other observations were recorded on the soil boring logs (Appendix B).

2.2.3 Staff Gage Installation and Monitoring

To measure the water elevations in the surface water bodies, four staff gages (identified by the prefix SG) were installed at the site as shown on Figure 1-2: three in Wetland 1 (SG-1 through SG-3) and one in Wetland 2 (SG-4). The staff gages were installed and monitored as outlined in the associated work plan (Ridolfi, 2002a). Surface water

elevations were recorded on water level measurement field sheets (Appendix C) and are summarized in Table 2-2.

With the exception of SG-4, each staff gage was installed near one or more piezometers so that surface water elevations could be compared to local ground water elevations. Staff gage SG-1 was installed approximately 15 feet east of PZ-2. Staff gage SG-2 was installed approximately 5 feet east of PZ-4. Staff gage SG-3 was installed 150 feet north-northwest of PZ-6 and 90 feet southeast of PZ-7. No piezometer was installed near SG-4 because sandy coarse gravel and cobble obstructions were encountered while hand augering in the near-surface soil.

2.2.4 Seepage Meter Installation and Monitoring

To measure the ground water flux across the sediment-surface water interface in Wetlands 1 and 2, three "drum method" seepage meters were installed. The seepage meters were constructed and installed as outlined in the associated work plan (Ridolfi, 2002a), with the exception that a fourth seepage meter was not installed in the south end of Wetland 1 because the surface water was not deep enough. The location of each seepage meter (identified by the prefix SM) is shown on Figure 1-2. Seepage meter SM-1 was installed in Wetland 2, and seepage meters SM-2 and SM-3 were installed in Wetland 1. Seepage meters SM-2 and SM-3 were installed within 5 feet of each other, to provide quality assurance/quality control data.

Construction details for the seepage meters are shown on Figure 2-1. Each seepage meter was constructed with a half-section of a 55-gallon drum. Approximately half of each drum section was pushed into the sediment. Underlying pond water was allowed to displace or vent through the nozzle of the drums during insertion. A 1-gallon (3.79-

liter) collection bag, half-filled with a pre-measured volume of water (470 milliliters [ml]), was connected to the top of each drum section using a watertight nozzle.

The seepage meters were installed on November 25, 2002. They were monitored on November 26 and December 17, 2002, to determine whether the volume of water contained in each bag had changed. The findings of the seepage meter monitoring are discussed in Section 3.3.

2.2.5 Piezometer and Ground Water Well Monitoring

Measurements of the depth to ground water were periodically recorded at each of the eight piezometers throughout the course of the site characterization. After ten monitoring wells (identified by the prefix DCMW) were installed in November and December 2002 (see Section 2.4.2 for details of the installation), a final round of depth-to-ground water measurements was made at the newly installed monitoring wells and existing monitoring wells, which had been installed by Brown in 1999 (Figure 1-2). Depth-to-ground water measurements were made to the nearest 0.01 foot using a Solinst Model 101 water level meter.

Data sheets listing the measurements made in the field and calculations used to determine water level elevations appear in Appendix C. Water level elevations for the piezometers and monitoring wells are summarized in Table 2-2.

2.3 Surface Soil Investigation

Site characterization activities at Poplar Point included a surface soil assessment. This work was performed in August and November 2002 in accordance with the Surface Soil

Sampling Work Plan (Ridolfi, 2002b) and the Soil Boring and Monitoring Well Installation Work Plan (Ridolfi, 2002c).

2.3.1 Purpose of the Surface Soil Investigation

The objective of the surface soil sampling was to determine whether surficial soil contamination is present in areas near discolored soil, USTs, ASTs, former disposal sites, the sites of possible discharges, or where previous sampling/analysis detected chemicals at elevated concentrations.

2.3.2 Surface Soil Sampling

To focus on shallow impacts, surface soil sampling stations were selected by reviewing historical data collected by Brown, E&E, Environ, and RAI for samples collected from the surface in media described as either soil or sediment. To streamline review of these data, contaminants of potential concern identified during previous studies were used as indicator chemicals.

Surface soil samples (identified by the prefix SS) were collected from 32 sample stations (SS-01 through SS-32). At 25 stations, both shallow (0 to 0.25 foot below ground surface [bgs]) and deep surface soil samples (0.25 to 0.5 foot bgs) were collected. At sample station SS-29, three samples were collected: the first from 0 to 0.25 foot bgs, the second from 0.25 to 0.5 foot bgs, and the third from 2 to 4 feet bgs. Only one shallow sample (0 to 0.25 foot bgs) was collected at each of sample stations SS-30 through SS-32. At sample stations SS-07 and SS-25, samples were collected from sediment at the bottom of storm drain catch basins or sumps. At sample station SS-27, the sample was collected from sediment in the Stickfoot Sewer, which was accessed through a manhole near the pump house.

The surface soil samples were collected as outlined in the associated work plans with the following exceptions:

- The sample collected at sample station SS-07 was collected from a drain/sump located near the proposed SS-07.
- No sample was collected below the former 10,000-gallon AST near the boiler room, because the ground surface in this area was covered with asphalt and concrete. Only three samples were collected from the property occupied by the Howard Road Academy, a school adjacent to the site: two from inside the playground area and one from a swale south of the school. These samples were collected to address community concerns associated with the proximity of the schoolyard to the site.

Soils encountered during the sampling activities were described in accordance with the USCS. Sample station coordinates and associated soil descriptions, sampling details, and the analytical chemistry performed on each sample are summarized in Table 2-1.

2.4 Subsurface Soil Investigation: Soil Boring and Monitoring Well Installation

Site characterization activities at Poplar Point included completing soil borings and installing monitoring wells. These activities were conducted in November and December 2002 in accordance with the Soil Boring and Monitoring Well Installation Work Plan (Ridolfi, 2002c).

2.4.1 Purpose of Completing Soil Borings and Installing Monitoring Wells

The objective of completing soil borings and installing monitoring wells was to determine whether subsurface contamination is present in areas near USTs, ASTs, former disposal sites, the sites of possible discharges, or where previous sampling/analysis detected chemicals at elevated concentrations. Information obtained from the soil borings was used to assess the relationship between the geological units at the site and the Anacostia River.

2.4.2 Soil Boring, Subsurface Soil Sampling, and Monitoring Well Installations

To aid in determining locations for the installation of permanent monitoring wells near the Green Fuel Oil property, 12 temporary monitoring well (TMW) soil probes (TMW-50 through TMW-61) were completed using a direct-push-probe rig. One subsurface soil sample and one ground water sample were collected from each probe-hole location. The ground water and soil samples were analyzed for diesel-range hydrocarbons by Environmental Services Network Southwest of Atlanta, Georgia, in an on-site mobile laboratory. However, the analytical results were determined to be unreliable and therefore were not used to site monitoring wells DCMW006-02 and DCMW007-02. Instead, the locations of these wells were selected on the basis of subsurface conditions observed at the soil probes, such as petroleum odors in soil and sheen noted on ground water samples. The subsurface soil conditions and other observations noted during the TMW activities are summarized in the soil boring logs (Appendix B).

During November and December 2002, 13 soil borings were completed. Ten of the soil borings were completed as monitoring wells (DCMW006-02 through DCMW015-02). Two subsurface soil samples were collected from each soil boring (identified by the prefix SB). Sample station coordinates and associated soil descriptions, sampling

details, and the analytical chemistry performed on each sample are summarized in Table 2-1.

The soil borings and monitoring well installations were completed as outlined in the associated work plan with the following exceptions:

- To comply with a new tracking system developed by D.C., the well names were changed from those in the work plan (e.g., MW-30 became DCMW006-02).
- To minimize impacts to vegetation and fencing along the north-south road, soil borings and monitoring wells SB-101, DCMW008-02, and DCMW009-02 were completed along the eastern side, instead of the proposed western side, of the road.
- A monitoring well was not installed at SB-101 because the lower permeable unit was not encountered at this location.
- Monitoring wells were not installed at SB-102 and SB-103 because an insignificant quantity of ground water was encountered in the near-surface fill material at these locations.
- Monitoring well DCMW006-02 was installed 60 feet north-northwest of the northwestern corner of the Green Fuel Oil property, instead of the proposed location near the former 275-gallon diesel AST. The well was installed at this location because petroleum odors were observed in soil encountered at the soil probe (TMW-51) completed near this area, while no stained soils or petroleum odors were observed in the soil probe (TMW-53) completed near the diesel AST.
- Monitoring well DCMW012-02 was screened in the surficial fill material, instead of the proposed screened interval in the deeper permeable unit. This well was

installed at a shallower depth because only the smaller track-mounted drill rig could access the drill site due to soft surface soil.

- An additional deeper well, identified as DCMW015-02, was installed near the northwestern portion of the D.C. Lanham Area.

Soil borings that were not completed as monitoring wells were backfilled with medium bentonite chips. Soil cuttings from the soil borings were collected, containerized, and stored for proper disposal pending evaluation of the subsurface soil sample analyses. Subsequently, the investigation-derived waste (IDW) was disposed of; disposition of the material is documented in Appendix D.

The monitoring well locations are depicted on Figure 1-2. Aboveground casing protectors with locking well caps were installed at each well location. The casing protectors were cemented in place with concrete pads. Construction details for each monitoring well are depicted on the soil boring and monitoring well logs (Appendix B).

Each monitoring well was developed using disposable polyethylene bailers. Approximately 5 gallons of water were purged from each monitoring well during development. Purged water was collected, containerized, and stored for proper disposal pending evaluation of the ground water sample analyses. Subsequently, the IDW was disposed of; disposition of the material is documented in Appendix D.

Horizontal coordinates were determined for each newly installed monitoring well using a Trimble Pathfinder Pro Global Positioning System. Vertical elevations of the tops of monitoring well casings were determined by performing a level survey using an auto level. The tops of the steel protective casing covers on Brown's monitoring wells were used as benchmarks during the level survey. The elevations of Brown's steel protective

casing covers were determined in 2001 by the National Geodetic Survey (NGS) in support of an Anacostia marsh restoration project (NGS, 2002).

2.5 Ground Water Investigation

Site characterization activities at Poplar Point included sampling new and existing monitoring wells and piezometers. This work was performed in several phases throughout 2002 in accordance with the Soil Boring and Monitoring Well Installation Work Plan (Ridolfi, 2002c).

2.5.1 Purpose of Ground Water Investigation

The objective of the ground water sampling was to determine whether subsurface contamination is present in areas near USTs, ASTs, former disposal sites, the sites of possible discharges, or where previous sampling/analysis detected chemicals at elevated concentrations.

2.5.2 Monitoring Well and Piezometer Sampling

One ground water sample was collected from the ten newly installed monitoring wells and the eight piezometers. Ground water samples were also collected from seven of the existing monitoring wells installed by Brown in 1999 (MW02, MW02A, MW04, MW05, MW07, MW23A, and MW23B).

The ground water samples were collected as outlined in the associated work plan with the following exceptions:

- Water quality indicator parameters were measured with an Orion Model 250A pH meter and a YSI specific electrical conductance meter instead of a flow-through water quality multi-probe.
- The watertight caps on the monitoring wells installed by Brown in 1999 were not vented prior to making water level measurements because each cap has a small vent hole that allowed the wells to vent.
- A water sample (identified as 470E-SW-01) was collected from Stickfoot Sewer using a peristaltic pump.

All purged water was collected, containerized, and stored for proper disposal pending evaluation of ground water sample analyses. Subsequently, the IDW was disposed of; disposition of the material is documented in Appendix D. The ground water sample information is presented in Table 2-1 and on the ground water sampling event field sheets (Appendix E).

2.6 Wetland Drum and Debris Survey

A wetland drum and debris survey was completed in August 2002. The purpose of the drum and debris survey was to quantify the approximate number of drums and other debris items at the site and to remove the materials to an appropriate disposal facility. The drum and debris survey report (Appendix D) summarizes the methods and findings of this field survey.

3.0 PHYSICAL CHARACTERISTICS OF THE POPLAR POINT SITE

3.1 Soils

Soil descriptions and general observations from the soil borings, piezometer hand auger borings, and TMW soil probes are summarized on the soil boring logs (Appendix B). Additional subsurface soil information was obtained by reviewing the following:

- Soil boring logs completed by Brown in 1999;
- Soil boring logs completed by Environ in 1999;
- Soil boring information obtained from a subsurface investigation report completed for the Washington Metropolitan Area Transit Authority (DeLeuw et al., 1981);
- Anacostia River cores completed by the Academy of Natural Sciences in June 2003 (Velinsky, 2003a and 2003b); and
- Anacostia River cores completed by Horne Engineering on behalf of the Louisiana State University.

The additional subsurface information from the sources noted above is included in Appendix F. Cross sections depicting subsurface soil conditions were prepared based on information from the above-mentioned sources. The locations of the cross sections are shown on Figure 3-1. The cross sections include two in a north-south direction (N1 to S1 and N2 to S2, Figures 3-2 and 3-3) and two in a west-east direction (W1 to E1 and W2 to E2, Figures 3-4 and 3-5).

Cross Section W2 to E2 (Figure 3-5) extends from the site to the east, beneath the Anacostia River at the Academy of Natural Science's Core 6 (see September 25, 2003

memorandum in Appendix F). An attempt was made to correlate subsurface units observed at Core 6 to those observed at DCMW015-02; however, the distance between these borings and the fact that the river bends sharply between adjacent borings make the correlation very speculative.

3.1.1 Fill Material

Surface soils at the site consist of fill material and dredge spoils 0.5 foot to 20 feet in thickness. The fill material consists primarily of silt, clay, gravel, and sand with occasional brick, glass, wood, and concrete fragments. The fill material was encountered at the majority of Ridolfi's borings and was also noted in the majority of Brown's soil boring logs. The fill material is generally thickest near the southwestern corner of the site (up to 20 feet thick at TMW-56) and along the eastern side of the central north-south road (10 to 13 feet thick). The fill is thin at soil borings completed within Wetland 1 (2 to 3.5 feet thick) and near the southern greenhouses (0.5 foot to 4 feet thick).

Because the site consisted of tidally influenced mudflats before fill material was placed between approximately 1910 and 1920, it is presumed that the current topography was shaped by the filling and subsequent site grading. The pattern of fill thickness generally corresponds with ground-surface elevations as depicted on Figures 5 and 6 of Brown's Phase II ESA report (Brown, 1999). Ground-surface elevations are high (approximately 9 to 13 feet above mean sea level [msl]) near the southwestern corner of the site where fill thicknesses are greater (4 to 20 feet) and low (approximately 1 foot to 5 feet above msl) within Wetland 1 where fill thicknesses are lesser (2 to 3.5 feet). Ground-surface elevations along the eastern side of the central north-south road range between approximately 5 and 12 feet above msl and the fill is 10 to 13 feet thick. The

ground surface near the southern greenhouses is at approximately 6 feet above msl and the fill is 0.5 foot to 4 feet thick.

3.1.2 Holocene Clay

Throughout the majority of the site, the surficial fill material is underlain by soft gray silty clay with occasional organics and pockets of peat. This gray clay has been interpreted by others as a Holocene deposit (DeLeuw et al., 1981). This interpretation is reasonable to accept because the unit has a typical transgressive character (mostly fine-grained sediments, an aggradational pattern) that is characteristic of a major rise in base level, which occurred in the Holocene. For the purpose of this site characterization report, the soft gray clay is referred to as the "Holocene clay."

The Holocene clay was encountered at nearly every soil boring completed through the fill material, with the exception of soil borings completed in the southwestern portion of the site, which include Ridolfi's borings DCMW006-02, DCMW007-02, and all TMW soil probes, as well as Brown's soil borings MW07, MW23A, MW-23B, SB-4 through SB-7, and SB-43. At these borings, a sandy gravel unit was observed directly below the fill material. This sandy gravel unit, which is described in more detail in the following sections, is referred to as the "middle permeable unit" in cross sections N1 to S1 and W1 to E1. The southwestern extent of the Holocene clay likely represents the former (pre-dredging, pre-filling) extent of the tidally influenced Anacostia River. This is consistent with the location of the historical riverbank as shown on Figure 1-3.

The Holocene clay extended to elevations ranging from 35 to 42 feet below msl (40 to 50 feet bgs) at soil borings completed near the northern, central, and western portions of the site. At soil borings completed near the southwestern and south-central portions of the site, the Holocene clay extended only to elevations ranging from 20 feet below msl to 1

foot above msl (12 to 22 feet bgs). The variable thickness of the Holocene clay likely indicates the presence of a former channel and terrace feature, with the terrace located near the southern and southwestern portions of the site. The approximate northern extent of the top of the former terrace, as interpreted from the pattern and thicknesses of the geologic units described in this report, is shown on Figure 3-1.

The Holocene clay was also encountered at soil borings FPS-54U and FPS-56U, which were completed north of the site in the Anacostia River as part of the subsurface investigation conducted for the Washington Metropolitan Area Transit Authority (see cross section in Appendix F). Through the center of the site, from south to north, this unit appears to extend from the southern portion of the site to beneath the Anacostia River, at FPS-54U (Figure 3-3).

3.1.3 Upper Permeable Unit

At some soil borings, a coarse to fine-grained wet sand unit is present beneath the fill material and within and above the upper level of the Holocene clay. For the purpose of this report, this material is referred to as the "upper permeable unit."

At some soil boring locations, the overlying fill material and the upper permeable unit are similar. In fact, the potential exists that the upper permeable unit is fill material that was deposited during the early stages of dredging activities at the Anacostia River. Soils grouped as upper permeable unit in this report differ from soils grouped as fill material, in that the upper permeable unit did not contain artificial materials (i.e., brick, concrete, and glass) and pockets of mottled clay. Soils associated with the upper permeable unit consisted of mostly fine sand and were consistent over a relatively large area, such as Wetland 1.

Distinguishing between fill material and the upper permeable unit on Brown's soil boring logs was difficult without access to the actual soil samples. For the purpose of this report, the soils were classified as either fill material or the upper permeable unit on the basis of the soil descriptions listed in the boring logs and comparison of the descriptions to soils encountered at nearby Ridolfi borings.

Two separate bodies of upper permeable unit appear to be present at the site, north of the former terrace. As mentioned above, the upper permeable unit was encountered at most soil borings completed within and near Wetland 1. The upper permeable unit was also encountered at three soil borings completed between the southern and northern greenhouses.

3.1.4 Middle Permeable Unit

At soil borings completed south of the northern extent of the former terrace, a wet brown fine sand and sandy rounded gravel were encountered directly below the Holocene clay. This unit is referred to as the "middle permeable unit."

Only one soil boring, MW07, was completed through the middle permeable unit. At this soil boring, the middle permeable unit extended to an elevation of 25 feet below msl.

The middle permeable unit appears to be situated on top of the former terrace. The edge of the former terrace is evidenced by the termination of the middle permeable unit between SB08 and SB-101 (Figure 3-4); between DCMW013-02 and SB-101 (Figure 3-3); and between DCMW015-02 and MW02 (Figure 3-2).

3.1.5 Lower Permeable Unit

North of the northern edge of the former terrace, a wet brown fine sand and sandy rounded gravel unit, with characteristics similar to the middle permeable unit, lie under the Holocene clay. This unit, referred to as the "lower permeable unit," was encountered at soil borings MW02, MW10, DCMW008-02, and DCMW009-02. This unit was also encountered at soil borings FPS-54U and FPS-56U, which were completed north of the site in the Anacostia River as part of the subsurface investigation completed for the Washington Metropolitan Area Transit Authority (see cross section in Appendix F). Through the center of the site, from south to north, this unit appears to extend from the area near soil boring DCMW008-02 to beneath the Anacostia River, at FPS-54U (Figure 3-3).

At some areas of the site, it does not appear that the middle permeable unit and the lower permeable unit are connected. The lower permeable unit was encountered at elevations ranging from 37 to 40 feet below msl and extended to elevations ranging from 46 to 51 feet below msl. The top portion of this unit (37 to 40 feet below msl) is 12 to 15 feet below the bottom portion of the middle permeable unit (25 feet below msl).

A comparison of the soil lithology observed at soil boring SB-101 to the lithologies observed at DCMW013-02 and DCMW008-02 (Figure 3-3) also indicates that the middle and lower permeable units are not connected in some areas. Neither the middle nor the lower permeable unit was encountered at soil boring SB-101. At this boring, the Holocene clay lies directly above the Cretaceous clay (described below). This indicates that the middle permeable unit pinches out between DCMW013-02 and SB-101 and that the lower permeable unit pinches out between DCMW008-02 and SB-101. However, these two units may be connected at other areas of the site.

3.1.6 Underlying Cretaceous Clay

The lowermost unit encountered at the site is a hard silty orange and gray mottled clay with sand and gravel. This clay was interpreted as a Cretaceous unit by DeLeuw et al. (1981). For the purpose of this report, this clay is referred to as the Cretaceous clay.

The Cretaceous clay is generally encountered below and in direct contact with the middle and lower permeable units. At one soil boring location, SB-101, the Cretaceous clay is below and in direct contact with the Holocene clay.

3.2 Hydrogeology

Four of the units described above are considered water-bearing units: the surficial fill material and the upper, middle, and lower permeable units. Some ground water was encountered in the Holocene clay; however, the ground water in this unit was localized and of insignificant quantity.

To assess the hydraulic head relationships between monitoring wells screened in corresponding units, ground water elevations observed during Ridolfi's depth-to-ground water measurements were reviewed. Ground water elevations reported during previous investigations were not used, because it appeared that the measuring point elevations on the monitoring wells were not accurately surveyed.

Table 3-1 summarizes the units in which monitoring wells and piezometers are screened. Some of Brown's wells are screened across more than one unit, which makes them valueless for assessing the hydraulic head relationships of individual units. In addition, some of Brown's wells are screened at widely differing intervals within individual units, which also makes the wells valueless for assessing hydraulic head

relationships of individual units. As shown in Table 3-1, wells were grouped according to the water-bearing unit in which they are screened. Wells determined to be useful for assessing the hydraulic head relationship in individual units are highlighted in Table 3-1 with bold font. The remaining wells (shown in italicized font) were not considered in the findings discussed in this section.

3.2.1 Fill Material

The hydrogeologic properties of the fill material vary considerably from borehole to borehole. Some localized pockets of saturated permeable material were encountered in the fill material; however, it is unlikely that the individual pockets are hydraulically connected over a large area (i.e., from the east side of the site to the west side of the site).

In general, ground water in the fill material may likely flow in the direction in which the underlying Holocene clay surface is sloping, which also varies considerably (Figures 3-2 through 3-5). A north-south trending channel-type feature is present in the surface of the Holocene clay, with the low portion of the channel near SB-101 and DCMW009-02 (Figures 3-4 and 3-5). From north to south, the channel generally slopes downward from both directions toward DCMW009-02.

Seven wells appear to be screened in the fill material. The majority of these wells are located near the garage building. The ground water elevations observed in these wells vary considerably, despite their proximity. The highest ground water elevation was observed in MW03, with lower elevations observed in each surrounding well. This pattern of hydraulic head relationships indicates that the shallow ground water flows radially outward from MW03. The high level of ground water in MW03 may be

attributed to direct surface water intrusion, because the well was installed in fill material that was placed into the excavation of the former UST pit.

3.2.2 Upper Permeable Unit

Because the fill material and the upper permeable unit are, in some areas, hydraulically connected, these units likely have similar hydrogeologic characteristics. Piezometers PZ-1 through PZ-8, all in or near Wetland 1, were screened in this unit. Five rounds of ground water level measurements were recorded at the wetland piezometers throughout the course of Ridolfi's site characterization activities (Table 2-2). Ground water elevation contour diagrams were developed from the July 22 and August 29, 2002, ground water level measurements (Figures 3-6 and 3-7).

As shown on Figures 3-6 and 3-7, ground water levels were high near PZ-2 and low near PZ-5 and PZ-6. The ground water elevation contours indicate that the ground water flows to the north near PZ-2 and in a westerly direction near the central portion of Wetland 1.

Ground water elevation contour diagrams were not completed for the November 15, November 21, and December 21, 2002, ground water level measurements. As shown on Table 2-2, the ground water levels observed on these dates were relatively similar from one piezometer to the next, with each water level near 3 feet above msl. Surface water elevations observed at staff gages SG-1 through SG-3 were also near this level. It is believed that the ground surface in Wetland 1 was completely saturated from the top of the Holocene clay to the ground surface during this period, likely because of the significant precipitation and snowmelt that occurred during late fall and early winter.

3.2.3 Middle Permeable Unit

Ten monitoring wells are screened in this unit. Three of these wells (MW07, MW23A, and MW23B) are not useful for assessing the hydraulic head relationship of wells screened in this unit, because the wells are screened at widely varying intervals.

Figure 3-8 was prepared using December 21, 2002, data from the ground water elevations observed at select wells screened in the middle permeable unit (MW01, DCMW007-02, DCMW011-02, DCMW013-02, DCMW014-02, and DCMW015-02). The ground water elevations were high near DCMW015-02 and MW01 (1.84 and 1.63 feet above msl, respectively) and low near DCMW007-02 (1.14 feet above msl). These hydraulic head relationships indicate the direction of ground water flow is toward the southwest.

3.2.4 Lower Permeable Unit

Four monitoring wells are screened in this unit, all at intervals that appear to be useful for assessing hydraulic head relationships.

A contour diagram of the lower permeable unit ground water elevation (Figure 3-9) was prepared using the December 21, 2002, ground water elevation measurements. The ground water elevations were high near MW10 (1.80 feet above msl) and low near MW02 (1.20 feet above msl). These hydraulic head relationships indicate the direction of ground water flow is toward the west.

Ground water levels at wells in the lower permeable unit were similar to the levels observed at wells in the middle permeable unit. Water levels in the lower permeable unit ranged from 1.20 to 1.60 feet above msl, and water levels in the middle permeable

unit ranged from 1.02 to 3.13 feet above msl. These units are shown as separate units on cross sections N1 to S1 (Figure 3-2), N2 to S2 (Figure 3-3), W1 to E1 (Figure 3-4), and W2 to E2 (Figure 3-5); however, the possibility exists that there is a hydraulic connection between the middle and lower permeable units.

3.3 Surface Water/Wetlands Hydrology

As discussed in Section 2.2.4, three "drum method" seepage meters were installed at the site to measure the ground water flux across the sediment-surface water interface in Wetlands 1 and 2. The locations of the seepage meters are shown on Figure 1-2.

On November 25, 2002, 470 ml of water were placed in each water bag. The seepage meters were monitored on November 26 and December 17, 2002, to determine whether the volume of water changed. On November 26, 2002, the water bags were visually inspected, and it was determined that no significant change in water volume had occurred; therefore, the water bags were left in place.

On December 17, 2002, the water bags were removed from the seepage meters and the volume of the water in each bag was measured. At each seepage meter, the volume of water in the bag had increased. The amount of water recovered was 830 ml at SM-1, 1,380 ml at SM-2, and 1,600 ml at SM-3. These increases in water volume may indicate an upward migration of ground water into the surface water during this period.

As discussed in Section 2.2.3, staff gages were installed near three piezometers in Wetland 1 to compare surface water elevations to local ground water elevations. The locations of the staff gages are shown on Figure 1-2. Surface water elevations were recorded on water level measurement field sheets (Appendix C) and are summarized in Table 2-2. On July 22 and 23, 2002, the surface water level at SG-1 (2.67 feet above msl)

was higher than the ground water level at PZ-2 (1.04 feet above msl). This indicates a downward flux of surface water to ground water. Surface water was not present at SG-2, SG-3, and SG-4 during the July 2002 measurements.

At the time of the August 29, 2002, measurements, surface water was not present at SG-2 and SG-3. No staff gage measurements were recorded at SG-1 and SG-4 on this date, but surface water was not present at those staff gages either.

During the November 15, November 21, and December 21, 2002, water level measurements, the surface water levels were similar to corresponding ground water levels (near 3 feet above msl). The measurements indicate that the surficial material in Wetland 1 was completely saturated from the top of the Holocene clay to the ground surface during this period, likely because of the significant precipitation and snowmelt that occurred during late fall and early winter.

3.4 Stickfoot Sewer Elevation Survey

At the time Ridolfi surveyed the top-of-casing elevations of site monitoring wells, the elevation of the Stickfoot Sewer manhole (near the pump house) was also surveyed. The elevation of the bottom portion of the Stickfoot Sewer pipe (creek bed) was also surveyed at the center of the manhole. The elevation of the northern rim of the manhole is 11.97 feet above msl. The elevation of the creek bed at the center of the manhole is 0.97 foot above msl.

4.0 NATURE AND EXTENT OF CONTAMINATION

This section describes the nature and extent of contamination at the Poplar Point site based on chemical results from samples collected by Ridolfi in 2002 and the results of several previous investigations. Data from each of the field events were integrated into an Excel spreadsheet and an ArcView project that were used to generate maps and tables summarizing site conditions. The Excel spreadsheet is provided on a CD-ROM attached to this report. Analytical data reports for the samples collected by Ridolfi are also included on the CD-ROM in PDF format.

Data validation reports, which summarize the quality control review of the analytical data generated from Ridolfi's investigation, are included in Appendix G. Tables 4-1 through 4-21 summarize analytical results for chemicals detected at concentrations above project screening levels (detailed below for each medium) in the surface soil, sediment, subsurface soil, and ground water samples. Sample results for chemicals with concentrations below project screening levels are not included in Tables 4-1 through 4-21. For each chemical in each medium, the lowest applicable screening level was used for comparison purposes. In the discussion of the results and on the figures that depict the sample results, comparison to other screening levels is also presented to provide some sense of the magnitude of the issues associated with a given chemical or to identify hotspots.

It is important to note that not all the screening levels discussed in this report are intended to be used for cleanup purposes. Specifically, although residential and industrial screening levels are used, neither represents current or probable future exposure scenarios. However, those screening levels are still useful for identifying samples with relatively elevated chemical concentrations and for identifying spatial

patterns of contamination or areas that may have several chemicals at concentrations in excess of screening levels. These patterns may provide insight into historical practices that released chemicals to the environment or into the fate and transport processes that affected the distribution of chemicals after their release.

4.1 Surface Soil

For the purpose of this site characterization, soil samples are considered "surface soil" if any portion of the sample was collected between the ground surface and 2 feet bgs. Concentrations of the parameters detected in the surface soil samples were compared to the following screening levels:

- U.S. EPA Region III Biological Technical Assessment Group (BTAG) Screening Levels (Soil) for Protection of Flora and Fauna;
- D.C. Risk-Based Screening Levels (RBSLs) for Residential and Industrial Soil;
- U.S. EPA Region III Risk-Based Concentrations (RBCs) for Residential and Industrial Soil;
- U.S. EPA Region III Soil Screening Levels (SSLs) for Ground Water Migration with Dilution Attenuation Factors (DAFs) of 1 and 20; and
- D.C. Soil Quality Standards for Petroleum-Contaminated Soil.

4.1.1 Inorganic Compounds

Laboratory analytical results for the 20 inorganic parameters detected in surface soil at concentrations above the project screening levels are summarized in Table 4-1. The

analytes most frequently detected at concentrations in excess of screening levels are arsenic, chromium, lead, and zinc.

Inorganic parameters such as arsenic, chromium, lead, and zinc are naturally occurring elements, and their presence does not necessarily indicate anthropogenic contamination. In the context of characterizing risk and selecting remedial actions, it is prudent to exclude samples that are likely to represent natural sources and to focus instead on anthropogenic contamination. It is common practice in this situation to develop remediation goals based on background concentrations, although there are different statistical approaches for comparing site data to background. One approach is to use three times the mean concentration of the background data set as a comparison level. Other approaches use a statistical measure such as the 90th percentile or the 95th upper confidence limit on the mean.

Results available for surface soil samples collected at and near the Poplar Point site during various investigations have been reviewed to develop an approach for quantifying "natural background" concentrations for selected inorganic chemicals in soil (Appendix H). For this site, four areas were selected to represent background (i.e., locations that have geological media most similar to those found at the site and that have not been impacted by contamination): the USNRS Area, the former dog training area (northern edge of the AOC Area), the area north of the D.C. Lanham Area, and the Howard Road Academy. The samples collected from these background areas are outlined with square boxes on applicable figures in Appendix H and on Figure 4-1 of this report.

The mean arsenic concentration of the background samples is 3.1 milligrams per kilogram (mg/kg), which exceeds the U.S. EPA RBC for residential soil (0.43 mg/kg)

and is only slightly below the U.S. EPA RBC for industrial soil (3.8 mg/kg). The 90th percentile of the background samples is 5.0 mg/kg.

Approximately half of the surface soil samples collected in the AOC Area have arsenic concentrations below 5 mg/kg, and about half have arsenic concentrations between 5 and 20 mg/kg. Arsenic was detected at concentrations greater than 20 mg/kg (a value used as an action level elsewhere in D.C.) in five samples from the southern and central portion of the AOC Area. Arsenic concentrations in the D.C. Lanham Area were greater than 5.0 mg/kg at approximately half of the sample locations. Arsenic concentrations greater than 20 mg/kg were identified in samples from Wetland 1, from near the former 275-gallon diesel AST, and from north of the Green Fuel Oil property, as well as in one sample collected northwest of Wetland 4.

Chromium was detected in the surface soil samples at concentrations ranging from 6.8 to 219 mg/kg. These concentrations exceed most project screening levels, but are below the U.S. EPA RBCs for residential soil (230 mg/kg) and industrial soil (6,100 mg/kg). The mean chromium concentration of the background samples is 27.3 mg/kg; three times the mean background concentration is 82 mg/kg. Only one sample, from the southern portion of Wetland 1, exceeded 82 mg/kg.

Every lead detection in the surface soil samples exceeds the BTAG screening levels, which are the only screening levels available for lead. The mean lead concentration of the background samples is 40.1 mg/kg. The 90th percentile and three times the mean background concentration are 71 and 120 mg/kg, respectively. Because numerous samples have lead concentrations exceeding these values, a concentration of 248 mg/kg, which represents an extreme value in the site data, was used for screening. Four samples from the AOC Area and three samples from the D.C. Lanham Area had lead concentrations exceeding 248 mg/kg (Figure I-8).

Zinc was detected in the surface soil samples at concentrations greater than the BTAG screening level for flora and, in some cases, at concentrations greater than the U.S. EPA SSL for ground water migration (DAF 1). However, each of the zinc concentrations is below the U.S. EPA RBCs and D.C. RBSLs for both residential and industrial soil. The mean zinc concentration of the background samples is 62.6 mg/kg. For zinc, the 90th percentile and three times the mean background concentrations are 107 and 188 mg/kg, respectively. Zinc was detected at concentrations greater than 188 mg/kg in four samples from the southern and central portions of the AOC Area. Zinc was detected at concentrations greater than 188 mg/kg in 13 samples from the D.C. Lanham Area. Most of these samples were collected in or near Wetland 1; one sample was collected near the Green Fuel Oil property.

4.1.2 Pesticides and Polychlorinated Biphenyls

Laboratory analytical results for 12 pesticides and PCBs detected in surface soil samples at concentrations above the project screening levels are summarized in Table 4-2. The analytes most frequently detected at concentrations in excess of screening levels are the pesticides 4,4'-DDE and 4,4'-DDT.

Figure 4-2 shows 4,4'-DDT concentrations in surface soil samples. The concentrations of 4,4'-DDT ranged from 4.5 to 130,000 micrograms per kilogram (µg/kg), all in excess of the D.C. RBSLs for residential and industrial soil (4.07 µg/kg). Samples collected at three locations, two near the southeastern portion of Wetland 1 and one at a more northerly location in Wetland 1, exceed the U.S. EPA RBC for industrial soil (17,000 µg/kg).

The concentrations of 4,4'-DDE ranged from 87 to 8,700 µg/kg. Concentrations of 4,4'-DDE exceed the U.S. EPA RBC for residential soil (1,900 µg/kg) in samples collected from four sample locations along the western side of the central north-south road, at one sample location near the central portion of Wetland 1, and at one sample location near the former 275-gallon diesel AST. These concentrations do not exceed the U.S. EPA RBC for industrial soil (17,000 µg/kg).

The pesticide 4,4'-DDD was detected at concentrations above the U.S. EPA RBC for residential soil at several surface soil sample locations. The 4,4'-DDD concentrations at sample station SS-08 also exceed the U.S. EPA RBC for industrial soil. Sampling station SS-08 is near the southeastern portion of Wetland 1.

Total PCBs were detected at a concentration (7,500 µg/kg) above the U.S. EPA RBC for industrial soil (2,900 µg/kg) at sample location SS-08. This total PCB concentration represents the concentration of Aroclor 1248 (2,800 µg/kg) summed with half the detection limits for other PCB Aroclors, which were not detected at or above the method detection limits. Taken alone, the concentration of Aroclor 1248 in this sample exceeds the U.S. EPA RBC for residential soil (320 µg/kg), but was below the U.S. EPA RBC for industrial soil.

Total PCBs were detected at a concentration (3,380 µg/kg) above the U.S. EPA RBC for industrial soil (2,900 µg/kg) at sample location SB40. The total PCB concentration represents the concentration of Aroclor 1260 (3,380 µg/kg), which was the only PCB analyzed for in this sample. Sample station SB40 is located near the northern portion of the garage building.

4.1.3 Semivolatile Organic Compounds

Laboratory analytical results for 22 semivolatile organic compounds (SVOCs) detected in surface soil samples at concentrations above the project screening levels are summarized in Table 4-3. The analytes most frequently detected at concentrations in excess of screening levels are benzo(a)pyrene, fluoranthene, and pyrene.

Benzo(a)pyrene was detected at concentrations above screening levels in 88 surface soil samples. Figure 4-3 shows benzo(a)pyrene concentrations in soil (both subsurface and surface). Elevated benzo(a)pyrene concentrations were detected throughout the majority of the D.C. Lanham Area and the AOC Area, including four of the five background samples collected north of the site. Samples collected in the USNRS Area were either non-detects or had analyte concentrations below the U.S. EPA RBC for residential soil, with the exception of the samples collected at SO-18 from 0 foot to 2 feet bgs. Benzo(a)pyrene was also detected at elevated concentrations in the samples collected at the Howard Road Academy property.

The concentrations of fluoranthene and pyrene exceed only the BTAG screening levels for flora and fauna, with the exception of the fluoranthene concentration in sample SB08 from 0 foot to 2 feet bgs, which is 133,000 µg/kg. This concentration exceeds the D.C. residential and industrial RBSLs (101,000 µg/kg). Soil boring SB08 was completed near the southeastern portion of Wetland 1. Fluoranthene and pyrene concentrations for all other samples are lower than the D.C. residential and industrial RBSLs and the U.S. EPA residential and industrial RBCs.

Concentrations of anthracene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(g,h,i)perylene, or chrysene were detected at concentrations above the D.C. RBSLs for industrial soil in two samples (SB08 and SD-1/2) collected near the southeastern

corner of Wetland 1 and in one sample collected at MW04, near the south adjoining P&P Auto Body property. The concentrations of benzo(a)anthracene and benzo(b)fluoranthene in sample SB08 from 0 foot to 2 feet bgs exceed the U.S. EPA RBCs for industrial soil. The benzo(b)fluoranthene concentration in sample MW04 from 0 foot to 4.5 feet bgs also exceeds the U.S. EPA RBC for industrial soil.

4.1.4 Volatile Organic Compounds

Laboratory analytical results for volatile organic compounds (VOCs) detected in surface soil samples at concentrations above the project screening levels are summarized in Table 4-4.

Methylene chloride, 1,4-dichlorobenzene, and toluene were the only VOCs detected at concentrations above project screening levels in the surface soil samples. The detections of methylene chloride are likely the result of laboratory interferences; methylene chloride was also detected in the associated laboratory method blank for nearly every sample.

1,4-dichlorobenzene was detected at a concentration of 5 µg/kg in soil sample SU-01, which was collected from the storm drain/sump in the office building of the northern greenhouses. This concentration exceeds only the U.S. EPA SSL for Ground Water Migration DAF 1 (0.36 µg/kg).

Toluene was detected at a concentration of 140 µg/kg in soil sample SD-1/2S, which was collected from 0 foot to 2 feet bgs near the southeastern portion of Wetland 1. This concentration exceeds only the BTAG screening levels for flora and fauna (100 µg/kg).

4.1.5 Petroleum Hydrocarbons

Laboratory analytical results for petroleum hydrocarbons detected in surface soil samples at concentrations above the project screening levels are summarized in Table 4-5. Figures 4-4 and 4-5 depict diesel-range and motor oil-range concentrations at each soil sampling location.

Petroleum hydrocarbon chromatographic profiles for 25 samples (surface soil, subsurface soil, and ground water) were reviewed to identify petroleum hydrocarbon mixtures and to determine the potential for contaminant source identification using chemical "fingerprinting." Appendix I contains a memorandum summarizing the analysis of petroleum hydrocarbon profiles. The petroleum hydrocarbon detections appear to result from anthropogenic (petroleum-derived) sources. Three principal profiles were identified in the samples:

1) Light lube-type oil, possibly a vehicle for the application of other organic chemicals;
2) Medium-weight lube-type oil, possibly a motor oil and/or hydraulic pump fluid; and
3) A discrete organic chemical exhibiting a characteristic pattern in the medium lube oil range.

Diesel-range hydrocarbons were detected at concentrations in excess of the D.C. soil quality standard for petroleum-contaminated soil in the three surface soil samples (one of which was a field duplicate) collected at sampling station SS-20, which is adjacent to the northern portion of the Green Fuel Oil property. The concentrations of diesel-range hydrocarbons were 3,500, 3,600, and 2,300 mg/kg. The concentrations of motor oil-

range hydrocarbons were also elevated in two of these samples (1,600 and 1,700 mg/kg).

4.1.6 Dioxins/Furans

As part of Environ's 1999 site investigation, two surface soil samples were collected from sample station BP01 near the former northern burn pit. The samples were collected from 0.0 to 0.5 foot bgs and 1.0 foot to 1.5 feet bgs. The laboratory analytical results for these two samples are summarized in Tables 4-6 and 4-7.

In Tables 4-6 and 4-7, toxic equivalents (TEQs) are used to report the toxicity-weighted masses of the mixtures of dioxins for each sample. Each dioxin congener is assigned a toxic equivalency factor (TEF) as recommended by the World Health Organization (Van den Berg et al., 1998). The TEF denotes a given dioxin compound's toxicity relative to 2,3,7,8-TCDD, which is assigned the maximum toxicity designation of 1. Other dioxin congeners receive lower TEFs, with each TEF roughly proportional to that dioxin congener's toxicity relative to that of 2,3,7,8-TCDD.

To determine the total TEQ for each sample, the concentration in picograms per gram (pg/g) or parts per trillion (ppt) was multiplied by the corresponding TEF to obtain the TEQ for each congener. For congeners that were not detected at or above the laboratory method detection limits, one-half of the detection limit was used as the congener concentration. The TEQs for all congeners were then summed to obtain the total TEQ.

The total TEQ value for sample BP01 from 0.0 to 0.5 foot bgs was 15.7, and the TEQ value for sample BP01 from 1.0 foot to 1.5 feet bgs was 8.0. These values exceed the U.S. EPA residential RBC for 2,3,7,8-TCDD (4.3 pg/g) and are below the U.S. EPA industrial

RBC of 38 pg/g. Both of the TEQ values are also below the BTAG screening level for 2,3,7,8-TCDD for the protection of fauna (10,000 pg/g).

4.2 Sediment

The distinction between soil and sediment is unclear in some areas of the Poplar Point site and may change seasonally depending on weather conditions. During Ridolfi's August 2002 field activities, areas identified as Wetlands 1, 2, and 4 on Figure 1-2 were dry, and the samples from these locations would logically be classified as soil. However, these same areas were quite wet in November 2002, with up to 2 feet of standing water at some of the sample locations. For completeness, chemical results from samples collected in these changing areas are compared to both soil screening levels in Section 4.1 and to sediment screening levels in this section. The following sediment screening levels were used in the comparison:

- U.S. EPA Region III BTAG Screening Levels (Sediment) for Protection of Flora and Fauna; and

- NOAA's Threshold Effects Levels (TELs) and Probable Effects Levels (PELs) from its Screening Quick Reference Tables (SQRTs).

4.2.1 Inorganic Compounds

Laboratory analytical results for nine inorganic parameters detected at concentrations above sediment screening levels are summarized in Table 4-8. The analytes most frequently detected at concentrations in excess of screening levels are cadmium, lead, and nickel.

Cadmium was detected above the TEL (0.596 mg/kg) in 17 surface soil/sediment samples. Only one of these samples also exceeds the PEL (3.53 mg/kg); it was collected from a drain/sump located near the southern portion of Wetland 1.

The concentrations of lead in the surface soil/sediment samples ranged from 56 to 315 mg/kg. Most of these concentrations (22 out of 30 samples) exceed the PEL (91.3 mg/kg). The samples with lead concentrations below the PEL were collected at four locations in Wetland 1 and one location in Wetland 4, the only surface soil/sediment sample (SS-17) collected from Wetland 4.

Nickel was detected at concentrations in excess of sediment screening levels in 32 surface soil/sediment samples. Only ten samples contained nickel concentrations above the PEL (35.9 mg/kg). These samples were collected from seven locations near the southeastern portion of Wetland 1.

4.2.2 Pesticides and Polychlorinated Biphenyls

Laboratory analytical results for pesticides and PCBs detected at concentrations above sediment screening levels are summarized in Table 4-9. Five pesticides/PCBs (4,4'-DDD, 4,4'-DDE, 4,4'-DDT, dieldrin, and total PCBs) were detected at concentrations in excess of sediment screening levels in the surface soil/sediment samples.

The concentrations of 4,4'-DDD ranged from 4.1 to 110,000 µg/kg in the surface soil/sediment samples. All but two concentrations (4.1 µg/kg at SS-01 and 7.4 µg/kg at Sd-1/4s) exceed the PEL (8.51 µg/kg).

The concentrations of 4,4'-DDE ranged from 25 to 8,700 µg/kg in the surface soil/sediment samples. Each of these concentrations exceeds the PEL (6.75 µg/kg).

The concentrations of 4,4'-DDT ranged from 24 to 130,000 µg/kg in the surface soil/sediment samples. Each of these concentrations exceeds the U.S. EPA Region III BTAG Screening Levels (Sediment) for Protection of Flora and Fauna (1.58 µg/kg). A PEL is not available for 4,4'-DDT.

Dieldren was detected at concentrations above the TEL (2.85 µg/kg) in three samples (SD-1/2d from 0 foot to 2 feet bgs, SS-02 from 0.25 to 0.5 foot bgs, and WL03 from 0 foot to 2 feet bgs). Only the concentration in WL03 (50 µg/kg) also exceeded the PEL (6.67 µg/kg).

The concentrations of total PCBs ranged from 110 to 6,000 µg/kg in the surface soil/sediment samples. The concentrations of total PCBs in 13 samples exceed the PEL (277 µg/kg). Each of these samples also contained 4,4'-DDD at concentrations above the PEL.

4.2.3 Semivolatile Organic Compounds

Laboratory analytical results for SVOCs detected at concentrations above sediment screening levels are summarized in Table 4-10. Several SVOCs were detected at concentrations above the BTAG screening levels; however, only benzo(a)anthracene, benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene were detected at concentrations above the PELs.

Benzo(a)anthracene was detected above the PEL (385 µg/kg) in five surface soil/sediment samples collected near the southeastern portion of Wetland 1. In one of these samples, the concentrations of benzo(a)pyrene, chrysene, fluoranthene, phenanthrene, and pyrene also exceeded the PELs.

4.3 Subsurface Soil

Soil samples are considered "subsurface soil" if the top portion of the sample ("depth from") was collected at a depth of 2 feet bgs or more. Concentrations of the parameters detected in the subsurface soil samples were compared to the following screening levels:

- U.S. EPA Region III BTAG Screening Levels (Soil) for Protection of Flora and Fauna;
- U.S. EPA Region III RBCs for Residential and Industrial Soil;
- U.S. EPA Region III SSLs for Ground Water Migration with DAFs of 1 and 20;
- D.C. RBSLs for Residential and Industrial Soil; and
- D.C. Soil Quality Standard for Petroleum-Contaminated Soil.

4.3.1 Inorganic Compounds

Laboratory analytical results for 18 inorganic parameters detected in the subsurface soil samples at concentrations above the project screening levels are summarized in Table 4-11. The analytes most frequently detected at concentrations in excess of the screening levels are arsenic, chromium, lead, nickel, and zinc.

Arsenic was detected at concentrations above project screening levels in 70 subsurface soil samples. The concentrations ranged from 0.9 to 118 mg/kg. The arsenic concentration in each sample exceeds the D.C. RBSLs for residential soil (0.101 mg/kg) and industrial soil (0.403 mg/kg); the U.S. EPA SSLs for Ground Water Migration (DAF 1, 0.0013 mg/kg and DAF 20, 0.026 mg/kg); and the U.S. EPA RBC for residential soil (0.43 mg/kg). Arsenic concentrations in 40 of the samples also exceed the U.S. EPA RBC for industrial soil (3.8 mg/kg). Arsenic concentrations in 17 samples from

intervals as deep as 7.5 to 9 feet bgs exceed 20 mg/kg. All of the arsenic concentrations are below the BTAG screening level for flora (328 mg/kg). A BTAG screening level for fauna is not available for arsenic.

Chromium was detected at concentrations above project screening levels in 75 samples. The chromium concentrations ranged from 6.6 to 119 mg/kg. These concentrations exceed the BTAG screening levels for flora (0.02 mg/kg) and fauna (0.0075 mg/kg), the D.C. RBSLs for residential and industrial soil (0.0461 and 0.201 mg/kg, respectively), and the U.S. EPA SSL for Ground Water Migration DAF 1 (2.1 mg/kg). In some cases, these chromium concentrations also exceed the U.S. EPA SSL for Ground Water Migration DAF 20 (42 mg/kg). Only one sample exceeds 82 mg/kg, which is three times the mean background concentration. The chromium concentrations do not exceed the U.S. EPA RBCs for residential and industrial soil (230 and 6,100 mg/kg, respectively).

Lead was detected at concentrations above the BTAG screening levels for flora (2 mg/kg) and fauna (0.01 mg/kg), the only screening levels available for lead, in 74 subsurface soil samples. The lead concentrations ranged from 6 to 440 mg/kg. Sixteen samples exceed 120.4 mg/kg, which is three times the mean background concentration.

Nickel was detected at concentrations above project screening levels in 74 samples. The nickel concentrations range from 4 to 35.5 mg/kg. These concentrations do not exceed the U.S. EPA RBCs for residential and industrial soil (1,600 and 41,000 mg/kg, respectively).

Zinc was detected at concentrations above project screening levels in 72 samples. The concentrations ranged from 11 to 421 mg/kg. These concentrations do not exceed the U.S. EPA RBCs for residential and industrial soil (3,900 and 100,000 mg/kg,

respectively). Six samples have concentrations exceeding 188 mg/kg, which is three times the mean background concentration.

In addition, cadmium was detected in some of the subsurface soil samples at concentrations ranging from 0.5 mg/kg to 5.1 mg/kg. Cadmium concentrations exceed the D.C. RBSLs for industrial soil (1.31 mg/kg) in 26 subsurface soil samples, but do not exceed the U.S. EPA RBC for industrial soil (1,000 mg/kg). Twenty-five subsurface soil samples have cadmium concentrations that exceed 1.5 mg/kg, which is three times the mean background concentration.

4.3.2 Pesticides and Polychlorinated Biphenyls

Laboratory analytical results for the eight pesticides and PCBs detected in subsurface soil samples at concentrations above the project screening levels are summarized in Table 4-12. The analytes most frequently detected at concentrations in excess of the screening levels are the pesticides 4,4'-DDE and 4,4'-DDT.

The concentrations of 4,4'-DDE ranged from 120 to 7,200 μg/kg, with two samples exceeding 1,000 mg/kg. The highest 4,4'-DDE concentration and the only concentration to exceed the U.S. EPA and D.C. RBSLs for residential soil (1,900 and 2,260 μg/kg, respectively) was detected in a sample collected near the northern burn pit. This concentration also exceeds the D.C. RBSL for industrial soil (6,730 μg/kg), but not the U.S. EPA RBC for industrial soil (17,000 μg/kg).

The concentrations of 4,4'-DDT ranged from 4.5 to 740 μg/kg in the subsurface soil samples. These concentrations exceed the D.C. RBSL for residential and industrial soil (4.07 μg/kg), but are below the U.S. EPA RBCs for residential and industrial soil (1,900 and 17,000 μg/kg, respectively). The highest concentration of 4,4'-DDT was detected in

the same sample that had the highest concentration of 4,4'-DDE (collected near the northern burn pit).

Concentrations of Aroclor 1260 in two samples (DCMW006-02 from 2.5 feet to 4 feet bgs and SO-6d) are above the U.S. EPA RBC for residential soil (320 µg/kg) and resulted in exceedances of total PCBs for these two samples. These concentrations did not exceed the U.S. EPA RBC for industrial soil (2,900 µg/kg). Soil sample SO-6d was collected to the west of the northern greenhouses, and DCMW006-06 was completed at the southwestern portion of the site, near the Green Fuel Oil property.

4.3.3 Semivolatile Organic Compounds

Laboratory analytical results for 19 SVOCs detected in subsurface soil samples at concentrations above the project screening levels are summarized in Table 4-13. The analytes most frequently detected at concentrations in excess of the screening levels are benzo(a)pyrene, benzo(b)fluoranthene, fluoranthene, and pyrene.

Benzo(a)pyrene was detected at concentrations above screening levels in 28 subsurface soil samples. Figure 4-3 shows benzo(a)pyrene concentrations in soil (both subsurface and surface). Concentrations of benzo(a) pyrene in all but one of the 28 subsurface soil samples exceed the D.C. RBSL and the U.S. EPA RBC for residential soil (105 µg/kg and 87 µg/kg, respectively). In 12 samples, the concentrations of benzo(a)pyrene also exceed the D.C. RBSL for industrial soil (313 µg/kg). The benzo(a)pyrene concentrations in MW10 from 2.5 to 9 feet bgs, SB01 from 10 to 10.5 feet bgs, SB02 from 8 to 8.5 feet bgs, SB21 from 5 to 7 feet bgs, SD-1/3d, and 470E-SS-29-03 also exceed the U.S. EPA RBC for industrial soil (780 µg/kg).

Benzo(b)fluoranthene was detected at concentrations above screening levels in 29 samples. The concentrations exceed the U.S. EPA RBC for residential soil (870 µg/kg) in seven samples and the D.C. RBSL for residential soil (1,050 µg/kg) in five samples. Concentrations in four samples exceed the D.C. RBSL for industrial soil (3,130 µg/kg). Concentrations of benzo(b)fluoranthene exceed the U.S. EPA RBC for industrial soil (7,800 µg/kg) in only two of the samples (SB01 from 10 to 10.5 feet bgs and SB21 from 5 to 7 feet bgs).

The concentrations of fluoranthene and pyrene exceed only the BTAG screening levels for flora and fauna. The fluoranthene and pyrene concentrations did not exceed other screening levels.

Concentrations of chrysene, benzo(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, or indeno(1,2,3-cd)pyrene are above the D.C. RBSLs for industrial soil or the U.S. EPA RBCs for industrial soil in some samples collected at SB01, SB02, SB21, SD-1/3, and SS-29.

4.3.4 Volatile Organic Compounds

Laboratory analytical results for seven VOCs detected in subsurface soil samples at concentrations above the project screening levels are summarized in Table 4-14. These VOC concentrations exceed the BTAG screening levels for flora and fauna and the U.S. EPA SSLs for Ground Water Migration (DAF 1 and in some cases DAF 20). The VOC concentrations did not exceed the U.S. EPA and D.C. RBSLs for industrial and residential soil. Of the VOCs detected at concentrations above screening levels, only benzene has a D.C. cleanup standard for hydrocarbon-contaminated soil (1,000 µg/kg); the benzene concentrations do not exceed that screening level.

The analyte most frequently detected at concentrations in excess of the screening levels is methylene chloride. However, methylene chloride was also detected in the laboratory method blank associated with many of these samples. It is likely that the majority of the methylene chloride detections result from laboratory contamination. Excepting acetone, which is also a common laboratory contaminant, the other VOCs that exceed screening levels are often associated with petroleum releases. These VOCs were detected at locations near USTs or ASTs, including MW03, SB37, and SB38. MW03 and SB38 were completed near the former 1,000-gallon UST and the former 275-gallon AST near the garage building. Soil boring SB37 was completed near the former 275-gallon AST at the northwestern portion of the northern greenhouses.

4.3.5 Petroleum Hydrocarbons

Laboratory analytical results for petroleum hydrocarbons detected in subsurface soil samples at concentrations above the project screening levels are summarized in Table 4-15. Figures 4-4 and 4-5 depict diesel-range and motor oil-range concentrations at each soil sampling location.

Diesel-range hydrocarbons were detected at a concentration above the D.C. soil quality standard for petroleum-contaminated soil (960 mg/kg) in one subsurface soil sample (SB37 from 5 to 9 feet bgs). This sample was collected at a soil boring completed near the former 275-gallon AST near the northwestern corner of the northern greenhouses.

Motor oil-range hydrocarbons were detected at an elevated concentration (1,100 mg/kg) in a sample collected at a soil boring completed in the former dog training area (DCMW0012-02). Motor oil-range hydrocarbons were also detected at an elevated concentration (970 mg/kg) in a sample collected at a soil boring completed near the former northern burn pit.

4.4 Ground Water

Concentrations of the parameters detected in the ground water samples were compared to the following ground water screening levels:

- U.S. EPA Safe Drinking Water Act Maximum Contaminant Levels (MCLs);
- D.C. Ground Water Criteria (Class G1);
- D.C. RBSLs for Residential and Industrial Ground Water;
- D.C. Cleanup Standards for Hydrocarbon-Contaminated Ground Water;
- U.S. EPA Drinking Water Advisory levels for MTBE; and
- U.S. EPA Region III RBCs for Tap Water.

Concentrations of parameters detected in ground water samples collected from monitoring wells screened in fill material, Holocene clay, the upper permeable unit, or the middle permeable unit were also compared to the following surface water screening levels:

- U.S. EPA National Recommended Water Quality Criteria (NRWQC) for Fresh Water Criteria Maximum Concentrations (CMCs);
- U.S. EPA NRWQC for Fresh Water Criteria Continuous Concentrations (CCCs); and
- U.S. EPA NRWQC for Human Health Consumption of Organisms.

Chemical results for wells screened in the lower permeable unit were not compared to surface water standards because it is unlikely that water from this interval would discharge to surface water.

4.4.1 Inorganic Compounds Compared to Ground Water Screening Levels

Laboratory analytical results for 11 inorganic chemicals detected at concentrations above ground water screening levels in the unfiltered ground water samples are summarized in Table 4-16. The analytes most frequently detected at concentrations in excess of the screening levels are arsenic, lead, and manganese.

Arsenic was detected at concentrations above the U.S. EPA RBC for tap water of 0.000045 milligrams per liter (mg/L) in 45 samples (six of which were non-detects with detection limits greater than the RBC). Three samples collected by Brown in July 1997 (MW02, MW02A, and MW07) contained arsenic concentrations above the U.S. EPA MCL (0.01 mg/L) and the D.C. ground water criteria (0.05 mg/L). Subsequent sampling and analysis at each of these wells (Brown in May 1999, Environ in December 1999, and Ridolfi in November 2002) yielded arsenic concentrations below the U.S. EPA MCL and the D.C. ground water criteria.

Arsenic was detected at a concentration above the U.S. EPA MCL and the D.C. ground water criteria at two piezometers in Wetland 1.

Lead was detected at concentrations above screening levels in six of Brown's 1997 samples. However, subsequent sampling and analysis at these wells resulted in lead concentrations below the ground water screening levels. Lead was detected at concentrations above the U.S. EPA MCL (0.015 mg/L) in four of Ridolfi's 2002 samples (DCMW006-02, DCMW008-02, DCMW012-02, and DCMW015-02) and in one of Brown's May 1999 samples (MW21). Three of these concentrations (DCMW008-02, DCMW012-02, and MW21) also exceed the D.C. ground water criteria (0.05 mg/L). Monitoring well DCMW008-02 is located to the east of the central north-south road.

Monitoring well DCMW012-02 is located in the former dog training area, and MW21 is located to the north of the garage building.

Manganese was detected at concentrations above the D.C. ground water criteria (0.05 mg/L) in 33 samples. In five of these samples (DCMW006-02, DCMW007-02, PZ-1, PZ-5, and PZ-7), manganese concentrations also exceed the U.S. EPA RBC for tap water (5.1 mg/L). Monitoring wells DCMW006-02 and DCMW007-02 are located near the Green Fuel Oil property, and PZ-1, PZ-5, and PZ-7 are located in Wetland 1.

Arsenic, beryllium, cadmium, chromium, and lead were detected at concentrations above ground water screening levels in Brown's 1997 ground water sample identified as WL03. This sample was reportedly a grab sample collected directly from a test pit; test results may have been biased high by suspended or dissolved solids in the sample.

4.4.2 Inorganic Compounds Compared to Surface Water Screening Levels

Laboratory analytical results for inorganic parameters detected at concentrations above surface water screening levels are summarized in Table 4-17. Aluminum, arsenic, copper, iron, lead, manganese, and zinc were detected in the ground water samples at concentrations above either the CMC or the NRWQC for Human Health Consumption of Organisms. Of these detections, only the concentrations of copper in PZ-6 (0.013 mg/L) and zinc in PZ-8 (0.169 mg/L) exceed the CMC.

4.4.3 Semivolatile Organic Compounds Compared to Ground Water and Surface Water Screening Levels

Laboratory analytical results for two SVOCs detected at concentrations above the ground water screening levels are summarized in Table 4-18. The two SVOCs are bis(2-ethylhexyl)phthalate and naphthalene.

The concentrations of bis(2-ethylhexyl)phthalate in Brown's May 1999 sample from MW10 and of naphthalene in Brown's July 1997 sample from MW03 exceed the U.S. EPA RBCs for tap water, the only surface water screening level available for these parameters. However, subsequent sampling at MW03 (Brown in May 1999) resulted in a non-detect for naphthalene. Monitoring well MW10 has not been sampled since Brown's May 1999 sampling event.

SVOCs were not detected at concentrations at or above surface water screening levels at wells screened in fill material, Holocene clay, the upper permeable unit, or the middle permeable unit.

4.4.4 Volatile Organic Compounds Compared to Ground Water Screening Levels

Laboratory analytical results for five VOCs detected at concentrations above the ground water screening levels are summarized in Table 4-19.

Benzene was detected at concentrations above the U.S. EPA MCL, D.C. ground water criteria, and the D.C. cleanup standard for hydrocarbon-contaminated ground water (all established at 5 micrograms per liter [µg/L]) in five samples. The July 1997 sample from one of these wells (MW03 near the garage building) is the only sample to exceed

the D.C. residential RBSL for benzene in ground water (254 µg/L). The benzene concentrations are below the D.C. industrial RBSL (799 µg/L). The only ground water sample collected by Ridolfi that exceeds project screening levels is the sample collected from DCMW009-02. The benzene concentration in this sample (7.2 µg/L) exceeds the U.S. EPA MCL, D.C. ground water criteria, and the D.C. cleanup standard for hydrocarbon-contaminated ground water.

Vinyl chloride was the only other VOC to exceed its MCL. The sample collected by Brown in May 1999 from MW21 contained vinyl chloride at a concentration of 2.2 µg/L. This concentration exceeds the U.S. EPA MCL (2 µg/L) and the U.S. EPA RBC for tap water (0.015 µg/L), but is below the D.C. residential (47.1 µg/L) and industrial (148 µg/L) RBSLs. Monitoring well MW21 is located to the north of the garage building.

Concentrations of 1,2-dichloroethane and ethylbenzene exceed the U.S. EPA RBC for drinking water; methyl tertiary-butyl ether, or MTBE, exceeds the U.S. EPA drinking water advisory level, which is based on taste and odor.

4.4.5 Volatile Organic Compounds Compared to Surface Water Screening Levels

Laboratory analytical results for benzene, the single VOC detected at concentrations above the surface water screening levels, are summarized in Table 4-20. Benzene concentrations in Brown's May 1999 and/or July 1997 samples from two locations near the garage building exceed the NRWQC for Human Health Consumption of Organisms. No other screening levels are available for benzene in surface water.

4.4.6 Petroleum Hydrocarbons

Laboratory analytical results for petroleum hydrocarbons detected at concentrations above the D.C. cleanup standards for hydrocarbon-contaminated ground water are summarized in Table 4-21.

Diesel-range organics were detected above the D.C. cleanup standard (1.0 mg/L) in Ridolfi's samples from MW07, DCMW010-02, and DCMW012-02. Monitoring well MW07 is located to the north of the Green Fuel Oil Property, DCMW010-02 is located near the northern burn pit, and DCMW012-02 is located in the former dog training area. The most recent samples (Brown's 1999 samples) collected from monitoring wells near the garage building (MW03, MW10A, MW20, and MW21) also exceed the cleanup standard.

The concentration of diesel-range organics in Brown's May 1999 sample from MW04 exceeds the D.C. cleanup standard. However, the sample collected from this well by Ridolfi in November 2002 does not exceed the standard.

Concentrations of gasoline-range hydrocarbons exceed the D.C. cleanup standard (1.0 mg/L) in the two samples collected by Brown in July 1997 and May 1999 from MW03, which is located near the southern portion of the garage building.

No surface water screening levels are available for petroleum hydrocarbons.

4.5 Surface Water

Concentrations of parameters detected in surface water samples were compared to the following screening levels:

- U.S. EPA NRWQC for Fresh Water CMCs;
- U.S. EPA NRWQC for Fresh Water CCCs; and
- U.S. EPA NRWQC for Human Health Consumption of Organisms.

Only one parameter was detected in the surface water samples at a concentration above project screening levels: manganese at a concentration of 0.25 mg/L (dissolved) in Ridolfi's field-filtered surface water sample 470E-SW-01, which was collected from the Stickfoot Sewer at a manhole located near the pump house. This concentration exceeds the U.S. EPA NRWQC for Human Health Consumption of Organisms. No other screening levels are available for manganese.

Some VOCs (chloroform, dibromochloromethane, acetone, and bromodichloromethane) were detected in surface water samples SU-01, SW-1/1, SW-1/2, SW-1/2D, SW-1/3, SW-1/4, SW-1/5, SW-1/6, SW-01, and WL04. No surface water screening levels are available for these parameters.

4.6 Stickfoot Sewer Sample Results

Concentrations of parameters detected in the surface water sample collected from Stickfoot Sewer (470E-SW-01) were compared to the same surface water screening levels detailed in Section 4.5.

Only one parameter (manganese in 470E-SW-01) was detected at a concentration above project screening levels. Manganese was detected at a concentration of 0.25 mg/L (dissolved) in the field-filtered sample. This concentration exceeds the U.S. EPA NRWQC for Human Health Consumption of Organisms. No other screening levels are available for manganese.

Concentrations of parameters detected in the sediment sample collected from Stickfoot Sewer (470E-SS-27) were compared to the sediment screening levels detailed in Section 4.2 (see Tables 4-8 through 4-10).

Chromium and nickel were detected in 470-SS-27 at concentrations above sediment screening levels. The concentration of chromium (23.5 mg/kg) exceeded only the BTAG screening level for flora (0.005 mg/kg). The concentration of nickel (58 mg/kg) exceeded each sediment screening level, including the PEL (35.9 mg/kg).

Eleven SVOCs were detected in 470E-SS-27 at concentrations above the lowest project screening levels. Three of these parameters were detected at concentrations above the PELs.

Motor oil-range hydrocarbons were detected in 470E-SS-27 at a concentration of 160 mg/kg. Sediment and soil screening levels are not available for motor oil-range hydrocarbons.

4.7 Storm Drain/Sump Sample Results

Sediment samples were collected from three storm drains/sumps at the site. One sample was collected from the storm drain/sump near the southeastern portion of Wetland 1. Four samples (one of which was a field duplicate) were collected from the storm drain/sump in the area between the chemical storage buildings and the pump house. Two samples were collected from the storm drain/sump in the office building of the northern greenhouses. Laboratory results for the storm drain/sump samples were compared to the surface soil project screening levels (see Tables 4-1 through 4-5).

Inorganic parameters, pesticides, and SVOCs were detected at concentrations above the lowest applicable project screening levels in sample 470E-SS-07, which was collected from the storm drain/sump near the southeastern portion of Wetland 1. The concentrations of arsenic (63 mg/kg), 4,4'-DDD (110,000 µg/kg), and 4,4'-DDT (64,000 µg/kg) exceed the U.S. EPA RBCs for industrial soil.

Inorganic parameters, pesticides, and SVOCs were detected at concentrations above the lowest applicable project screening levels in the samples collected from the storm drain/sump between the chemical storage buildings and the pump house. Only the concentrations of arsenic exceed the U.S. EPA RBC for industrial soil.

Inorganic parameters, pesticides, VOCs, and SVOCs were detected at concentrations above the lowest applicable project screening levels in the samples collected from the storm drain/sump sump in the office building of the northern greenhouses. The concentrations of arsenic and benzo(a)pyrene exceed the U.S. EPA RBCs for industrial soil.

5.0 SUMMARY OF SITE CHARACTERIZATION

5.1 Summary of Physical Site Characteristics

The Poplar Point site is quite flat; ground surface elevations range from approximately 2 to 10 feet above msl. Since active nursery operations ceased, wetlands have developed in several areas of the site because stormwater that was once pumped off site now collects in topographically low areas. Stickfoot Sewer runs under the eastern portion of the site and conveys both stormwater and Stickfoot Creek from areas south of the site to the Anacostia River.

Near-surface material at the site consists of fill that was placed beginning about 100 years ago. The fill was placed to reclaim "swamp" land and also because the site was a convenient location for the disposal of sediment dredged from the Anacostia River to deepen a navigational channel for Navy vessels and other boat traffic. The fill consists of 1 foot to 20 feet of dredged sand and silt, as well as miscellaneous materials including bricks and other debris. Underlying the fill in most areas of the site is a thick layer of soft gray Holocene clay that was deposited in marshes fringing the Anacostia River. The clay is up to 40 feet thick near the river and thins moving away from the river to the south, pinching out near the southern portion of the site. There are a few discontinuous pockets of sand (or the connections are not well understood) lying on top of the Holocene clay.

A fine wet sand interbedded with a sandy rounded gravel (called the middle permeable unit in this report) underlies the Holocene clay or fill in the southern portion of the site. This unit was apparently a terrace deposit. Farther north, where the Holocene clay is considerably thicker, a unit with sand and sandy gravel lithology (called the lower

permeable unit in this report) is encountered below the Holocene clay. One boring, SB-101, drilled in the south-central portion of the site encountered neither the middle nor the lower permeable unit. This, along with the elevations where the two units were encountered, suggests that the two permeable units are not physically connected in this area (see Figure 3-3). However, the potential exists that these two units are connected at other areas at or near the site. A hard, orange silty clay was encountered under the lower permeable unit in a few borings that were drilled sufficiently deep.

Water level measurements were taken in monitoring wells and piezometers to evaluate the direction of ground water flow. Wells screened in similar hydrogeologic units were grouped together for this exercise. Evaluation of the water levels in the fill suggests that flow is controlled by the topography of the underlying Holocene clay and presumably by localized areas with preferential recharge. However, water level patterns are erratic, suggesting that there is no consistent direction of ground water flow in the fill material. Ground water flow directions in the upper, middle, and lower permeable units are to the west, southwest, and west, respectively.

In the vicinity of the site, the Anacostia River is tidally influenced, with about 2 feet of tidal variation per day. Previous reports suggest that there may be a tidal influence in the water levels in several monitoring wells. However, it appears from the cross sections prepared during this study that only the lower permeable unit is possibly connected hydraulically to the Anacostia River.

5.2 Summary of Nature and Extent of Contamination

A large number of samples have been collected from the Poplar Point site and analyzed for a wide range of chemicals. Plate 1 was assembled as a means of displaying areas of the site with significantly elevated concentrations of one or more chemicals. Plate 1

provides a screening summary of the site but is not intended to represent all of the site risks or to indicate areas that require remedial actions.

5.2.1 Soil

Four indictor chemicals are shown on Plate 1 for soil: benzo(a)pyrene, 4,4'-DDT, arsenic, and petroleum products (diesel and motor oil). Benzo(a)pyrene was detected above the U.S. EPA Region III RBC of 780 µg/kg for industrial soil in seven samples from the AOC Area. Three samples from Wetland 1, all collected near the fence line adjacent to the AOC Area, contained elevated concentrations of benzo(a)pyrene. Two samples collected from background locations north of Anacostia Drive also contained elevated levels of benzo(a)pyrene.

4,4'-DDT was detected above 1,900 µg/kg in a sample collected near the southern greenhouses and in a storm drain sample collected in the AOC Area. Additionally, 4,4'-DDT was detected at elevated concentrations in four samples from the southern portion of Wetland 1, one sample from the north-central portion of Wetland 1, and one sample from the southern portion of the D.C. Lanham Area.

Arsenic was detected at concentrations exceeding 20 mg/kg in four samples from the AOC Area and in two samples collected near the southern end of Wetland 1. Soil samples from six additional locations in Wetland 1 also had elevated arsenic concentrations. In addition, two samples collected near the Green Fuel Oil property and one from the south-central portion of the D.C. Lanham Area have elevated arsenic concentrations.

Diesel-range hydrocarbons were detected at an elevated concentration (exceeding 960 mg/kg) in a soil sample collected in the AOC Area near a former 275-gallon AST, and

motor oil-range hydrocarbons were detected at an elevated concentration in a sample collected from the dog training area. Two samples from the D.C. Lanham Area also had elevated concentrations of petroleum products: one from near the former burn pit and one from near the Green Fuel Oil property.

5.2.2 Ground Water

Plate 1 shows the monitoring wells at the Poplar Point site that have the most significant ground water impacts. Diesel-range hydrocarbons, motor oil-range hydrocarbons, or other fuel constituents have been detected at concentrations exceeding screening levels in these monitoring wells. Most of the wells are near the locations of former USTs or ASTs. One well is located near a former burn pit, suggesting that fuel used in burning activities has impacted the ground water. Diesel-range organics were detected in DCMW012-02 (a relatively shallow well) in the north-central portion of the AOC Area at a concentration above the D.C. cleanup standard. This well is not adjacent to any known fuel-storage facilities.

Methyl tertiary-butyl ether, a gasoline additive known as MTBE, was detected at concentrations above the U.S. EPA's drinking water advisory level (based on taste and odor) in four monitoring wells, all located near the former garage in the AOC Area. Vinyl chloride was detected above a screening level in one monitoring well north of the garage.

Benzene was detected at a concentration slightly above the MCL in monitoring well DCMW009-02, which is screened in the lower permeable unit below a thick layer of clay. The benzene detected in this well could be associated with gasoline impacts found near the garage.

Other chemicals detected in ground water include several inorganic compounds, VOCs, and SVOCs. The inorganic compounds are likely associated with the solids in turbid samples or with samples collected from shallow perched zones in the fill and are not widespread. Similarly, the detections of miscellaneous organic compounds in ground water do not seem to indicate a pervasive problem in ground water.

5.3 Recommendations

Several samples collected at the southern end of Wetland 1 contained a variety of chemicals at concentrations that exceed screening levels. Historically, the southern end of Wetland 1 was a collection point for surface water runoff; chemical concentrations in the soil in this vicinity may reflect the cumulative effect of past practices throughout the D.C. Lanham Area. Some of the contaminated material may be removed as a component of the restoration activity. In other areas, it may be prudent to perform limited removals or to place a clean cap to break the exposure pathway. Additional soil/sediment samples should be collected from Wetland 1 to better define the extent of contamination. These should include profiles across flow channels in the wetland and cores in selected locations to define the thickness of the contaminated sediment. Samples from several sumps and storm drains contain chemical concentrations that exceed screening levels. It would be prudent to remove sediment from these collection points to prevent its migration through storm sewers, as well as to prevent direct contact with these materials.

The AOC prepared a corrective action plan for the petroleum-related contamination associated with the former garage and submitted the report to the D.C. UST Division in 2003. The D.C. UST Division issued a conditional site closure letter dated July 2003.

Several other areas of the site have petroleum impacts. It is recommended that well DCMW009-02 be resampled for benzene, toluene, ethylbenzene, and xylenes and that wells MW-07 and DCMW012-02 be resampled for diesel-range organics. Remedial planning for the area adjacent to Green Fuel Oil property should also be conducted. This may include installation of several monitoring wells adjacent to that facility.

Although previous studies have indicated that ground water at the site may be tidally influenced by a connection to the Anacostia River, data supporting this conclusion are very limited. It may be prudent to place pressure transducers in several monitoring wells near the river to record water level measurements for at least a few tidal cycles (several days). Additionally, it is appropriate to install monitoring wells between the site and the Anacostia River, to further evaluate the potential for off-site contaminant transport. Data from these wells would be used in conjunction with the results of the sediment sampling effort conducted by the Academy of Natural Sciences to study the connection between the site and the river.

Some restoration alternatives include "daylighting" of Stickfoot Sewer. Measurement of flow (discharge) and collection of water chemistry during various flow regimes should be conducted in Stickfoot Sewer to support restoration planning.

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7.0 ACRONYMS

ACM	asbestos-containing material
AOC	Architect of the Capitol
AST	aboveground storage tank
bgs	below ground surface
Brown	Thomas L. Brown Associates, P.C.
BTAG	Biological Technical Assessment Group
BTEX	benzene, toluene, ethylbenzene, and xylenes
CCC	Criteria Continuous Concentration
CMC	Criteria Maximum Concentration
DAF	Dilution Attenuation Factor
D.C.	District of Columbia
DERP	Defense Environmental Restoration Program
DOH/EHA	Department of Environmental Health/Environmental Health Administration
E&E	Ecology and Environment, Inc.
EIS	Environmental Impact Statement
Environ	Environ Corporation
ESA	Environmental Site Assessment
FUDS	Formerly Used Defense Sites
GSI	Geotechnical Services, Inc.
I-295	Interstate 295
IDW	investigation-derived waste
MCL	maximum contaminant level
METRO	Washington Metropolitan Area Transit Authority Metrorail
µg/kg	micrograms per kilogram (or parts per billion in solids)

µg/L	micrograms per liter (or parts per billion in water)
mg/kg	milligrams per kilogram (or parts per million in solids)
mg/L	milligrams per liter (or parts per million in water)
ml	milliliter
msl	mean sea level
MTBE	Methyl tertiary-butyl ether
NGS	National Geodetic Survey
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRWQC	National Recommended Water Quality Criteria
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEL	Probable Effects Level
pg/g	picogram per gram
ppt	parts per trillion
PREscore	preliminary ranking evaluation score
RAI	Resource Applications, Inc.
RBC	risk-based concentration
RBSL	risk-based screening level
Ridolfi	Ridolfi Inc.
SQRT	Screening Quick Reference Table
SSL	Soil Screening Level
SVOC	semivolatile organic compound
TEF	toxic equivalency factor
TEL	Threshold Effects Level
TEQ	toxic equivalent
TMW	temporary monitoring well
U.S. DOT	U.S. Department of Transportation

USCS	Unified Soil Classification System
U.S. EPA	U.S. Environmental Protection Agency
USNRS	U.S. Naval Receiving Station
UST	underground storage tank
VOC	volatile organic compound
Volkert	Volkert Environmental Group, Inc.

TABLES

FIGURES

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Geophysical Investigation Report

APPENDIX B

Soil Boring Logs with Monitoring Well Diagrams

APPENDIX C

Water Level Measurement Field Sheets

APPENDIX D

Drum, Debris, and Investigation-Derived Waste Removal

APPENDIX E

Ground Water Sampling Event Field Sheets

APPENDIX F

Soil Boring Logs, Cross Sections, and River Cores from Other Investigations

APPENDIX G

Laboratory Analytical Data Validation Reports

APPENDIX H

Background Concentrations for Selected Inorganic Chemicals in Surface Soil

APPENDIX I

Memorandum on Analysis of Petroleum Hydrocarbon Profiles

ATTACHMENT

CD-ROM with Laboratory Analytical Data and Electronic Project Database