NPS Proposed Final Supplement to Washington Gas Feasibility Study and All Other Existing Site Information/ Basis for Proposed Plan National Park Service Anacostia Park Site Water Street S.E. Washington, D.C.

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Prepared for:

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List of Abbreviations and Acronyms

ARARs	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)
CAA	Clean Air Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DC	District of Columbia
DNAPL	Dense Non-Aqueous Phase Liquid
DPW	Department of Public Works
E & E	Ecology and Environment, Inc.
ERA	Ecological Risk Assessment
ES	East Station
GAC	Granular Activated Carbon
HHRA	Human Health Risk Assessment
HI	Hazard Index
MGP	Manufactured Gas Plant
NCP	National Contingency Plan
NCP-East	National Capital Parks-East
NCR	National Capital Region
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
µg/L	micrograms per liter
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
POTW	Publicly Owned Treatment Works

List of Abbreviations and Acronyms (cont.)

RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SVOCs	Semi-Volatile Organic Compounds
USACE	United States Army Corp of Engineers
USC	United States Code
USEPA	United States Environmental Protection Agency
VOCs	Volatile Organic Compounds
WG	Washington Gas

1 Introduction

1.1 Purpose and Organization of the Report

This document was developed by the National Park Service (NPS)/National Capital Region (NCR) to supplement the feasibility study (FS) prepared by the Washington Gas and Light Company (WG) in March, 1999, and all other existing site information, to fulfill NPS lead agency responsibilities, including identifying, evaluating and selecting remedies that provide for the protective cleanup of contaminated NPS properties, and satisfaction of the NPS public involvement requirements found in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), §117(a) and the National Contingency Plan (NCP), §300.430(f)(2).

The primary purpose of the present document is to supplement the FS prepared by WG, and all other existing site information, for the NPS property affected by WG waste. The WG FS addressed the areas occupied by the former manufactured gas plant (MGP) and contiguous areas known or suspected to be affected by MGP contaminants, including the 3.9-acre NPS property. The NPS property is across Water Street from the WG property. It lies between Water Street and the Anacostia River in the District of Columbia (DC) (Figure 1-1).

The present document supplements existing site records to assist the NPS in best addressing contamination on its property. The document presents remedial action objectives specific to the NPS property, further evaluates alternative approaches to address contaminated soil, groundwater, and sediment to meet these objectives, and provides supporting information to assist the NPS in recommending and selecting the site remedy. It also incorporates remedial alternatives already presented and evaluated by WG, some of which have already been initiated at the site. This document will serve, in addition to all other existing site information, as the base for preparation of the NPS Proposed Plan.

Subsequent to the FS, WG published a Proposed Plan in June, 1999 and a Decision Document in September, 1999 that set forth the approved remedial action for all of the impacted properties except the NPS property. The Proposed Plan for the WG, East Station site, 12th Street S.E., Washington D.C. published by WG in 1999 has been through both the review and the public comment and

response cycles, and has been approved by the United States Environmental Protection Agency (EPA).

In preparing this present document, the NPS has reviewed existing site information, including the June 1999 WG Proposed Plan, and 1999 Decision Document since many of the concerns are identical, and the possible remedies are similar. To better support the NPS evaluation of alternatives, WG performed additional soil sampling on the NPS parcel during November 2001, and their consultant revised the human health risk assessment to accommodate this new data. The updated risk assessment is found in "Assessment of Health Risk to Utility and Landscape Workers on National Park Service Property South of East Station in Washington D.C.", Hydro-Terra Inc., published in March 2002. This document recalculates the risk to workers on NPS property based on the results of soil sampling at 12 additional sampling sites on NPS property, in addition to the 8 soil sampling sites and 12 soil-gas sampling sites used during the RI/FS health risk assessment. The WG Decision Document and all supporting documentation form part of the Administrative Record for the East Station Site, and will form part of the Administrative Record for the NPS site. These documents are referenced in the following report, as sources of more complete information.

The present document adds to the WG FS and existing site information in three key areas:

- It incorporates new data from the additional samples collected on the NPS property after the WG FS was completed, including a new human health risk assessment (HHRA) derived from a combination of existing data and the new site-specific sampling data;

- It considers ARARs specific to the NPS site that did not apply to the entire East Station site; and

- It considers remedies as they apply only to the NPS site, both in evaluating alternatives, and in selecting the preferred alternative.

Section 1 of this report presents the site location and description, and site background and characteristics. Section 2 presents the development of remedial action objectives (RAOs), including the identification of all Applicable or Relevant and Appropriate Requirements (ARARs), and a summary of site risks. Section 3 presents a description and evaluation of remedial action alternatives and the justification for the selection of the preferred alternative.

1.2 Site Location and Description

The "East Station site" as defined in CERCLA is located to the south of "M" Street and east of 11th Street (Figure 1-1). The site is defined as the area impacted by the waste residuals of town gas manufacturing. The East Station site covers an area of approximately 18.8 acres and includes property owned by WG, formerly

containing the East Station manufactured gas plant, as well as properties owned by NPS, DC, and the United States Army Corps of Engineers (USACE). The site drains into the Anacostia River.

The parcel of land governed by this document is the section of the "East Station site" owned by NPS and impacted by town gas manufacturing wastes and covers an area of approximately 3.9 acres (the NPS site). It is adjacent to the Washington Gas property located at 1240 12th Street, S.E., Washington, D.C. This parcel of land is part of the Anacostia Park Section G, which is a component of the land administered by the National Capital Parks-East (NCP-East) a unit of the National Park Service's National Capital Region (NCR). A small U.S. Reservation (No. 298, approximately 0.25 acres), just north of Water Street, is not included as part of the "NPS Site" further evaluated in this document since it will be remediated as part of the WG property.

1.3 Site Background and Characteristics

The NPS site is situated over what were formerly marshes, wetlands, mudflats, and marginal upland adjoining them along the Anacostia River tidal estuary. Much of Anacostia Park, and specifically this section of the Park, was created as a result of dredge and fill operations directed by the USACE between 1908 and 1919.

The yearly reports of the Chief of Engineers, U.S. Army, during the period 1908 – 1919 (Washington Perspectives, October 1985), show that the land now forming the portion of Anacostia Park between Water Street and the sea wall was created between 1914 and 1919. The majority of the work was completed by 1917. The seawall was constructed by dredging a trench into the soft sediments on the river bottom. The trench was filled with crushed rock and allowed to settle under its own weight. More rock was added until the pile stabilized with its top at approximately low tide level. The seawall foundation extends to low water level from at least six feet below low water and the seawall itself originally extended to six feet above low water in general. The foundations are at least 23 feet across, being approximately symmetrically placed under the wall itself. The wall was built of dry stone, without mortar, but was capped with pre-cast concrete blocks in this area. Along parts of the site wooden piles had to be driven into the river bed to prevent the foundation from subsiding sideways into the river channel.

The WG-owned part of the East Station site (the WG site) has now been developed, and is the site of two large office buildings with their associated parking lots. It also contains an older two-story building, which is used for WG office space and treatment of groundwater pumped from beneath the site. Immediately south of the building and also on the WG property is a facility used for fueling vehicles with natural gas.

The NPS has proposed as part of a General Management Plan for Anacostia Park that their property will be developed as a connected part of the Anacostia Park

System to provide public access to the waterfront, and a variety of recreational opportunities. The NPS property is currently serving several limited uses:

- An unfenced part of the site allows public access to the river for fishing, non-motorized boating and open space passive or picnic-type recreation, in a part of Anacostia Park with very limited alternative public access to the river.
- DC Department of Public Works (DPW) stores roadway maintenance equipment on a portion that DPW uses under NPS permit;
- ST Services (formerly Steuart Petroleum) has an easement which crosses the site to transport petroleum fuels via underground and aboveground pipelines from its off-loading pier in the Anacostia River to a storage and distribution facility located immediately east of the WG East Station property; ST Services is phasing out its use of NPS property;
- A pump house formerly used by WG to pump water from the river is still present on the NPS property; and
- A rowing club uses a small area of the property for recreation.

The USACE's quarter-acre property along the river is used as a staging area for crews removing floating debris from the Anacostia and Potomac rivers.

A railway and freeway lie north of the East Station site in a 400-foot wide corridor. Land use north of the corridor is residential and commercial. The Washington Navy Yard is located west both of the site and of 11th Street. The Navy Yard is the administrative support center for Navy activities in the DC area.

The same type of contamination found at the WG site has been found on the NPS site. The fill beneath the surface of the site is contaminated by wastes from the production of town gas. As further described below, these wastes contain tar, oil, coke, volatile aromatic organics such as benzene, semi-volatile polynuclear aromatic hydrocarbons (PAHs), some of which are carcinogens, complexed cyanide, and heavy metals. The groundwater beneath the site is contaminated by the wastes from the site and can potentially contaminate the Anacostia River. Sediments in the river are contaminated with material that could be attributable to the site, although this is still being investigated by the WG, EPA and NPS, among others. Some of the tar is present at sufficient concentrations to form a separate liquid phase, a Dense Non-Aqueous Phase Liquid or DNAPL, that can migrate within the site and could also impact the river.

1.3.1 Impacts from Gas Manufacturing Activities

Manufactured gas was produced continuously by WG on their property from 1888 to 1948. The East Station was used to manufacture coal gas until 1914, carbureted water gas until 1932, reformed gas until 1948, and oil gas until 1983.

During the years 1888 to 1948, as the gas manufacturing process changed, the facility was enlarged and modified. In 1948, natural gas became available and manufactured gas was only produced intermittently by the plant during periods of peak gas demand. Between 1970 and 1983 the plant was operated once a year to check equipment. Following the closure of the plant in 1983, a Phase I investigation was conducted. Demolition of the gas manufacturing plant proceeded until 1988 at which time the Phase II investigation began. The aboveground oil storage tanks on the property were removed in 1997.

Coal and oil were the principal gas manufacturing feedstocks. Gasification by-products were tar, oil, coke, and lampblack. Coke was the principal solid residual, and most of it was recycled as plant fuel or sold commercially. Coke was also used in filter beds to purify process water, producing a solid residual of off-specification coke contaminated with tar and oil. Periodic cleaning of the filter beds produced a residual product, some of which appears to have been placed as fill on the East Station Site.

By-product tar was sold commercially or used as a boiler fuel. Sampling evidence suggests that some tar was mixed with solid waste and was placed as fill on the site. Leakage from various plant structures is another probable source of the detected tar as well as oil found in soil above and below the water table. Leakage of oil from underground pipelines operated on the site by ST Services is also potentially a source of oil found on the portion of the East Station Site lying along the Anacostia River.

Wood chips containing iron oxide were used in the removal of cyanide from manufactured gas, and, when purification capacity was exhausted, some of the wood chips contaminated with complexed cyanides and absorbed tar were also placed as fill on the site.

During the course of site operational history, WG undertook major cut and fill alterations on its property and apparently disposed of town gas waste onto adjoining property. This is substantiated by the nature of the fill found on the NPS site.

The thickness of fill under the NPS property ranges from approximately 1 foot to approximately 13 feet, with an average thickness of approximately 8 feet, and a volume of approximately 50,000 cubic yards (yds^3). All of this fill is potentially, but not necessarily, contaminated with WG waste, including tar.

The entire volume of water in the fill is contaminated, most of it exceeding 1,000 micrograms per liter (µg/L) of semi-volatile organic compounds (SVOCs), and containing significant levels of volatile organic compounds (VOCs) and heavy metals.

The fill is underlain by a natural layer of silt. Under the silt on the NPS site, some of the groundwater in the sand and gravel is contaminated with components of gas manufacturing tar waste. Approximately half of the area of this sand and gravel unit under the NPS site has been shown to be contaminated.

Both the fill and sand and gravel layer beneath part of the NPS site are contaminated with coal tar.

1.3.2 Environmental Investigations

Seven significant environmental investigations of the East Station Site have taken place since 1983. They are listed below, and can be found in the Administrative Record for the NPS site:

- Preliminary Contamination Investigation (Phase I) (Hydro-Terra, 1983).
- Contamination & Land-Use Study (Phase II) (Hydro-Terra, 1989).
- Additional Sampling & Ground-Water Recovery System Design (Phase III) (GeoTrans, 1991).
- Site Investigation for WMATA Facility (Engineering-Science, 1994).
- Preliminary Assessment of NPS/East Station Site (Ecology and Environment, 1995).
- Additional Remedial Investigation and Feasibility Study (Phase IV) (Hydro-Terra, 1999).
- Assessment of Health Risks to Utility and Landscape Workers on NPS Property (Hydro-Terra, 2002)

The investigations show that the site is filled with dredge spoils and industrial (town gas) waste from WG. The main contaminant of concern is coal tar, which contains carcinogenic and toxic PAHs, VOCs (especially benzene), and toxic heavy metals constituents. Soil and groundwater, both shallow (in the fill) and deep (in a sand and gravel aquifer beneath the natural silt under the fill), are contaminated with coal tar and town gas waste constituents that have been dumped onto or migrated onto the Site.

NPS listed the site as Washington Gas and Light site on the Federal Facilities Compliance Docket; this listing occurred on October 10, 1993. In addition to the RI/FS studies of the East Station site, which only incidentally addressed the NPS site, WG also sampled surface and near-surface soils (0-3.5 ft) on the NPS site, in November 2001 (Figure 1-2). These data provided a more representative set of samples for the Human Health Risk Assessment, of March 2002. Soil-gas sampling points were used to assess health risks from VOCs (Figure 1-3).

The different phases of site investigative activities compose an iterative process that has been gradually extended to encompass the entire area of contaminated fill. The information collected has been used to define the nature and extent of groundwater contamination, and delineate the general limits of DNAPL, so that appropriate remedies could be identified, evaluated, and designed. USEPA, NPS and DC have all participated with WG in reviewing proposals, overseeing fieldwork, monitoring cleanup, and reviewing reports.

NPS has provided technical support using the services of its contractor, Ecology and Environment, Inc., (E & E) to review and assess field investigations by WG, so as to ensure the adequacy of the technical data collected. USEPA Region 3 provided formal review of the RI reports including the RI Human Health Risk Assessment (HHRA) and the Ecological Risk Assessment (ERA), the FS, the WG Proposed Plan and the WG Decision Document.

The conclusions of the site investigations are that the NPS property consists of four layers of material that are the source of contaminants or control the distribution and migration of contaminants on the site. The source of the contamination is town gas manufacturing waste and other gas manufacturing by-products, which were used as fill material across the site. The surface layer of the site is fill, including dredge spoils, much of it mixed with and contaminated by coal tar, VOCs, and heavy metals. The fill is thickest within a former inlet of the Anacostia River beneath the western portion of the site, and rests on a natural layer of silt. On the south end of the site, the fill abuts the seawall and terminates at the seawall.

Beneath the fill is a layer of natural silt. Findings on contaminant migration show that this layer of silt essentially prevents further vertical migration of contaminants where it remains intact. However, the silt layer is discontinuous where it was excavated and removed over part of the WG property, allowing tar from the fill to migrate to a layer of sand and gravel below the silt. Through this mechanism, tar and other waste constituents have contaminated the groundwater in the sand and gravel aquifer, including part of the sand and gravel layer extending under the NPS property.

The fourth layer is the Arundel Clay, which lies beneath both the sand and gravel and the silt layers. Because of its thickness (approximately 100 feet), low hydraulic conductivity, and upward hydraulic gradient from the Patuxent Aquifer to the overlying aquifers at the site, it prevents fluid flow to the Patuxent Aquifer that lies beneath the clay.

The seawall forms the limit of the NPS site and the boundary of the fill. The wall is permeable and allows river water and groundwater to flow into and out of the fill. This occurs as a result of groundwater extraction by pumping, by tidal fluctuations, or as a result of flood and drought levels of the river

The groundwater in both the fill and the sand and gravel layer below the silt layer would naturally discharge to the Anacostia River if it were not intercepted by pumping wells. DNAPL in the fill layer could also potentially migrate and discharge to the river. The shallowest aquifer beneath the site with sufficient yield to supply potable water is the Patuxent Aquifer, which lies beneath the Arundel Clay layer (the Arundel Clay is an aquaclude), and studies of nearby sites imply that the hydraulic head in the Patuxent Aquifer is currently higher than heads in the surficial layers, so potential flows are upwards from the aquifer, rather than downwards from the site. There are no wells in this aquifer within four miles of the site that are used for drinking water, therefore no drinking water wells are at risk for contamination originating at the site.

1.3.3 History of Site Activities

Since 1976, actions have been taken by WG at the East Station site to address environmental conditions. All actions have received review and comment by the District, USEPA and the NPS. As needed, permission has been obtained from appropriate agencies for construction activities on NPS land. These actions are summarized below. They are described in detail in the WG Decision Document, which is part of the Administrative Record.

In 1976, after a release of oil of unknown origin to the Anacostia River, WG undertook a number of pump-and-treat initiatives. The first effort involved installation of a 150-foot lateral groundwater interceptor drain (Trench Well) that was emplaced within the fill near the river on the NPS and USACE properties. Groundwater containing tar and oil was pumped from the Trench Well and treated before being released to the river under a National Pollutant Discharge Elimination System (NPDES) permit. Treated groundwater was discharged to the river until 1993. Since 1993, treated groundwater has been discharged to the publicly owned treatment works (POTW) under a discharge permit.

In 1990, WG placed a soil cover on portions of the East Station property not covered by impermeable structures, and stabilized the soil with turfgrass.

In 1993, WG installed a new groundwater treatment facility on the East Station site capable of treating 36,000 gallons of water a day. Contaminated groundwater extracted from the Trench Well is treated by these three steps: (1) sedimentation to remove the DNAPL; (2) oil/water separation to remove floating oil and emulsified tar; and (3) air stripping to remove entrained organic gases before release of the treated groundwater to the POTW under a discharge permit. Air and the entrained organic gases from the air stripper(s) pass through granular activated carbon (GAC) filters, and the treated air is released to the atmosphere under an air-discharge permit.

In 1994, three total-fluids (all liquids) recovery wells were installed at the south end of the East Station property: two in the shallow fill and one in the deeper sand/gravel unit. Using these three wells, approximately 8,000 gallons of fluids

per day, in addition to the volume captured from the Trench Well, are captured and treated through the new groundwater treatment system. This pump-and-treat system continues to operate.

Since 1996, WG has removed DNAPL that accumulates in some of the extraction wells installed on the East Station Site, and stores it before proper disposal. In 1996, WG began extracting fluid from two wells finished in the fill. In 1997, three additional wells on the NPS property, two in the fill and another in a deeper sand/gravel unit, became DNAPL-recovery wells as well. Total recovery rates for DNAPL have declined over time, averaging about 50 gallons a month as of July 1999.

In 2002, WG made changes to the pump and treat system including installing provisions to capture and extract shallow ground water flowing to the Anacostia River from NPS property. This was accomplished by the installation of a trench drain extending northeast of the trench well. Modifications were also made to a well located at the northeast corner of the DC DPW building converting it into a groundwater recovery well able to pump water to the trench well. WG also installed a new double walled water line between the trench well and the treatment facility and modified the trench well to better accommodate the new sources of groundwater and allow for easier extraction of collected tar. The flow rate from the trench well following flow stabilization is estimated to average between 20 and 22 gallons per minute as compared to an average of about 12 gallons per minute before the additional measures to capture groundwater were employed. Currently some 30,000 gallons a day of groundwater are therefore extracted from the Trench Well, treated, and discharged to the POTW (Hydro-Terra, January 2003).

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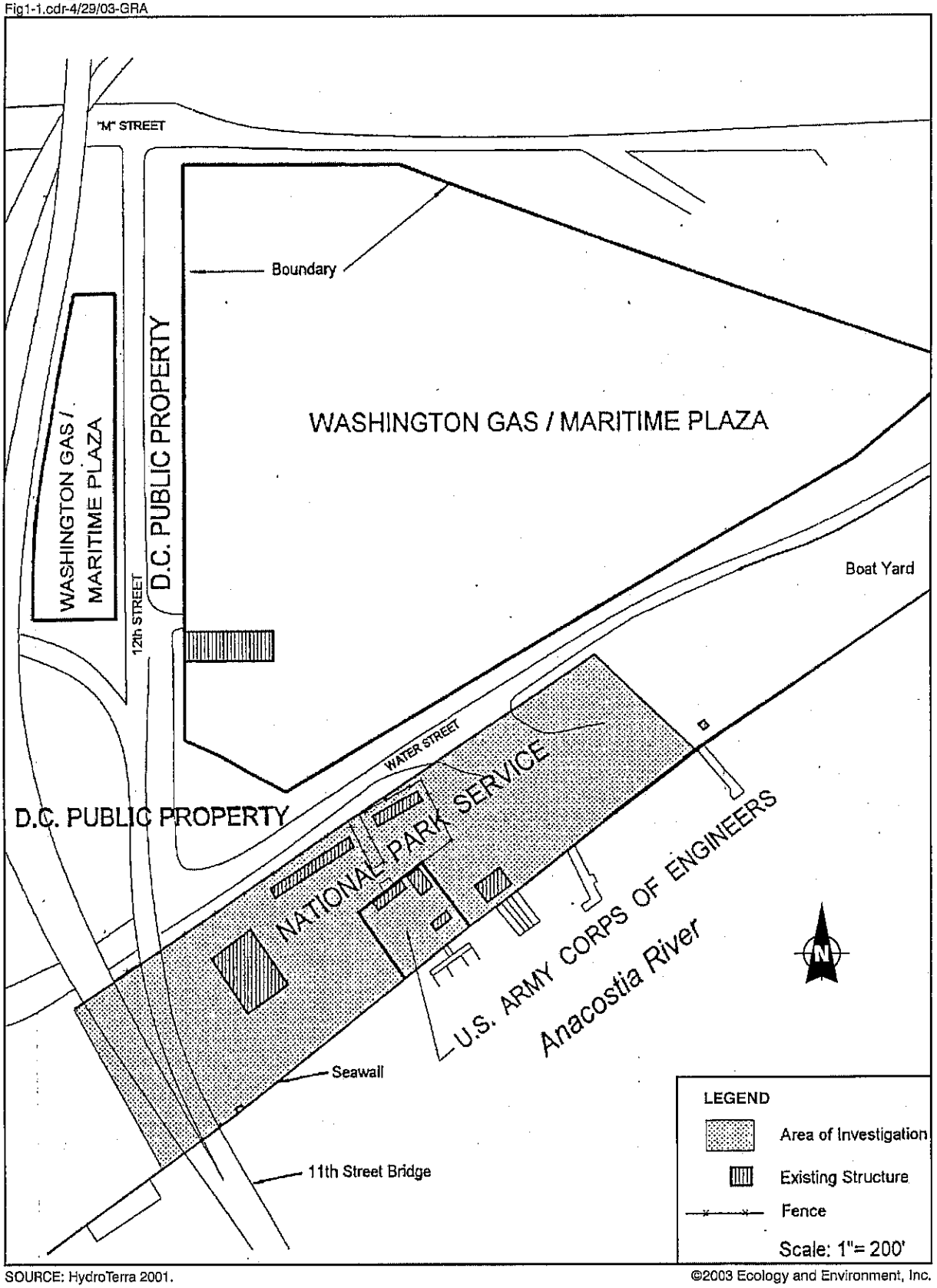

SOURCE: HydroTerra 2001.

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Figure 1-1 SITE MAP, NATIONAL CAPITAL PARKS - EAST; WATER STREET, S.E., WASHINGTON, D.C.

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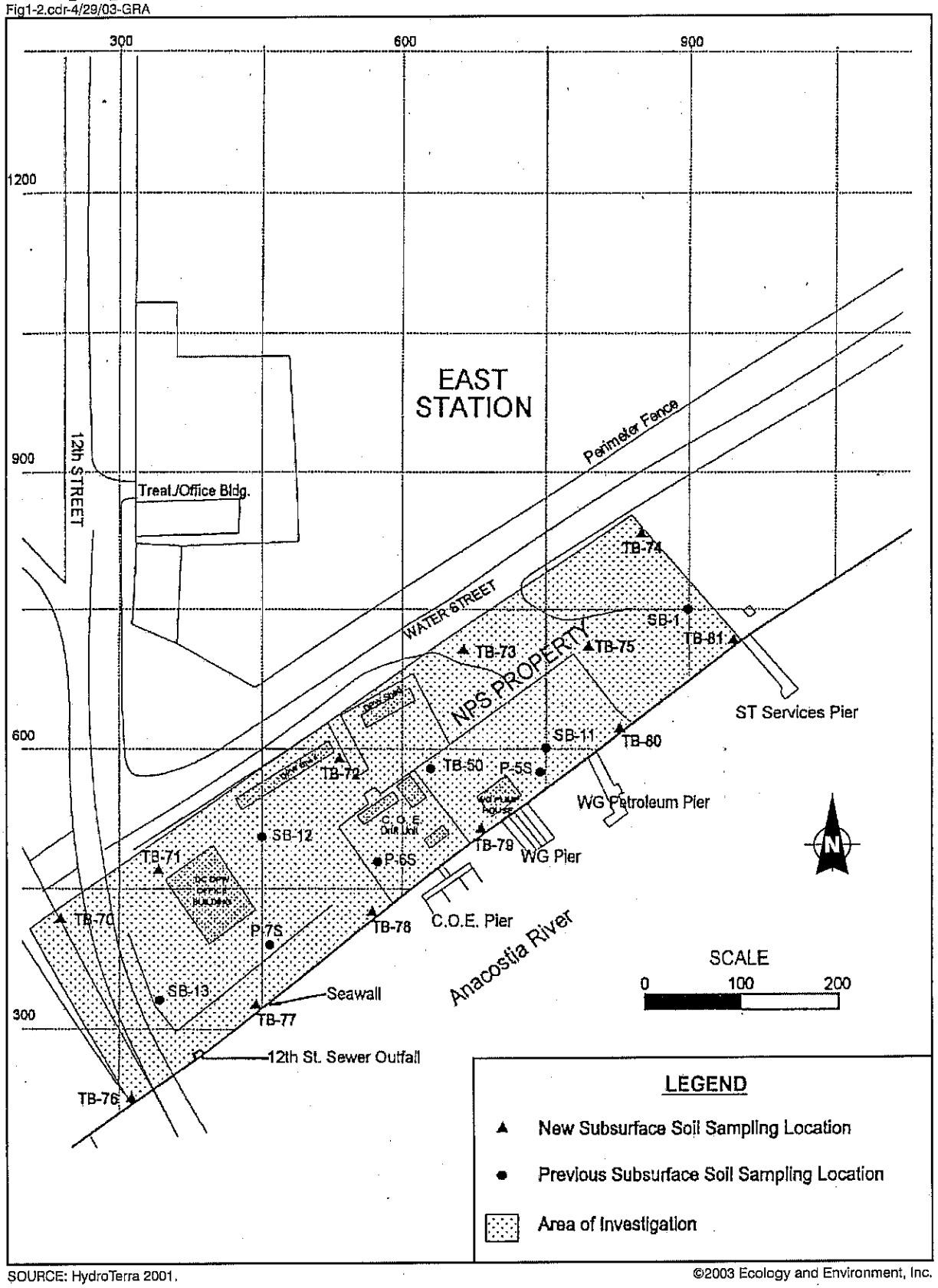

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Figure 1-2 LOCATION OF SOIL-SAMPLING POINTS
NCP-E, WATER STREET, S.E. WASHINGTON, D.C.

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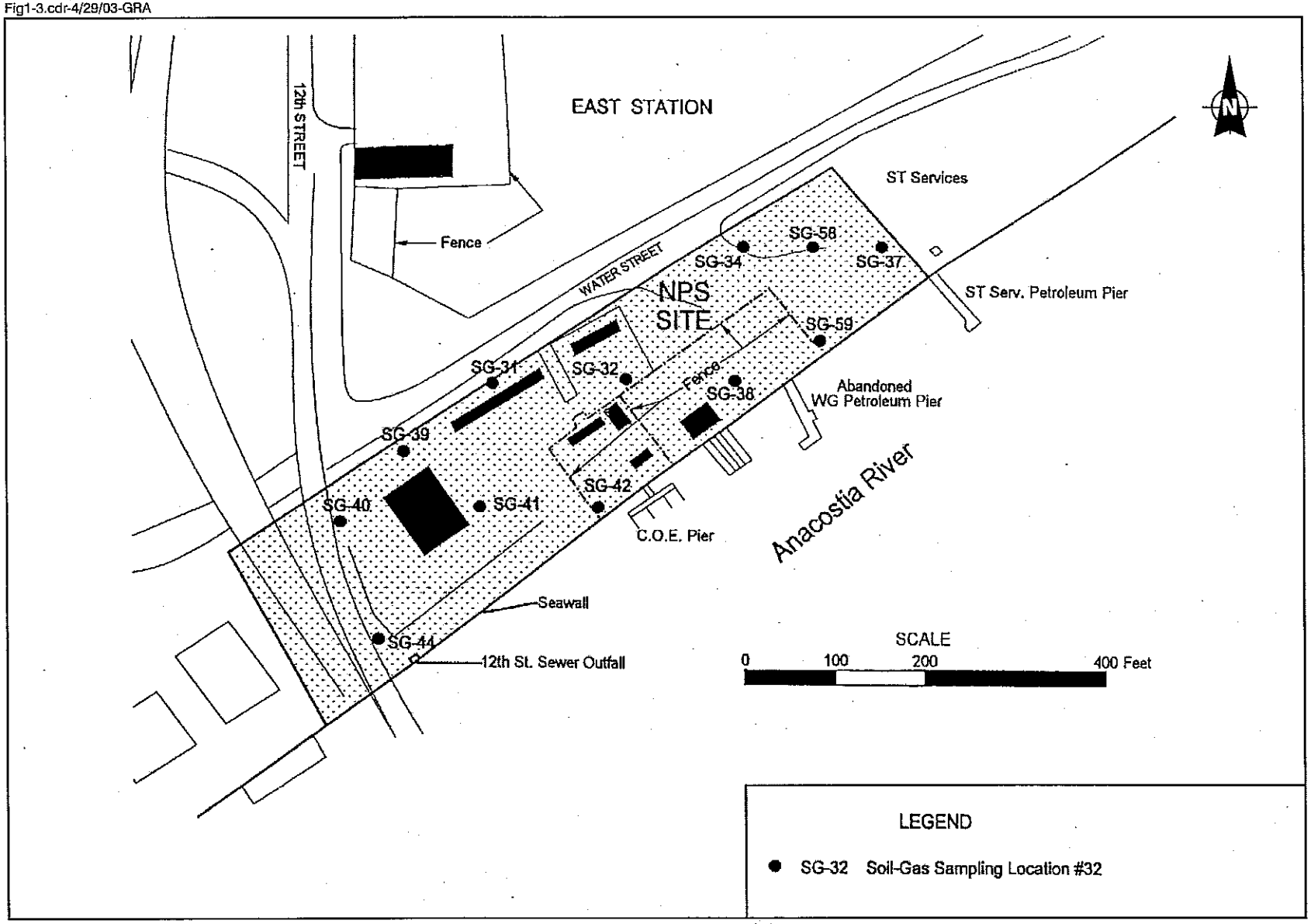

SOURCE: HydroTerra 2001.

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Figure 1-3 LOCATION OF SOIL-GAS SAMPLING POINTS
NCP-E, WATER STREET, S.E. WASHINGTON, D.C.

2 Remedial Action Objectives

2.1 Summary of Site Risks

As the lead agency, it is the NPS's responsibility to ensure that the remedial action selected for the NPS site protects public health or welfare and the environment from actual or threatened releases of hazardous substances into the environment. The primary site risk deemed unacceptable is the exposure of the public to existing surface soil contamination.

2.1.1 Summary of Human Health Risks

When the RI plan was being developed by WG, USEPA, NPS and DC for the East Station site, it was concluded that primary potential routes of human exposure to chemicals were:

- Ingestion of soil;
- Dermal contact with soil and river sediment;
- Inhalation of VOCs and dust; and
- Ingestion of fish taken from the river.

Thirty two exposure scenarios were evaluated by WG's consultants for the entire East Station site, covering current land uses, the transition period when the properties will be converted to future uses, and future uses (Table 2-1). WG considered two future uses of their portion of the East Station property: commercial/industrial use and residential use. In their evaluation, it was assumed that the future use of the riverfront NPS property would be recreational, with this entire area converted to a public park.

The only human health risk scenario evaluated during the RI by WG, specifically related to the use of the NPS property only, was exposure to unremediated soil for a juvenile using the NPS property as a recreational park. Other scenarios addressed risk over the entire East Station site, regardless of property ownership.

The NCP sets forth an acceptable range of risk for cancer from 1E-4 to 1E-6 [(40 CFR § 300.430 (e) (2) (i) (a) (2)]. In the RI/FS, WG considered that a potential

threat exits when cancer risk is greater than 1 excess lifetime cancer occurrence in a population of 10,000 people (1E-4), which is generally the highest risk acceptable to the USEPA. Because of its mandate to conserve and protect NPS property for the use and enjoyment of future generations, and because neither the public nor park workers should be exposed to any significant risk while doing so, the NPS chooses to reduce risks beyond 1E-4 as far as practicable.

Exposure to unremediated soil for a juvenile using the NPS property as a recreational park was estimated to involve an estimated lifetime additional cancer risk of three cancers for 10,000 people (3×10^{-4}). This shows that the surface soil poses an unacceptable risk and for this reason surface soil at the NPS site has to be remediated.

In the case of non-cancer (non-carcinogenic) health risk, a hazard index of 1.0 or greater is considered a potential threat. Those exposure scenarios found to have a potential risk above the threshold levels are identified in Table 2-1. The exposure of a utility worker to VOCs was calculated for the entire East Station site and produced a hazard index of 3.9 for exposure to benzene. This implies unacceptable levels of exposure to a toxic chemical across the entire area of contamination, including on the NPS property. A similar conclusion was drawn with respect to a bulldozer operator, whose exposure to manganese in inhaled dust resulted in a hazard index of 35.

The most recent investigative activity on the NPS property in November 2001 was an effort to more accurately define the calculations of exposure risk to utility and landscape workers to subsurface soil, within the NPS property alone (Hydro-Terra, 2002).

The non-carcinogenic risks were calculated to be below a hazard index of 1, and therefore do not represent a significant risk. The cancer risks to utility workers on NPS property are 1.14×10^{-5} for exposure to inhalation of subsurface soil gas (1.14 excess cancers per 100,000 population for lifetime exposure) and 1.11×10^{-6} for dermal contact with subsurface soil. The risk to landscape workers is 2.84×10^{-6} for exposure to inhalation of subsurface soil gas (Table 2-2). Risks for other carcinogenic scenarios were significantly less.

These results are below the 1E-4 threshold of potentially acceptable risks but above the 1E-6 threshold of negligible risks.

The site is characterized by small pockets of coal tar contamination, or 'hot spots', in the subsurface that are irregularly distributed throughout the fill material and contribute to the risks to utility and landscape workers. Therefore, NPS proposes to reduce the risks to utility and landscape workers by the removal of these 'hot spots'.

2.1.2 Summary of Ecological Risks

A screening-level ecological risk assessment (ERA) was performed during the WG RI and is part of the Administrative Record. Potential ecological routes of exposure that were identified include:

- Ingestion of contaminated sediment by aquatic invertebrates and by vertebrates;
- Ingestion of contaminated soil or plants by terrestrial vertebrates; and
- Root uptake by plants of contaminants in soil and water.

The potential stressors are VOCs, SVOCs, and inorganics (metals and complex cyanides). These are found in the upper two feet of soil, in stormwater runoff, in groundwater, river water, and in sediments.

Chemicals identified in each medium of concern with a hazard quotient above 1.0 were identified as chemicals of potential concern. Table 2-3 identifies the chemicals of potential ecological concern in each media.

Remedial of the surface soil to address the human health risks and excavation of 'hot spots' in the underlying soil will result in a significant simultaneous reduction of the ecological risks posed by soil contamination at the site, since most biological activity at any site is confined to the topsoil and immediately beneath it.

No critical habitats and no endangered species or habitats of endangered species are affected by the chemicals at the site. The Anacostia River has probably been affected by chemicals from the site, as well as other sources located in the watershed of the river. The USEPA has initiated a study of sediment contamination in the river, and the NPS is an active participant in the study. If these studies and actions that result from them, suggest that a sediment remedy is practicable, then the NPS will propose a remedy.

2.2 Applicable or Relevant and Appropriate Requirements (ARARs)

The NPS in its mission to protect and preserve the property entrusted in its care for the enjoyment of future generations, must comply with a number of statutes, regulations, executive orders and NPS policies, as well as propose remedies that serve to protect human health and the environment. This obligation is reflected, in part, by Section 121 (d) of CERCLA, which requires the NPS to comply with ARARs, which can be chemical-specific, location-specific, or action-specific.

In the WG FS, WG addressed the chemical-specific ARARs applicable to the East Station site. These essentially focus on the concentrations of chemical contaminants, which when exceeded in specific media, result in an unacceptable risk to human health or to the environment.

Likewise, in the FS evaluation of remedial alternatives, WG discussed applicable action-specific ARARs. Action-specific ARARs that may apply to the NPS remedial action include:

- The Resource Conservation and Recovery Act (RCRA) Subtitle C: The RCRA requirements apply to disposal of hazardous waste generated during excavation or to disposal of DNAPL collected directly from wells or a groundwater treatment unit.

- Clean Water Act (Federal and DC Ambient Surface-Water Quality Criteria): The Clean Water Act (CWA) applies to preventing chemicals and wastes from entering the river and causing ambient water quality criteria to be exceeded. For example, the permitted discharge of treated groundwater to the POTW, which discharges into the Potomac River.

- Occupational Safety and Health Administration (OSHA) Standards: OSHA requirements apply to measures that protect the health of construction, utility, maintenance workers, and NPS personnel.

- Executive Order 11988 (Floodplain Management): Measures protecting the 100-year floodplain apply to actions that may obstruct a floodplain by filling or by creating situations that could result in uncontrolled erosion (40 CFR Part 6, Appendix A).

- Clean Air Act (CAA): The CAA applies to any air discharge released to the atmosphere from the groundwater treatment facility or through soil disturbance.

WG did not address the location-specific ARARs that the NPS must address during its review of remedial action alternatives. Applicable statutes or orders include:

- The National Historic Preservation Act (NHPA)(1966) as amended through 1992;

- Executive Order No. 11593 (Protection and Enhancement of the Cultural Environment), May 13, 1971;

- National Park Service Organic Act, 16 U.S.C. Section 1 et seq.;

- Public Law No. 65-208, 40 Stat., 918, 950-951 (August 31,st 1918); which created Anacostia Park;
- National Park Resource Protection, Public Use and Recreation (36 CFR Part 2);

- National Park Area Nuisance (36 CFR Part 5.13);

- Park Solid Waste Act (16 USC Section 460 l-22(c)) and Solid Waste Sites in Units of the National Park System (36 CFR Part 6);
- Coastal Zone Management Act (16 USC Section 1451); and
- Fish and Wildlife Coordination Act (16 USC 661 *et seq.*).

In addition, the *Draft Purpose and Significance Statement, Anacostia Park Management Plan* (1999) and the *Resource Management Plan, National Capital Parks East* (revised in 1999), are documents that fall in the category To Be Considered (TBC).

The cumulative impact of the ARARs not specifically used by WG during its FS is particularly reflected in the NPS concern to remediate both surface and subsurface soil as needed, in a way that places no undue restriction on public enjoyment of the site and the development of the site for any appropriate Park purpose.

The potential eligibility of the seawall for protection under the National Historic Preservation Act, as it has been deemed eligible elsewhere in the Washington DC area, also need to be considered by the NPS to ensure full compliance with the NHPA. The NPS must be able to maintain or restore the seawall as needed, without exposing workers to unacceptable levels of hazardous substances. These requirements are reflected in the Remedial Action Objectives.

2.3 Remedial Action Objectives

WG RAOs, as stated in their FS, did not consider any human health risk scenarios for the NPS site beyond exposure to surface soil during recreational use. Specifically, they did not address exposures to subsurface soil by workers installing foundations or utilities, or repairing the seawall, or the lesser exposure of landscape workers to subsurface soils.

The NPS, in its selection of remedies and identification of the preferred alternative for the site, must consider full and free use of the area as a park, accessible to the general public for their safe enjoyment. This not only means use of the park as a recreational area, but also involves construction, such as the installation of utilities, of park-related services, and of access roads, paths, and other enhancements such as maintenance of the historic seawall, which provides a boundary to the park on the riverside and maintains the physical integrity of the NPS site.

Because NPS may, in the future, need to disturb subsurface soil to install water, electricity or gas lines or other utilities to serve its park land, to construct pathways or buildings, or to maintain or restore the seawall, an adequate remedy mandates that the NPS may do so without encountering hazardous substances at

levels requiring engineering controls, personal protection or special disposal requirements.

Protection of the adjacent Anacostia River sediment and water as fish and wildlife resources is also an important objective of the on-site remediation.

Additionally, there is continued use of the property by the USACE (access to its property); and by DC DPW (which has an on-going permit) to be considered.

The Remedial Action Objectives (RAOs) are presented in the sections below for each of the contaminated media on site, and for off-site media (sediments and river water) that could potentially be impacted by the site. They were established based on the analysis of site risks and ARARs.

2.3.1 Soils

The RAOs for soils are:

- Prevention of unacceptable exposure of Park employees or members of the public using the park;
- Prevention of unacceptable exposure of utility, landscape or construction workers at the park;
- Prevention of erosion of contaminated soil into the Anacostia River by overland flow or by the collapse or breaching of the seawall, during remediation and subsequent park operations;
- Prevention of unacceptable exposure of ecological receptors at the park

Cleanup levels will be based on the cancer and non-cancer risks presented in Section 2.1.1.

2.3.2 DNAPL

The cleanup objectives for tar (DNAPL) are:

- Collection of any DNAPL mobile enough to be capable of flow, to remove it for off-site treatment;
- Removal of DNAPL in soils to a depth that will prevent unacceptable exposure of park users, park employees, utility or construction workers, and ecological receptors; and
- Prevention of migration of DNAPL into the Anacostia River.

The first and third of these objectives were addressed in the WG FS and Proposed Plan, and the second is addressed in this document under the heading of soils remediation.

2.3.3 Groundwater

Because there are no aquifers currently used for water supply that are impacted by the site, the major RAO for groundwater is to prevent off-site migration into surface water.

The two water-bearing zones under the site require separate remedial actions that are currently being implemented:

- Pumping wells in the fill, including the interceptor trench, create a cone of depression in the water table that captures water flowing off the site and draws some water from the river into the fill. Groundwater is extracted using capture wells, then is treated in the on-site groundwater treatment system, and discharged off-site.

- Pumping wells in the sand and gravel zone beneath the silt layer capture contaminated groundwater entering the NPS property and prevent it from migrating any further. Extracted water and DNAPL is treated in the on-site groundwater treatment system, and discharged off-site.

Remediation will continue indefinitely with review at five-year intervals. Cleanup objectives are performance based (no migration off site), rather than risk based. However, all ground waters in the District are by default designated of drinking water quality and the two shallow water-bearing zones beneath the Site should ultimately comply with DC groundwater standards or their classification should be changed by the District Department of Consumer and Regulatory Affairs (DCRA).

2.3.4 River Sediment

There are other potential sources of the contaminants in the sediments of the Anacostia River and there is insufficient evidence that PAHs and other contaminants in sediments adjoining the site are entirely attributable to the site. The RAO is to further investigate the extent of sediment contamination, and the sources that contribute to it, and ultimately to agree on an acceptable remedy.

Table 2-1: Summary of Human Health Risk Assessment (Hydro Terra, March 1999)

Scenario No.	Population	Exposure Location	Exposure Route	Time Frame			Cancer Risk	Hazard Index
				Pres	Trans	Future		
1	Angler	Anacostia R.	Fish Ingestion	x	x	x	2.8E-07	4.8E-03
2	Swimmer/ Wader	Anacostia R.	Sediment Ingestion	x	x	x	9.7E-07	5.0E-03
3			Sediment Dermal	x	x	x	8.9E-06	7.6E-03
4	Offsite Resident	Outside Study Area	Soil VOC Inhalation	x	x	x	4.3E-09	4.3E-04
5			Eroded Dust Inhalation	x	x		2.4E-09	9.2E-05
6			Bulldozer Dust Inhalation		x		8.0E-07	7.4E-01
7			Excav. Soil VOC Inhalation		x		5.0E-08	4.8E-03
8	Offsite Office Worker	Outside Study Area	Soil VOC Inhalation	x	x	x	2.2E-10	1.1E-05
9			Eroded Dust Inhalation	x	x		1.2E-10	2.3E-06
10			Bulldozed Dust Inhalation		x		3.4E-08	3.2E-02
11			Excav. Soil VOC Inhalation		x		1.6E-09	7.4E-04
12	Onsite Office Worker	East Station Property	Soil VOC Inhalation			x	9.6E-10	4.6E-05
13			Bulldozed Dust Inhalation		x		4.9E-07	4.5E-01
14		NPS Property	Vehicular Dust Inhalation	x	x	x	2.8E-07	5.1E-03
15		East Station Property	Excav. Soil VOC Inhalation		x		2.3E-08	1.1E-03
16			Soil VOC Inhal. via Cracks			x	2.8E-10	1.4E-05
17	Onsite Resident	East Station Property	Soil VOC Inhalation			x	8.7E-09	8.6E-04
18			Soil VOC Inhal. via Cracks			x	2.5E-09	2.6E-04
29			Surface Soil Ingestion			x	9.0E-05	9.7E-01
31			Surface Soil Dermal			x	2.4E-04	4.6E-01
19	Utility Maint. Worker	Study Area	Subsurface Soil VOC Inhal.	x	x	x	5.5E-05	3.9E+00
20			Subsurface Soil Ingestion	x	x	x	2.8E-06	4.5E-03
21			Subsurface Soil Dermal	x	x	x	1.2E-05	6.4E-03
22	Juvenile Recreation	NPS Property	Soil VOC Inhalation			x	1.8E-08	2.2E-03
30			Surface Soil Ingestion			x	3.2E-05	2.2E-01
32			Surface Soil Dermal			x	3.0E-04	3.5E-01
23	Construction Worker	East Station Property	Soil VOC Inhalation		x		1.1E-10	1.5E-04
24			Eroded Dust Inhalation		x		1.4E-10	8.2E-05
25*			Bulldozed Dust Inhalation		x		3.7E-05	3.5E+01
26			Excav. Soil VOC Inhalation		x		2.5E-09	3.5E-03
27			Soil Ingestion		x		4.5E-07	3.8E-02
28			Soil Dermal		x		1.9E-06	2.7E-02

Shaded areas indicate an exceedance of acceptable risk levels:
Hazard Index >1.0 Cancer > 1.0E-06

*Scenario 25 only applies to the bulldozer operator

Table 2-2: Risk to Human Health from Exposure to Subsurface Soils (Hydro Terra, 2002)

Scenario	Exposed Population	Carcinogenic Risk	Non-Carcinogenic Risk
Inhalation of soil gas	Utility workers	1.14×10^{-5}	8.34×10^{-1}
	Landscape worker	2.84×10^{-6}	2.01×10^{-1}
Ingestion of soil	Utility workers	3.54×10^{-7}	3.76×10^{-3}
	Landscape workers	1.77×10^{-7}	1.88×10^{-3}
Dermal contact	Utility workers	1.11×10^{-6}	2.67×10^{-3}
	Landscape workers	5.57×10^{-7}	1.33×10^{-3}

Table 2-3: Chemicals of Potential Concern for Ecological Risk Assessment (Hydro Terra, March 1999)

	Soils		Site Water		Anacostia R.	
Chemical	Surface	0 – 2 Ft.	Runoff	Ground	Water	Sediments
Metals						
Silver		X				
Aluminum	X	X	X		X	
Arsenic		X				X
Cadmium	X	X		X		X
Chromium	X	X		X		X
Copper	X	X				X
Iron	X	X	X		X	
Mercury	X	X	X			X
Manganese	X	X				
Nickel	X	X				X
Lead	X	X	X	X	X	X
Antimony		X				
Selenium		X				
Thallium		X				
Vanadium	X	X				
Zinc	X	X				X
Other Inorganic Chemicals						
Cyanides (complex)		X				
Semi-Volatile Organic Compounds						
Polynuclear aromatic Hydrocarbons	X	X				X
di (ethylhexyl) phthalate						X
Dibenzofuran						X
Volatile Organic Compounds						
Benzene		X				
Ethylbenzene		X				
Xylenes		X				

3 Description and Evaluation of Alternatives

3.1 Description of Alternatives

This section provides a summary of the media-specific alternatives evaluated in the WG FS for the entire East Station Site, and different alternatives that NPS is evaluating in this document, for consideration on the NPS property. Each medium (surface soil, subsurface soil, groundwater, DNAPL, and sediment) is considered separately.

The main difference from the retained alternatives evaluated in the WG FS consists in the additional alternative for subsurface soil: target area excavation of shallow soils (to 3 feet) and disposal off-site. It is discussed further in Sections 3.1.2.4 and 3.2.3.

All remedial alternatives considered by WG and the NPS for the NPS property located at the Washington Gas East Site are described below.

3.1.1 Surface Soil

The following remedies were retained and evaluated for surface soil at the NPS Site:

- No action, as a basis for comparison to the other alternatives;
- Soil removal and disposal off-site; and
- Phytoremediation

3.1.1.1 No Action

No action is defined as the absence of active steps to remedy the affected media, in this case, surface soil. No action is used as a baseline for evaluating the potential impact of undertaking any remedial actions.

Additional information pertaining to the no action alternative for surface soil can be found in the WG FS (Hydro Terra, March 1999).

3.1.1.2 Soil Removal and Disposal Off-Site

WG considered removal and replacement of surface soil for the NPS Site because it lies within the 100-year flood plain and regulations (40 CFR, Part 6, Appendix A) do not allow filling within a floodplain that reduces its capacity to carry floodwaters. Removal and replacement was the only option considered by NPS also, because no option to treat in place was considered a proven technology.

To prevent exposure to contaminants in surface soils the remedial alternative at the NPS property would therefore involve the removal of one foot of surface soil and replacement with six inches of clean fill, and six inches of topsoil over the 3.2 acres of the NPS site not covered by trees. This process satisfies the requirement to maintain the current surface land elevation. The soil removed will be disposed of offsite and the new topsoil fill will be vegetated to ensure the integrity of the clean soil cover.

The cost of this alternative is projected to be $777,000. It has been calculated to reflect the part attributable to the NPS property, in the cost initially presented by WG for the entire East Station site (for the alternative called "vegetative soil cover and/or buildings and paved areas" in the WG FS). It is presented in detail in Appendix A.

Additional information pertaining to the removal and disposal offsite alternative for surface soil can be found in the WG FS (Hydro Terra, March 1999).

The NPS suggests that the above alternative be implemented concurrently with future site plans to construct a hiking/biking path parallel with the river. Along the projected location of the path, the soil should be excavated to 18 inches below ground surface and the fill should consist of 18 inches of crushed stone on a properly prepared sub-base, 10 feet wide, for a distance of approximately 900 feet opposite the WG site. Installing the bike path concurrently with the soils remedial alternative will result in significant cost saving since the cost estimate to implement the remedial alternative is expected to remain nearly unchanged as a result of installing the bike path. In addition, intrusive activities to install the bike path at the site will be eliminated.

3.1.1.3 Phytoremediation

Phytoremediation is the planting of vegetation that would take up contaminants and remove them from the soil, followed by harvesting of the vegetation, and eventual off-site disposal of the plant waste. Plants may provide a useful, natural mechanism for stabilizing and reducing concentrations of contaminants in the soil.

Additional information pertaining to the phytoremediation alternative for surface soil can be found in the WG FS (Hydro Terra, March 1999). Because of its uncertain effectiveness, phytoremediation was only considered as a possible adjunct to other forms of remediation.

3.1.2 Subsurface Soil

The following remedies were retained and evaluated by WG for subsurface soil at the site:

- No action,
- Institutional controls,
- Target area excavation (of all contaminated soils, with removal and disposal off-site); and
- Phytoremediation.

The following remedy was added by NPS for subsurface soil at the site and will be further evaluated in subsequent sections:

- Target area excavation of shallow soils (with removal and disposal off-site).

3.1.2.1 No Action

No action is defined as the absence of active steps to remedy the affected media, in this case, subsurface soil. No action is used as a baseline for evaluating the potential impact from not undertaking any remedial actions.

Additional information pertaining to the no action alternative for subsurface soil can be found in the WG FS (Hydro Terra, March 1999).

3.1.2.2 Institutional Controls

Institutional controls involve action aimed at limiting and controlling exposure to chemicals contained in the onsite subsurface soil. Deed restrictions would incorporate special provisions into the property deed that would restrict certain excavation and construction activities in impacted areas. Institutional controls also involve health and safety awareness requiring personal protective equipment and educational programs to reduce potential hazards by limiting site worker and public exposure to the subsurface soil. Subsurface soil brought to the surface during excavation will have to be handled and managed in accordance with appropriate regulations.

Additional information pertaining to the institutional controls alternative for subsurface soil can be found in the WG FS (Hydro Terra, March 1999).

3.1.2.3 Target Area Excavation

Target area excavation involves the removal of fill soil in areas known to or suspected to contain significant DNAPL, and disposal off-site. The target soil is material that has been found to contain DNAPL above the residual concentration. WG considered three areas that would be excavated to depths up to 23 feet under this scenario; the estimated volume of soil to be removed is 64,000 cubic yards.

Additional information pertaining to the target excavation alternative for subsurface soil can be found in the WG FS (Hydro Terra, March 1999).

3.1.2.4 Target Area Excavation of Shallow Soils

The NPS considered this alternative for its site, given the potential for coal tar contamination that may be exposed when the surface soil layer is removed. However, the alternative considered is different from the target area excavation alternative evaluated in the WG FS and described in the previous Section, in the depth of subsurface soil removal. WG proposed target area excavation to depths of up to 23 feet in several areas, resulting in excavation of a very large soil volume (64,000 cu yds), and very high costs. NPS is proposing target area excavation limited to approximately 3 feet below ground surface.

The NPS proposes that during the removal of the 1-foot surface layer of soil on site, the underlying soil will be observed for signs of coal tar. If subsurface soils are clearly contaminated with coal tar or petroleum liquids, then selective removal will be performed. Contaminated soils will be excavated to a depth of six inches below the frost line (approximately 3 feet below ground surface) or to the water table if the water table is encountered first. Contamination with coal tar will be determined visually and by odor, but removal of the "hot spot" must be confirmed by sampling, unless the fill three feet of soil have been removed (or the water table has been reached). These soils will be disposed of off-site and replaced with clean fill.

This alternative for subsurface soils is further evaluated in Section 3.2.

3.1.2.5 Phytoremediation

Phytoremediation as a remedial alternative for subsurface soil is virtually identical to that described previously for surface soil in Section 3.1.1.3. The main distinction is that remediation effectiveness at depth is a function of the depth of the root zone and this is specific to the type of vegetation utilized and the depth to the permanent water table at the location of planting.

Additional information pertaining to the phytoremediation alternative for subsurface soil can be found in the WG FS (Hydro Terra, March 1999).

3.1.3 Groundwater

The following remedies were retained and evaluated for groundwater at the site:

- No action;
- Monitored natural attenuation;
- Pump and treat;
- Biosparging; and

- Phytoremediation.

3.1.3.1 No Action

The no action alternative for groundwater would involve terminating the present pump-and-treat system, with the exception of continued DNAPL recovery directly from wells.

Additional information pertaining to the no action alternative for groundwater can be found in the WG FS (Hydro Terra, March 1999).

3.1.3.2 Monitored Natural Attenuation

Natural attenuation would result from the combination of several subsurface contaminant attenuation mechanisms that are classified as either destructive or non-destructive. Destructive processes include biodegradation, abiotic oxidation, and hydrolysis. Non-destructive attenuation mechanisms include sorption, dilution caused by dispersion and infiltration, and volatilization. Under favorable circumstances, one or more of these processes can result in substantial reduction of particular contaminants.

Additional information pertaining to the monitored natural attenuation alternative for groundwater can be found in the WG FS (Hydro Terra, March 1999).

3.1.3.3 Pump and Treat

Pumping and treating of groundwater has historically been used for purposes of containment of contaminated groundwater. At the East Station site, this concept has been used for containment of groundwater in both the fill and the sand and gravel aquifer beneath the silt layer. Pump and treat has been in use since 1976 at the site, reducing the overall load of contaminants discharging to the Anacostia River. The intent is to ensure that no contaminated groundwater escapes from the site.

Additional information pertaining to the pump and treat alternative for groundwater can be found in the WG FS (Hydro Terra, March 1999).

3.1.3.4 Biosparging

Biosparging was considered by WG as a form of in-situ groundwater treatment to improve groundwater quality in the fill and sand and gravel units at the site. Such a system would serve to enhance natural attenuation by increasing the oxidative and biodegradation processes. A typical system would consist of a biosparging trench installed to the base of the fill to pump air or oxygen into the groundwater.

Additional information pertaining to the biosparging alternative for groundwater at the site can be found in the WG FS (Hydro Terra, March 1999).

3.1.3.5 Phytoremediation

Phytoremediation has the potential to remove or reduce chemicals in shallow groundwater found in the fill unit at the site. Phytoremediation would not have any effect on the groundwater in the sand and gravel aquifer beneath the silt layer because of its significant depth. The mechanism of particular interest is the ability of trees to directly uptake groundwater and the chemicals in that water and accumulate or transform them into non-toxic forms in the plant tissue.

Additional information pertaining to the phytoremediation alternative for groundwater can be found in the WG FS (Hydro Terra, March 1999).

3.1.4 Coal Tar (DNAPL)

The following remedies were retained and evaluated for DNAPL at the site:

- No action; and
- Recovery from wells.

3.1.4.1 No Action

No action is defined as the absence of active steps to remedy the affected media, in this case, DNAPL. No action is used as a baseline for evaluating the potential impact from not undertaking any remedial actions.

Additional information pertaining to the no action alternative for DNAPL can be found in the WG FS (Hydro Terra, March 1999).

3.1.4.2 Recovery From Wells

Removal of DNAPL from wells involves the continuation of current interim measures to pump DNAPL from nine wells using either fixed or portable pumps especially designed for DNAPL pumping. The optimum rate for removal of DNAPL would be determined for each well in order to maintain a reasonably efficient and effective extraction of DNAPL.

Additional information pertaining to the removal from wells alternative for DNAPL can be found in the WG FS (Hydro Terra, March 1999).

3.1.5 River Sediment

The following remedies were retained and evaluated for sediment at the site:

- No action; and
- Participation in a river-wide study of the Anacostia River Watershed (the Anacostia River Initiative).

3.1.5.1 No Action

No action is defined as the absence of active steps to remedy the affected media, in this case, sediment. No action is used as a baseline for evaluating the potential impact from not undertaking any remedial actions.

3.1.4.2 Participation in River-Wide Study

Contaminated sediments in the Anacostia River are a watershed-wide issue. WG proposed to join a river-wide study of sediment quality involving a number a private and public parties, such as the USEPA-led Anacostia River Initiative, as appropriate. This may identify mitigating measures and eventually recommend remedies.

3.2 Detailed Evaluation of Subsurface Soil Alternative

The remedial alternatives described in the previous section for the site soils, groundwater and DNAPL that were deposited on WG property, or spread under the adjoining Water Street and NPS site, were evaluated in detail in the WG FS, except for the Alternative described in section 3.1.2.4 (target area excavation of shallow soils).

Table 3-1 summarizes the evaluation of the remedial alternatives considered by WG, including costs. The detailed evaluation of the alternatives can be found in the WG FS (Hydro Terra, March 1999).

The following discussion presents an evaluation of the additional remedial alternative proposed by NPS for subsurface soil: Target area excavation of shallow soils and disposal off site.

3.2.1 Criteria for Evaluating Alternatives

CERCLA requires that the NPS, as the lead agency evaluate and compare the remedial cleanup alternative based on the nine criteria listed below. The first two, protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs), are threshold criteria and must be met unless ARAR waivers are granted. The preferred remedy should provide the best balance of tradeoffs with respect to the other criteria.

The nine criteria are:

1. Overall protection of human health and the environment. Addresses whether or not a remedy provides adequate protection and describes how potential risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.

2. Compliance with ARARs. Addresses whether or not a remedy will comply with identified federal and state environmental laws and regulations.

3. Long-term effectiveness and permanence. Refers to the ability of an alternative to maintain reliable protection of human health and the environment over time once the remediation goals have been met.

4. Reduction of toxicity, mobility, and volume through treatment. Refers to the degree to which the remedy reduces toxicity, mobility, and the volume of the contaminated media or wastes.

5. Short-term effectiveness. Addresses the period of time needed to complete the remedy and any adverse impact on human health and the environment that may be posed during the construction and implementation period.

6. Implementability. Refers to the technical and administrative feasibility of a remedy, including the availability of materials and services needed to carry out a particular option.

7. Cost. Evaluates the estimated capital costs and operation and maintenance (O&M) costs of each alternative for 30 years.

8. State agency acceptance. Indicates whether the State, or in this instance the District of Colombia, concurs with, opposes, or has no comment on the preferred alternative.

9. Community acceptance. Based on whether community concerns are addressed by the preferred remedy and whether or not the community has a preference for a remedy.

3.2.2 Detailed Evaluation Against Criteria

This section presents the detailed evaluation of the alternative of selective excavation and removal of subsurface soil retained by NPS for their site (target area excavation of shallow soils). This alternative differs from the WG proposal of target area excavation of all contaminated soils in that it restricts removal to approximately three feet below ground surface. It does not require removal of all coal tar contaminated soil, but only that which is shallow enough to expose utility or landscape workers to hazardous substances. Excavated soil will be replaced with clean fill.

This alternative would have similar advantages and disadvantages to the alternative of target area excavation evaluated in the WG FS (Alternative 3 in Table 3-1 under the heading Subsurface Soil), and applicable portions of the WG FS discussions are reproduced and expanded here.

Refer to the WG FS for additional information pertaining to other remedial alternatives for subsurface soil.

1. Overall Protection of Human Health and the Environment:

Selective excavation and removal of subsurface soil would remove a significant amount of the most contaminated material from the site. Such selective removal will eliminate some of the sources and potential for migration of contaminates in the shallow subsurface towards the river and could potentially improve groundwater quality. The selective excavation and removal of contaminated soil would reduce the risk associated with exposure of utility and landscape workers, as well as soil organisms and wildlife, to the subsurface soil. However, contaminants would remain in soil at greater depths.

2. Compliance with ARARs:
Removal of soil and replacement with clean fill will not raise the surface or obstruct floodwaters, as required by 40 CFR, Part 6, Appendix A.

The selective excavation and removal of contaminants will reduce contaminant transport from infiltration and may lower concentrations of contaminants of concern in shallow groundwater and improve surface water quality. However, this assumption is qualitative and speculative in nature.

The removal of the 'hot spots' in the subsurface would significantly reduce the risks to utility and landscape workers. This would comply with the location-specific ARARs and TBCs calling for full and free use of the area as a park, including allowing limited disturbances of subsurface soil to install water, electricity or gas lines or other utilities to serve its park land, to construct pathways or buildings, or to maintain or restore the seawall without requiring engineering controls, personal protection or special disposal requirements.

If, during the course of excavation activities, undisturbed natural soil is encountered, a Phase I Archaeological Identification Study should be conducted, or the natural soil left undisturbed, to conform to the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation.

3. Long-Term Effectiveness
The potential for the selective excavation and removal of contaminants to improve ground water and surface water quality would be a long-term benefit. The degree to which water quality will be improved is uncertain due to the fact that contaminants will remain at greater depths elsewhere on the site.

The selective excavation and removal of contaminated soil would permanently reduce the risk associated with exposure of utility and landscape workers to the subsurface soil.

4. Reduction of Toxicity, Mobility, and Volume:
The soil excavation and removal will not result in reduction of volume or toxicity of the wastes, and the soil excavated will have to be properly disposed of to a permitted facility.

However; selective excavation and removal of contaminants from the subsurface will reduce the total mass of contaminants at the site as well as mobility. The toxicity, mobility, and volume of contaminants elsewhere in the fill and deeper sand and gravel would not be reduced since this material would remain in the subsurface.

5. Short-Term Effectiveness:
There would be short-term effectiveness pertaining to the reduction of risks due to exposure of utility and landscape workers to shallow subsurface soil.

The short-term effectiveness and benefit of this removal action for groundwater would be limited because if would probably take years before any improvements in groundwater quality would be noticeable.

During the implementation of the remedial action, exposure to contaminated soil and potential dust generation could impact construction workers or surrounding community and environment. Implementing proper monitoring, construction procedures, and controls during construction activities can greatly reduce these risks.

6. Implementability:
This alternative is fully implementable.

7. Cost:
Actual costs incurred during the implementation of this alternative for subsurface soil would be proportionate to the soil volume removed, and to the amount of soil considered to be hazardous, if any. The exact cost can be calculated only after the extent of removal required has been determined. Based in part on the WG cost analyses performed during the FS, assuming that approximately 30% of the soil in the 1- to 3-foot interval will require excavation, and assuming that approximately 50% of the total amount of soil excavated will be hazardous, the cost for this alternative has been estimated as $983,000. This number is illustrative, and may change upon recalculation based on actual extent of removal required. The cost estimate and assumptions are presented more in detail in Appendix A.

7. State Agency Acceptance
NPS will seek concurrence from the District of Columbia.

8. Community Acceptance
Community acceptance of this alternative will be evaluated after the public comment period ends and will be described in the Record of Decision (ROD) for the site.

3.3 Justification for Selection of the Preferred Alternative

The NPS has a mission to preserve and protect resources unimpaired for the enjoyment of future generations. As the lead agency, the NPS has the

responsibility to ensure that the preferred alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the other criteria. The NPS expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA §121(b):

- Be protective of human health and the environment;
- Comply with ARARs (or justify a waiver);
- Be cost-effective;
- Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and
- Satisfy the preference for treatment as a principal element (or justify not meeting the preference).

The NPS also reasonably expects to be able to modify and use the land without excessive restrictions in fulfilling its mission.

The NPS believes that the WG preferred remedies for surface soil, groundwater, DNAPL, and sediments, as described in the WG FS, adequately meets the RAOs for the NPS site. Accordingly, they are not independently evaluated here.

The preferred remedies for groundwater, DNAPL, and sediments are part of the already proposed and approved plan for the WG site, and have been subject to public review and comment. They have an effect on the NPS site only insofar as they require access, and because the installation of wells, utilities and piping will affect NPS land. They will affect the implementation of the remedial action for soils to some extent because any existing fixtures or structures on the property will have to be protected during remediation of the soils.

In order to select the preferred remedy for subsurface soils on the NPS property, the following section presents a comparison of the alternatives evaluated for subsurface soil, and more specifically compares the alternative presented by WG FS as the preferred alternative for subsurface soils site-wide (institutional controls), and the alternative presented by NPS and further evaluated in Section 3.2.3 (Target Area Excavation of Shallow Soils and Disposal Off-Site).

3.3.1 Comparative Analysis of Alternatives for Subsurface Soil

Table 3-1 lists the proposed WG remedial alternatives for subsurface soil as: 1) No Action, 2) Institutional Controls, 3) Target Area Excavation, and 4) Phytoremediation. The Target Area Excavation of Shallow Soils and Disposal Off-Site further evaluated by NPS for their site alone will be called Alternative 5 for the purposes of the comparative analysis.

The intent of the comparative analysis is to assess the relative performance of Alternative 5, evaluated by NPS in this document.

The comparative analysis takes into consideration the evaluation criteria of overall protection of human health and the environment, compliance with ARARs, long-term effectiveness, reduction of volume toxicity, and mobility, short-term effectiveness, implementability, cost, agency acceptance and community acceptance.

1. Overall Protection of Human Health and the Environment

Alternative 1 (No Action) would not reduce risks to human health and the environment since the potential contaminants would be left in place without isolation measures to prevent potential exposure to subsurface soil and potential migration to surface water and groundwater. Alternative 4 (Phytoremediation) offers uncertain, and thus unacceptable, protection of human health and the environment.

The NPS believes that Alternative 2 (Institutional Controls) is not satisfactorily protective of human health. The characteristics of this site exhibit small pockets of contamination or areas of 'hot spots' throughout the subsurface that are irregularly distributed throughout the fill material. Failure to remove the shallow contaminated subsurface soil would result in unacceptable risk for utility and landscape workers.

Both alternatives 3 (Target Area Excavation) and 5 (Target Area Excavation of Shallow Soils) meet the RAOs regarding risks to human health and the environment, but the latter will have its effectiveness limited to the top 3 feet of soil. This is however the limit to which exposure is expected.

Compared to Alternative 3, Alternative 5 would present a greatly reduced impact on human health and the environment during remedial action.

2. Compliance with ARARs

Neither alternatives 1, 2 or 4 would allow unrestricted use of the site as a Park since potential contact with contaminated materials would remain. Under Alternative 2 exposure to unacceptable levels of contamination would be eliminated provided landscape and utility workers use protective equipment, which is not acceptable for unrestricted use of the property as a Park.

Alternatives 3 and 5 would comply with ARARs and TBCs. Under alternatives 3 and 5, it is likely that there will also be some degree of surface runoff and ground water quality improvement.

3. Long-Term Effectiveness and Permanence

Alternative 1 would not provide any long-term improvement for the protection of human health and the environment since there would be no actions implemented to improve the condition of the site. Impacted materials would remain onsite and potential migration of contaminants would not be reduced. It is unknown whether

or not Alternative 4 would be effective in providing some degree of long-term protection to human health and the environment.

Under Alternative 2, direct contact with contaminated materials and therefore exposure to contaminated materials would be eliminated, however, it would include limitations associated with institutional controls such as the use of protective equipment for landscape and utility workers and would therefore restrict the installation of buildings and utilities and impact any work required to maintain the seawall, which is critical to the integrity of the entire site.

Alternative 3 would provide long-term effectiveness of the improvements to potential exposure or migration in the fill. Alternative 5 will provide similar reduced human health and ecological exposure, which would be maintained as long as deeper intrusive activities are limited at the site.

In all cases evaluated except Alternative 3 some sources would remain on site and therefore potential exposure or contaminant migration would not be completely eliminated. However, long-term monitoring would ensure that there is no concern of contaminant migration to points of exposure.

4. Reduction in Toxicity, Mobility, or Volume

Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of potential contamination. Alternative 4 would provide for some reduction of toxicity, mobility, and volume but can only be assessed qualitatively. The improvements provided by alternatives 3 and 5, would reduce the toxicity, mobility, and volume of contaminants in the fill materials only. Overall reduction of toxicity, mobility, and volume of contaminants will depend on off-site treatment.

5. Short-Term Effectiveness

Alternative 1 provides no overall short-term protection. Alternative 2 would reduce the direct contact exposure potential to workers and the community and therefore provide for short-term effectiveness. Alternative 4 would likely not be very effective in the short term due to the time required for vegetation to become established.

Alternatives 3 and 5 would provide similar levels of short-term effectiveness. Although impacts associated with future intrusive and construction activities would be greatly reduced, it would probably take years before any ground water or surface water quality improvements would occur, if any. During the implementation of the remedial action, exposure to contaminated soil and potential dust generation could impact construction workers or surrounding community and environment. Implementing proper monitoring, construction procedures, and controls during construction activities can reduce these risks. The great depth of excavation postulated under Alternative 3 (23 feet in some places) implies great difficulty for controlling water entering the excavation. Large

volumes of water would have to be captured and treated to implement this alternative.

6. Implementability
None of the alternatives are expected to encounter any technical difficulties in implementation. However Alternative 3, as proposed by WG may be impracticable due to the depth of excavation required, to below the water table.

There are no administrative requirements for Alternative 1. Alternatives 2 through 5 require proper record keeping, evaluation of the O&M data and reports to regulatory agencies.

7. Cost
The estimated costs for alternatives 1 through 4 vary from $0 (Alternative 1) to $31,000,000 (Alternative 3), as summarized in Table 3-1. These costs are for implementation across the entire East Station site; they are presented in detail in the WG Decision Document (Hydro Terra, September 1999).

It is not clear how much of the contaminated fill to be excavated in Alternative 3 would come from under the NPS site. The total volume of contaminated fill assumed for Alternative 3 is 64,000 cubic yards at an average cost for remediation of approximately $485 per cubic yard. For purposes of comparison, if a similar calculation is made for the NPS site, assuming that one third, or approximately 16,000 cubic yards of the approximately 50,000 cubic yards of fill under the site has to be remediated, then the pro-rated cost for the NPS portion of the site would be approximately $7,750,000. The control of water entering the site would be difficult and might raise the cost. In addition there is potential for damage to the seawall during remediation.

The cost for Alternative 5 is $983,000, as detailed in Appendix A; it is for implementation on NPS property only. Because of the shallow depth of excavation, and deliberate avoidance of excavation below the water table, no additional costs for dewatering are anticipated.

8. State Agency Acceptance
NPS will seek concurrence from the District of Columbia for its preferred alternative.

9. Community acceptance
Community acceptance of the preferred alternative will be evaluated after the public comment period ends and will be described in the Record of Decision (ROD) for the site.

3.3.2 Proposed Remedy

The five components of the preferred alternative will reduce the risk to human health and the environment because the media impacted by the WG site will be

removed from the site or will be capped with clean fill. No more contaminants will be permitted to migrate off-site into the Anacostia River until it has been determined that the residual impacts are acceptable.
Since no in-situ method for remediating the contaminated soils will provide short or long-term relief with a reasonable degree of certainty, NPS proposes removal as the only acceptable option.

Removal of surface and subsurface soil to the proposed depths and their replacement with clean fill and six inches of topsoil meet most of the criteria for the selection of preferred remedies:

- It will meet the overall goals for protecting human health and the environment;
- It will comply with ARARs;
- It will be effective in the long term;
- It will *not* reduce the toxicity, mobility and volume of the wastes except for those wastes treated offsite (if any);
- It can be completed in a comparatively short time, and the adverse impacts on human health or the environment during remediation can be mitigated by engineering controls and personal protection equipment;
- It is readily implemented;
- Approximate costs for the surface and subsurface soil remedy is estimated at $1,760,000, including O&M costs. Note: the costs of the ongoing groundwater and DNAPL capture and treatment system is not included, only the surface and subsurface soil removal and replacement as a one-time operation; and
- DC and the community will comment on its acceptability during the public comment period.

A common element in all the preferred alternatives is retention of land ownership by the United States government and administration by the NPS. Because the proposed alternatives will not remove all contaminants from the site or render them harmless, some type of institutional control such as a property description with specific limitations on use will need to be developed for this NPS property. The institutional controls provide restrictions in the deed for the property that prohibit certain actions or changes to property use or to the property itself.

3.3.2.1 Surface Soil

To prevent exposure to contaminants in surface soils, the surface soil will be removed down to a depth of 1 foot, replaced with six-inches of clean fill, and capped with six-inches of topsoil.

This action is in compliance with ARARs and protective of human health and the environment. It is a permanent remedy, and can be readily implemented. The remedy will not result in a reduction in volume toxicity or mobility of the wastes left on site in the subsurface soil, and the contaminated soil excavated will have to

be disposed of off site at a permitted facility in accordance with applicable federal and state regulatory requirements.

Along the route of the planned hiking/biking path parallel with the river, the soil will be removed to a depth of 18 inches and the fill will consist of 18 inches of crushed stone on a properly prepared sub-base, 10 feet wide, for a distance of approximately 900 feet, opposite the WG site.

It is recommended that a vegetated soil cover be installed following soil removal. It is assumed that soil removal and vegetated soil cover installation will occur over 80 percent of the NPS property (approximately 3.2 acres) because the remaining 20 percent is currently forested. A vegetated soil cover would contain the surface soil onsite.

3.3.2.2 Subsurface Soil

During the removal of the 1-foot surface layer of soil on site, selective excavation of contaminated soil will occur. The underlying soil will be observed for signs of coal tar. If subsurface soils show visible and olfactory indications of contamination with coal tar or petroleum liquids, then selective removal will be performed. Typically such soils will be excavated to the water table or to a depth six inches below the frost line. For cost purposes the frost line was estimated to be 2 feet below the original surface, and total depth of excavation of contaminated soils will be to three feet below surface or to the water table if this is encountered first. Removal of the "hot spot" must be confirmed by sampling, unless the fill three feet of soil have been removed (or the water table has been reached).

All remedial work will be carried out to ensure compliance with ARARs. If, during the course of excavation activities, undisturbed natural soil is encountered, then a qualified professional will be hired to conduct a Phase I Archaeological Identification Study, or the natural soil will be left undisturbed. The study will conform to the Secretary of the Interior's Standards and Guidelines for Archaeology and Historic Preservation.

In accordance with the preferred remedy for surface soil, the fill used to replace contaminated subsoil will include, in part, the sub-base for the hiking/biking trail to be installed parallel to the river in accordance with the NPS Resource Management Plan.

Consistent with implementation of the remedy, the NPS will continue to provide a right-of-way to the USACE to access their property at all times.

NPS may wish to preserve the former WG pump house for future use. The structure effectively caps any subsoil beneath it, and excavation and replacement of any contaminated soil around it removes any future exposure for utility workers, NPS personnel and the public.

The proposed remedy will be protective of human health and the environment. It will comply with all ARARs and will be effective in the short- and the long-term. It is fully implementable and will allow the NPS to continue with its mission for the foreseeable future. However, the subsurface soil remedy can be implemented only in conjunction with the remedy for surface soil.

3.3.2.3 Groundwater

NPS believes that the WG Proposed Alternative for groundwater adequately meets the RAOs, subject to review every five years, and will continue to monitor its implementation. The following text in italics is taken directly from the WG Decision Document, which can be found in the Administrative Record.

Ongoing pumping and treatment of groundwater will continue. WG will continue to monitor water quality in wells near the Anacostia River on a quarterly basis up to the time of the required effectiveness evaluation; after that time, monitoring will have to continue but probably on a more limited basis. Within the same timeframe, WG will also annually sample river sediment near the site. Concurrent with the groundwater and sediment sampling, WG will assess the existence of natural attenuation processes and their effectiveness in preventing contaminant from entering the river. The applicability of phytoremediation in conjunction with pump and treat or natural attenuation will also be evaluated, and, if found to be effective, it will be integrated, to the extent feasible into the future uses of the properties on the site (See section 2.10.3, Washington Gas Proposed Plan, 1999).

The selected groundwater remedy for the East Station site includes the 2002 changes to the pump and treat system that result in capture of all the shallow ground water formerly flowing to the Anacostia River from under the NPS property, with the installation of a trench drain extending northeast of the trench well, and modifications to a well located at the northeast corner of the DC DPW building (converting it into a groundwater recovery well).

This remedy will result in control by a hydraulic barrier of pumping wells, and will continue to operate into the foreseeable future or until the NPS/USEPA accepts that the impacts of the groundwater on the river are acceptable. The NPS remedy will incorporate a special use permit with access provisions for Washington Gas to operate, maintain, repair, replace and monitor those wells located on NPS property. Similar access or right-of-way will be provided for DNAPL collection wells as needed.

The phytoremediation and natural attenuation alternatives that WG is considering for groundwater are still unproven technologies for this site. Extensive studies of their effectiveness would have to be performed before they could be implemented as an alternative to pump and treat. NPS wants to highlight the importance at this point of maintaining a reverse gradient by pumping, to prevent contaminated groundwater from reaching the Anacostia River.

3.3.2.4 DNAPL

NPS believes that the WG Proposed Alternative for DNAPL adequately meets the RAOs, and the following italicized text is taken directly from the WG Decision Document, which can be found in the Administrative Record.

Recovery of DNAPL directly from wells in which it naturally accumulates until no longer practicable will continue; as will recovery through the ongoing treatment of groundwater pumped from areas of known or suspected DNAPL accumulation. A study will be performed to determine if DNAPL is moving towards the river near the 12th Street Sewer outfall and between the Trench Well and the river. If DNAPL is found to collect in the exploration wells, direct extraction of the DNAPL from the wells will be undertaken river (sic). Additionally, "sentinel wells" in both the fill and sand/gravel units will be monitored monthly for the presence of DNAPL until the time of the five-year effectiveness review, longer of necessary. If DNAPL is detected in one of these wells, direct extraction of the DNAPL at the well head will begin. Collected DNAPL will be disposed of in accordance with RCRA requirements (See section 2.10.4, Washington Gas Proposed Plan, 1999).

3.3.2.5 River Sediment

The NPS understands that WG is participating in watershed studies of sediment quality, in conjunction with other parties involved in the restoration of the Anacostia River watershed.

The NPS is working with the USEPA Region 3 and other interested parties on the Anacostia River Initiative, to determine what watershed-wide programs will reduce contamination to the river. Based upon these efforts, the NPS will evaluate actions to reduce any sediment contamination resulting from migration of waste or waste components through the NPS site into the river. This may lead to recommendations for a remedial action to mitigate contamination in river sediments.

Table 3-1: Detailed Evaluation of Remedial Alternatives (Washington Gas, September 1999 - This Table was prepared for the East Station site* as part of the Washington Gas Feasibility Study; the NPS does not necessarily concur with the determinations contained herein for their property- see the added Notes in italic)

Alternative	Provides overall protection of human health and environment		Complies with ARARs	Provides long-term effectiveness and permanence	Reduces volume, toxicity, and mobility	Provides short-term effectiveness	Implementability	Cost
Surface Soil								
1. No Action	Human health: Environment:	No Yes	Yes for current use	Not effective for Future use	No	Effective for current use of the properties	Yes	None
Note: The "No Action" Alternative would not provide overall protection of human health and the environment, would not comply with ARARs and would not provide short term effectiveness on the NPS property.								
2. Containment (Vegetated Cover)	Human health: Environment:	No Yes	Yes	Effective for present and future, but will require maintenance	Reduce mobility of soil particles and prevents direct contact	Yes	Yes	$1,189,000
Note: This Alternative is NPS Preferred Alternative. It includes soil removal and replacement on the NPS property. An estimate of the cost attributable to the remedial action on NPS property is $777,000								
3. Phytoremediation	Human health: Environment:	Limited Limited	Maybe	May be effective	Some reduction in toxicity and mobility of chemicals	Probably not very effective in the short-term[1]	Maybe	$561,000[2]
*Note: An estimate of the cost attributable to the remedial action on NPS property is $112,200***								
Subsurface Soil								
1. No Action	Human health: Environment:	No No risks	No	Not effective	No	No	Yes	None
2. Institutional Controls	Human health: Environment:	Yes No risks	Yes	Effective for present and future	No	Yes	Yes	$225,000
*Note: NPS believes that this Alternative is not satisfactorily protective of human health and would not allow unrestricted use of the site as a park. An estimate of the cost attributable to the remedial action on NPS property is $45,000***								
3. Target-Area Excavation (Fill Unit)	Human health: Environment:	Yes No risks	Yes	Effective for fill unit and limited effectiveness for ground water	Effective in the Fill unit only	Presents risks to workers and nearby residents during excavation	Implementable, but may be impracticable [3,4]	$31,000,000[4]
Note: An estimate of the cost attributable to the remedial action on NPS property is $7,750,000								
4. Phytoremediation	Human health: Environment:	Uncertain No risks	Maybe	May be effective	Some reduction in toxicity and mobility of chemicals	Probably not very effective in the short-term[1]	Maybe	$561,000[2]
*Note: An estimate of the cost attributable to the remedial action on NPS property is $112,200***								
5. Target-Area Excavation of Shallow Soil on NPS Property	Human health: Environment:	Yes Yes	Yes	Effective for shallow fill	Effective for shallow fill	Yes - needs implementation of proper procedures and controls during construction	Yes	$983,000
Note: This Alternative is NPS Preferred Alternative. It was not considered in the Washington Gas Feasibility Study								

Table 3-1: Detailed Evaluation of Remedial Alternatives (Washington Gas, September 1999)

Alternative	Provides overall protection of human health and environment		Complies with ARARs	Provides long-term effectiveness and permanence	Reduces volume, toxicity, and mobility	Provides short-term effectiveness	Implementability	Cost
Ground Water								
1. No Action	Human health: Environment:	No risks Maybe	Likely	May be effective	Uncertain	Uncertain	Yes	None
2. Monitored Natural Attenuation	Human health: Environment:	No risks Maybe	Likely	May be effective	Uncertain	Uncertain	Yes	$100,000[5]
3. Pump and Treat	Human health: Environment:	No risks Yes	Yes	Effective only as long as it is operating	Effective to an extent[6]	Yes	Yes	$760,000[7]
4. Biosparging	Human health: Environment:	No risks Yes	Likely	Effective	Results in reduction in toxicity and volume of chemicals	Yes	Implementable but difficult[8]	$1,720,000
5. Phytoremediation	Human health: Environment:	No risks Limited	Limited	Limited effectiveness	Some reduction in toxicity and mobility of chemicals	Probably not very effective in the short-term[1]	Maybe	$126,000[2]
DNAPL								
1. No Action	Human health: Environment:	Likely Likely	Maybe	Not effective	No	No	Yes	None
2. Recovery from Well	Human health: Environment:	Likely Likely	Yes	Effective[9]	Yes	Moderately effective	Yes	$300,000

* *The East Station (ES) site (18.8 ac.) includes property owned by Washington Gas, as well as properties owned by NPS (3.9 ac.), DC, and the USACE.*

** *These costs were not independently calculated; they were estimated as a percentage (20%) of the cost estimated by WG to apply phytoremediation or institutional controls to the entire ES site. The NPS site closely approximates 20% of the area of the total 18.8-acre ES site and the costs should be approximately proportional.*

1 Phytoromediation may not be very effective in the short-term due to the time required for plant growth.

2 It is not possible to fully assess the cost for phytoremediation prior to site-specific studies and design at the site. This cost would be in addition to the cost of constructing a vegetative cover over much of the site.

3 Target-Area Excavation would be impracticable due to environmental concerns caused the handling of a large volume of material containing a relatively high concentration of tar.

4 Assumes removal of approximately 64,000 cubic yards of soil, all of which is a hazardous material; offsite disposal of the soil; re-routing of a high pressure gas line and a power line twice; removal and replacement of existing buildings on the NPS property; shoring a portion of the seawall; control and additional treatment of groundwater pumped from excavations; removal and replacement of a portion of Water Street; removal and replacement of existing monitoring wells; back-filling excavations with clean soil, and miscellaneous engineering, environmental, monitoring, safety control, and site restoration costs.

5 Cost to conduct additional sampling and natural-attenuation study.

6 Some quantity of contaminants will remain within the soil so that some dissolved contamination will always exist.

7 Costs for three years of operation. Subsequent costs will need to be estimated after this period.

8 The installation of biosparging trenches would be difficult because of the current infrastructure along the river. Buildings and other structures would most likely have to be displaced and large quantities of impacted soil would require disposal.

9 Product recovery is only effective as long as the product in the soil will flow into the recovery wells. When the residual saturation point is reached, product will not longer flow into the wells, but will stay absorbed in the soil.

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Cost Estimate Calculations

Preliminary Cost Estimate
Alternative: Surface Soil - Soil Replacement and Vegetated Cover
Washington Gas Site - NPS Property Only

Construction Cost Item	Unit Cost		Unit	Quantity	Cost	Cost Rounded to $100
Contractor Mobilization/Demobilization	$20,000	[1]	Lump Sum	1	$20,000	$20,000
Field Control	$5,000	[1]	Lump Sum	1	$5,000	$5,000
Erosion and Sediment Control	$24,300	[2]	Lump Sum	1	$24,300	$24,300
Strip Existing Vegetation	$585	[1]	acre	3.2	$1,872	$1,900
Strip Soil (1 foot) and Loading	$3.25	[1]	cy	5160	$16,770	$16,800
Transportation and Disposal of Non Hazardous Soil	$50	[1]	ton	6192	$309,600	$309,600
6" Clean Fill	$10	[1]	cy	2580	$25,800	$25,800
6" Topsoil	$15	[1]	cy	2580	$38,700	$38,700
Seeding	$1,300	[1]	acre	3.2	$4,160	$4,200
Subtotal Construction						$446,300
Engineering and Admnistration (10%)[4]						$44,630
Construction Management (12%)[4]						$53,556
Contingency (15%)[4]						$66,945
Total Construction Cost (rounded to $100)						**$611,400**

Operation and Maintenance Cost					Annual Cost	
Inspection	$85	[1]	hour	14 [3]	$1,190	$1,200
Analytical and Repair	$2,350	[2]	Lump sum	1	$6,600	$6,600
Subtotal O & M						$7,800
Administration (12%)[4]						$792
Contingency (15%)[4]						$990
Total Annual O & M Cost						$9,600
Total 30 Yrs O & M Present Worth (Using 4% Discount Rate)						**$166,000**
Total Present Worth Cost for NPS Surface Alternative (Rounded to $1,000)						**$777,000**

Assumptions:
Assume NPS area to have soil removed and replaced is approx 80% of site = 3.2 acres
1 cy soil = 1.2 tons

Notes:
(1) Unit costs obtained from WG FS for consistency in comparison
(2) Cost derived from WG FS proportionnally to acreage
(3) Quantity derived from WG FS proportionnally to acreage
(4) Percentage obtained from WG FS for consistency in comparison

Preliminary Cost Estimate
Alternative: Subsurface Soil - Selective Excavation and Removal of Contaminated Soil
Washington Gas Site - NPS Property Only

Construction Cost Item	Unit Cost		Unit	Quantity	Cost	Cost Rounded to $100
Field Control	$5,000	[1]	Lump Sum	1	$5,000	$5,000
Excavation of Contaminated Soil and Loading	$10	[1]	cy	3100	$31,000	$31,000
Transportation and Disposal of Non Hazardous Soil	$50	[1]	ton	1860	$93,000	$93,000
Disposal of Hazardous Soil by Incineration	$300	[1]	cy	1550	$465,000	$465,000
Transportation of Hazardous Soil	$630.00	[1]	load	133	$83,790	$83,800
Clean Fill	$12	[1]	cy	3100	$37,200	$37,200
Analytical Testing	$2,800	[2]	Lump Sum	1	$2,800	$2,800
Subtotal Construction						$717,800
Engineering and Admnistration (10%)[3]						$71,780
Construction Management (12%)[3]						$86,136
Contingency (15%)[3]						$107,670
Total Construction Cost (rounded to $1000)						**$983,000**

Assumptions:
Assume subsurface alternative initiated concurrently with surface alternative ie no mobilization costs, etc.
Assume 30 percent of soil in the 1 to 3 foot depth interval requires excavation (3100 cy).
Assume 50 percent of excavated material to be hazardous.
1 cy soil = 1.2 tons
Assume 14 tons per truck loading.

Notes:
(1) Unit costs obtained from WG FS for consistency in comparison
(2) Cost derived from WG FS proportionnally to acreage
(3) Percentage obtained from WG FS for consistency in comparison