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NSWC WHITE OAK
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Record of Decision

Former Naval Surface Warfare Center – White Oak
Site 49

Naval Facilities Engineering Command
Washington

United States Environmental Protection Agency
Region III

Maryland Department of the Environment

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RECORD OF DECISION

SITE NAME AND LOCATION

Former Naval Surface Warfare Center – White Oak
Site 49
Silver Spring, Maryland
EPA RCRA ID No. MD0170023444.

1. DECLARATION

1.1 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD) presents the determination that *in-situ* chemical oxidation with pneumatic fracturing along with institutional controls and long-term monitoring to address groundwater contamination is necessary to protect human health and the environment at Navy Installation Restoration Site 49, "Trichloroethene (TCE) Groundwater Plume in the 400 Area," at the former Naval Surface Warfare Center - White Oak (NSWC White Oak) ("the Site") in Silver Spring, Maryland. This determination has been made in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In 1997, ownership of the property occupied by Site 49 was transferred from the Department of the Navy (Navy) to the General Services Administration (GSA).

This decision is based on information contained in the Administrative Record file for the Site. The Maryland Department of the Environment (MDE) concurs with the selected remedy. A letter from MDE indicating concurrence is provided as Appendix A.

The United States Environmental Protection Agency (EPA) and the Navy recognize that publication and successful implementation of this ROD shall constitute fulfillment of requirements related to groundwater and soil at Navy Installation Restoration Site 49 as required by the RCRA Section 7003 Administrative Order for the Site (First Amended Administrative Order to the Department of the Navy, the Former Naval Surface Warfare Center - White Oak, June 2, 1998).

1.2 DESCRIPTION OF THE SELECTED REMEDY

The selected remedy for groundwater contamination with TCE at Site 49 is *in-situ* chemical oxidation with pneumatic fracturing along with institutional controls and monitoring.

Site 49 is defined as a five-acre area of groundwater contamination with TCE and its breakdown products that originates in the vicinity of Building 427 at the eastern end of the 400 area of the former NSWC White Oak. The contaminated groundwater is present primarily in a fractured rock aquifer. The specific source of the TCE has not been identified but it is considered to be due to past activities at Building 427. Building 427 is a former nine-story hydrostatic testing facility that was built in the mid 1960s and operated by the Navy up until the mid 1990s. A 2002 site inspection of the interior of the abandoned building found 2 empty five gallon cans labeled "solvent dry-cleaning type" in a storage room.

A leaching well was present on the exterior of the west side of the building and was reported to be connected to sinks within the building. The leaching well was excavated in 2002 as part of the Site 49 remedial investigation. It was also noted that a small area northeast of Building 427 along Perimeter Road was used for debris disposal and may conceivably have been used for the dumping of wastes.

While Building 427 is not in operation, the land and many of the buildings surrounding Building 427 are currently leased from GSA by the Air Force and are operated as the Arnold Engineering Development Center (AEDC).

Site 49 groundwater data collected as part of the remedial investigation indicates that TCE would present risks to future construction workers and hypothetical future on-site residents. These results support the need for groundwater remediation. The selected remedy of in-situ chemical oxidation will involve drilling up to approximately 25 open-cased borings ranging in depth from 80 to 120 feet deep, and pressure-injecting a chemical oxidant such as potassium permanganate to destroy the TCE and its breakdown products. At some locations it may be advantageous and feasible to first enlarge the rock fractures by the process of pneumatic fracturing using pressurized nitrogen gas. The selected remedy will also involve monitoring the groundwater and placing institutional controls on its use.

1.3 STATUTORY DETERMINATIONS

The selection of *in-situ* chemical oxidation with institutional controls and long-term monitoring for groundwater is based upon the results of groundwater sampling and analysis and of the risk assessment performed as part of the remedial investigation at Site 49. These results indicate that groundwater use, at least initially, must be restricted for protection of human health and the environment. It is assumed that a 5-year review would not be required because the remedy will be successful at reaching PRGs in less time. The closeout report would evaluate the protectiveness and effectiveness of the remedy. If PRGs are not met within five years, 5-year reviews would take place until groundwater PRGs are attained.

1.4 ROD CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for the Site.

- Chemicals of concern (COCs) and their respective concentrations (page 14).
- Baseline risk presented by the COCs (page 11 for groundwater and page 13 for surface water).
- Current and reasonably anticipated future land use assumptions (page 8).
- Potential land use that will be available at the site because of the selected remedy (page 22).
- Key factor(s) that led to selection of the remedy (i.e., how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (page 24).

Christopher J. Mossey, CAPT, CEC, USN
Commanding Officer
NAVFAC Washington

11/9/04
Date

Abraham Ferdas, Director
Hazardous Site Cleanup Division
U.S. EPA - Region III

11/16/04
Date

2. DECISION SUMMARY

2.1 SITE NAME, LOCATION, AND DESCRIPTION

The former NSWC-White Oak was originally established in 1946 as the Naval Ordnance Laboratory, with a mission to carry out research on military mines and explosives. The former facility is located in Prince George's and Montgomery Counties, approximately 5 miles north of Washington, D.C., off New Hampshire Avenue in Silver Spring, Maryland (see Figure 2-1). Through the years, the mission was expanded to include research involving torpedoes and projectiles. In September 1974, the facility combined with the Naval Weapons Laboratory, Dahlgren, Virginia, to become the Naval Surface Weapons Center, which was renamed the Naval Surface Warfare Center, Dahlgren Division, in 1988. After that time, the facility functioned as the principal Navy research, development, test, and evaluation center for surface warfare weapon systems, ordnance technology, strategic systems, and underwater weapons systems.

In response to the Base Realignment and Closure (BRAC) Act, NSWC-White Oak was closed in 1997. Approximately 662 acres of the approximately 712-acre property were subsequently transferred to the GSA in the Fall of 1997, and the remaining area in the southeastern portion of the facility was transferred to the U.S. Army in February 1998. The GSA has plans to reuse and develop the subject property; one of the major tenants will be the U.S. Food and Drug Administration (FDA). The property transferred to the U.S. Army will be used in conjunction with ongoing activities at the adjacent Adelphi Research Laboratory.

The EPA RCRA identification number for the former NSWC-White Oak is MD0170023444.

For purposes of CERCLA and the NCP, the Navy is the lead agency for the facility, pursuant to Executive Order 12580 and a Memorandum of Understanding signed by the Navy and the GSA in July 1997; MDE is the support agency. Additionally, EPA is exercising its authorities under Section 7003 of RCRA under which it issued an administrative order to the Navy. In accordance with these authorities, the Navy and EPA are jointly selecting the response actions at the former NSWC-White Oak facility.

2.2 SITE HISTORY, ENFORCEMENT ACTIVITIES, AND INVESTIGATIONS

2.2.1 Site History

Site 49 is located at the eastern edge of the 400 Area of the former NSWC White Oak in the north-central portion of the former navy facility (Figure 2-2). The topography in this portion of the former navy property contains considerable relief. The western portion of Site 49, including Building 427, is relatively flat. The central and eastern portions of Site 49 include a steep-sided ravine formed by Paint Branch. The total elevation drop from west to east across Site 49 is approximately 100 feet.

Contamination at Site 49 initially was identified during the Washington Suburban Sanitation Commission (WSSC) and White Oak sanitary sewer lines investigation (CH2M HILL, January 2004). Trichloroethene (TCE) was detected in groundwater samples collected using direct-push technology on two occasions from one location (near WSSC Manhole 32142) along the bedding of WSSC sewer that runs along Paint Branch hydraulically downgradient of the Building 427 area (Figure 2-3). Groundwater samples collected from sewer bedding up- and further down-pipe of Building 427 did not contain TCE. A subsequent screening investigation indicated that TCE was present in groundwater near Building 427 at concentrations as great as approximately 4,000 micrograms per liter (µg/L). Following a review of the screening investigation, this area was designated Site IR 49.

Building 427 is a nine-story hydrostatic testing facility that includes a 35-ft by 100-ft by 75-ft-deep interior water tank. This tank was fed by the exterior aboveground storage tank located immediately southeast of Building 427. Much of Building 427 (3 floors) is below ground. Building 427 was built in the mid 1960's and used by the Navy up until the mid 1990's. It has since been abandoned and is slated for demolition within the next few years. The Navy used the tank and building for hydrostatic testing of underwater weapons. Discussions with personnel who worked in, or had knowledge of the activities that took place in, Building 427 indicated that there was no known use of TCE in the building. A 2002 site inspection of the interior of the abandoned

Building 427 found two empty five-gallon cans labeled "solvent, dry-cleaning type" in a storage room on the 100 level.

A "limestone pit" or leaching well was present on the west side of the building and, according to construction drawings, was to be used for disposing of acidic waste water from the water treatment system used to pre-treat water before filling the testing tank. Former building personnel stated that the leaching well was never used for its designed purpose and that the wastewater lines leading to the leaching well were reportedly connected to sinks in rooms that were initially designed to be laboratories but were in actuality used as offices. The leaching well was excavated in 2002 as part of the Site 49 remedial investigation. Design drawings of the building and leaching well and pictures and details of the removal are provided in the RI report (CH2M HILL, 2003).

It was noted by former building personnel that inert torpedoes used for testing in the tank were sometimes cleaned on the loading dock area on the north side of Building 427. It was also noted that a small area outside the back (east) gate along Perimeter Road was used for debris disposal and may conceivably been used for unauthorized dumping of wastes because it is relatively remote and hidden from view. Construction drawings also indicate that a subsurface foundation drain runs along the perimeter of the building about 17 to 27 feet below grade. The drain consists of 6-inch perforated clay pipe draining to two manholes, one at the northwest corner of the building and one near the southeast corner of the building. The northwest manhole is a sump that collects and pumps water to the southeast manhole. The southeast manhole also receives water from two interior basement sumps. Water was discharged from the southeast manhole to Paint Branch by a pipe and open channel.

While Building 427 is not in operation, the land and many of the buildings surrounding Building 427 are currently leased from GSA by the Air Force and are operated as the AEDC. Access to the area leased by AEDC, which includes the land immediately surrounding and to the west of Building 427, is restricted.

2.2.2 Enforcement Activities

On June 2, 1998, EPA issued an Administrative Order to the Navy, pursuant to Section 7003 of RCRA, 42 U.S.C.§ 6973, that required the Navy to

(1) undertake "'Interim Measures' at the facility to prevent or mitigate threats to human health and/or the environment;

(2) perform a RCRA Facility Investigation (RFI) or Remedial Investigation (RI) to determine fully the nature and any release of hazardous wastes, solid wastes and/or hazardous constituents at and/or from the Facility; and

(3) perform a RCRA Corrective Measures Study (CMS) or Feasibility Study (FS) to identify and evaluate alternatives for corrective action necessary to prevent or mitigate migration or releases of hazardous wastes, solid wastes and/or hazardous constituents at and/or from the Facility.

EPA's RCRA 7003 Order provides the framework for completing the investigation and remediation of the former NSWC-White Oak facility under RCRA. The Order also recognizes that "EPA and the Navy intend to integrate the Navy's CERCLA response obligations and RCRA corrective action obligations" at the facility.

This ROD addresses groundwater at Site 49.

2.2.3 Site Investigations

Site 49 was initially identified during an unrelated investigation that the Navy conducted in 1999 through 2002 at the request of the WSSC to identify potential impacts from the former NSWC White Oak property to the WSSC sanitary sewer line that traverses the property through the Paint Branch valley (CH2M HILL, January 2004). TCE was detected in groundwater samples collected along the bedding of the WSSC sewer that runs along Paint Branch at a point adjacent to the Building 427 (Site 49). Follow-up sampling identified that the TCE was originating on the former Navy property in the area of Building 427. The area was designated as Site 49 and the origin of the TCE and the nature and extent of the contamination in groundwater, surface water and

soil was then fully characterized in the Site 49 RI (CH2M HILL May 2004), (see Figure 2-3). The removal of the leaching well and a visual inspection of Building 427 was conducted as part of the RI. In addition, the Building 427 perimeter drain and basement sumps were sampled for VOCs. Soil, surface water and groundwater grab samples were collected and twelve permanent monitoring wells were installed and sampled.

An FS was subsequently performed to identify and evaluate remedial alternatives (CH2M HILL, June 2004).

The former leaching well mentioned above, also referred to on architectural drawings as a limestone pit, was excavated on June 17, 2002 by Shaw E&I, Inc. (Shaw) as a housekeeping measure and a presumptive remedy. Two soil samples were collected for laboratory analyses during excavation. The first sample was collected from the bottom of the excavation and analyzed for VOCs.

Following removal of the leaching well, the excavation was backfilled and the area was seeded and covered with hay. The leaching well, which appeared to be constructed with an up-ended concrete sewer pipe with a diameter of 4 feet and a height of 5 feet, was disposed of as construction debris.

2.3 COMMUNITY PARTICIPATION

In accordance with Sections 113 and 117 of CERCLA, 42 U.S.C. Sections 9613 and 9617, the Navy, in conjunction with EPA, issued a Proposed Plan on July 01, 2004 that presented the preferred remedy for Site 49 groundwater. The Proposed Plan for Site 49, and the RI and FS for Site 49, became available for review by the public at that time and are among the documents that comprise the Administrative Record file for NSWC-White Oak, which is maintained at Naval Facilities Engineering Command (NAVFAC), Washington at the Washington Navy Yard, Washington D.C. Other documents relevant to the remedy selection for Site 49 groundwater were made available to the public in July 2004 in an information repository for NSWC-White Oak that is maintained at the Montgomery County Public Library, White Oak Branch in Silver Spring, Maryland. The notice of the availability of these documents, the public comment period, and a public meeting was published in the *Washington Post* on June 24, 2004, and in the *Silver Spring Gazette*, *College Park Gazette,* and *Burtonsville Gazette* on June 30, 2004. The public comment period was held from July 01, 2004 to July 30, 2004, and a public meeting was held on July 13, 2004. Additional community involvement is detailed in Section 3.0.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

Although the NSWC-White Oak facility is not on CERCLA's National Priorities List (NPL), in its response actions at the Site, the Navy has been guided by the NCP provisions pertaining to remedial actions. Section 300.430(a) (1)(ii)(A) of the NCP, 40 C.F.R. Section 300.340(a)(1)(ii)(A) provides that CERCLA NPL sites "should generally be remediated in operable units when early actions are necessary or appropriate to achieve significant risk reduction quickly, when phase analysis or response is necessary or appropriate given the size or complexity of the site, or to expedite the completion of the total cleanup." This ROD for Site 49 groundwater is the twelfth ROD prepared for sites at NSWC-White Oak.

This ROD sets forth why *in-situ* chemical oxidation with institutional controls and monitoring for groundwater is necessary to protect human health and the environment at Site 49. The soil at Site 49 was investigated to determine if a remaining source of contamination existed; no source was found. Surface water was also investigated, and the RI concluded that there are no adverse impacts to surface water.

2.5 SITE CHARACTERISTICS

2.5.1 Physical Setting

The former NSWC White Oak is located approximately five miles northeast of Washington D.C., near the boundary between the Piedmont and the Coastal Plain physiographic provinces. The facility lies in gently rolling terrain. The topographic expression of the area is typical of a deeply incised, dendritic stream channel pattern. Paint Branch and its tributaries dominate local drainage patterns.

The highest elevation of NSWC-White Oak is approximately 398 feet above mean sea level (msl). The lowest elevation is roughly 145 feet above msl. The terrain of the western portion of the facility slopes generally eastward toward Paint Branch with about 3.5 percent grade. Similar grades are encountered in the eastern portion of the facility, but slopes are more generally southward or are locally influenced by proximity to Paint Branch and its tributaries. Near stream channels, the ground slopes increase to as much as 65 percent.

The terrain in the vicinity of Site 49 consists of locally steep hills, particularly in areas dissected by stream channels. The drainage pattern at Site 49 is dominated by Paint Branch. Land cover varies between woodland, grassland, paved areas and buildings. Elevations at Site 49 range from approximately 275 feet above msl around Building 427 to approximately 180 feet above msl, at Paint Branch (Figure 2-4).

The subsurface geology of Site 49 is illustrated in Figure 2-5. Site 49 is primarily underlain by Piedmont bedrock and derived saprolite. Potomac group deposits and recent sediments are not present at Site 49. The saprolite is composed of the same materials as the underlying schist bedrock. The saprolite is strongly foliated, preserving the structures of the parent schist. Its thickness ranges from about 5 feet in the north and west to about 25 feet in the south and east. Underlying the saprolite is Precambrian to Cambrian, metasedimentary crystalline bedrock of the Wissahickon Formation.

2.5.2 Conceptual Site Model

Figures 2-6 provides a conceptual site exposure model (CSM) for human receptors to site media. The only media for which a complete exposure pathway exists is groundwater. No COPCs were identified in soil, therefore potential risks associated with soil were not quantified. No COPCs were retained for Paint Branch surface water, therefore no unacceptable risks are associated with this medium.

The CSM illustrates contaminant sources, release mechanisms, exposure pathways, migration routes, and potential receptors and provides a basis for the risk assessments summarized later in this ROD and, as a result, the basis for necessary response actions.

Human receptors evaluated for exposure to groundwater include: present and/or future adult, child and life-time resident, as well as adult construction worker. Although residential use is not reasonably anticipated, future residential use was still evaluated to determine whether unacceptable risks would exist. Current and potential future land and resource uses are discussed further in Section 2.6. Potential risks to human health are identified in Section 2.7.1, however, it is anticipated that the property will be nonresidential in the future.

Risks to ecological receptors have not been quantified as part of this study. The media affected at Site 49 is groundwater, the pathway for contaminant migration was most likely directly to the subsurface through a leaching well and would therefore not involve impacts to surface soil, where risks to ecological receptors would be an issue. Ecological risks from the surface water and sediment in this section of Paint Branch have been evaluated in a separate Basewide Ecological Risk Assessment (BERA) and have been found to be acceptable. Surface water data collected during the Site 49 RI are consistent with the findings of the BERA.

2.5.3 Nature and Extent of Contamination

The nature and extent of groundwater contamination at Site 49 can be summarized as follows:

- TCE and its breakdown products *cis*-1,2-dichloroethene (cis-DCE) and vinyl chloride were detected throughout the groundwater in fractured rock at Site 49.
- Contamination is present over a 5-acre area extending from Building 427 in the west to Paint Branch in the east.

The nature and extent of contamination in soil, surface water and groundwater is discussed in more detail below.

2.5.3.1 Soil

Soil was investigated in order to determine if a source of the TCE in groundwater could be identified, and not because of a known release to the soil. Investigation of soil conditions and potential source areas found no continuing sources for the TCE remaining in soil. Analytical data for the Site 49 soil samples is presented in the Site 49 RI (CH2M HILL, May 2004).

However, tetrachloroethene (PCE) was detected at very low concentrations in seven samples from three boring locations (maximum concentration 3.0 µg/kg). Chloromethane (maximum concentration 2.7 µg/kg), bromomethane (maximum concentration 1.4 µg/kg) and carbon disulfide (maximum concentration 1.7 µg/kg) were also detected in one area of the site at very low concentrations.

Semivolatile organic compounds (SVOCs) were detected in one area at low concentrations. Only one SVOC, benzo(a)pyrene, was detected in a subsurface soil sample at a concentration exceeding the EPA Region III RBC for residential soil. The maximum concentration of benzo(a)pyrene was 590 µg/kg.

Maximum detections of arsenic, iron and manganese at 2.7 mg/kg, 37,400 mg/kg and 2,090 mg/kg, respectively, exceeded EPA Region III RBCs for residential soil. However, the maximum detected concentration of arsenic was below the 95% UCLs for background at White Oak. Although the maximum detected concentration of iron and manganese exceeded the calculated 95% UCLs for background, it is unlikely that the results indicate anthropogenic soil contamination. Rather, the variability in concentrations detected in Site 49 samples appears to be consistent with variability expected in natural soils, based on the background data set and regional-scale reference data sets.

2.5.3.2 Groundwater

The nature and extent of groundwater contamination for Site 49 is based on the discussions and the analytical data for groundwater presented in the Site 49 RI report (CH2M HILL, May 2004). Figure 2-4 presents a site plan showing the boundary of Site 49, also presented are the existing and temporary monitoring well locations and conceptual isoconcentration contours of TCE in shallow groundwater. Figure 2-5 shows a cross-section of Site 49 and presents conceptual isoconcentration contours of TCE with depth.

The primary contaminants detected in groundwater are TCE and its breakdown products cis-DCE and VC. The maximum concentration of these contaminants is listed below.

- TCE – 4,400 µg/L
- cis-DCE – 1,100 µg/L
- VC – 5.7 µg/L

The contaminant plume extends 450 feet from the area of Building 427 on the west and is bounded by Paint Branch on the east. The northern side of the TCE plume extends 100 to 200 feet onto property owned by the Maryland National Capital Park and Planning Commission and remains undefined due to lack of offsite access rights.

The vertical delineation program, summarized on Figure 2-5, indicates that TCE concentrations increase with depth near the source area and decrease with depth away from the source. It is postulated that this may be due to the complex vertical gradients and groundwater flow patterns near Paint Branch.

Five metals were detected in the groundwater at concentrations above applicable screening levels. The metals and their maximum concentrations in filtered groundwater are: aluminum (6,800 µg/L.), chromium (75.5 µg/L) iron (14,100 µg/L), manganese (2,290 µg/L) and nickel (81 µg/L).

2.5.3.3 Surface Water

Surface water samples were collected along Paint Branch. Results indicate that surface water quality from Paint Branch, adjacent to Site 49, is consistent with background data and shows no anthropogenic influences

from Site 49. The absence of detectable concentrations of VOCs indicates that any groundwater discharged to Paint Branch from Site 49 has no adverse affect on surface water quality.

2.6 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

Site 49 is located at the eastern edge of the AEDC. The topography in this portion of the former NWSC-White Oak contains considerable relief. The western portions of Site 49, associated with AEDC, including Building 427, are relatively flat. The central and eastern portions of Site 49 include a steep-sided ravine formed by Paint Branch. The total elevation drop from west to east across Site 49 is approximately 100 feet.

Groundwater at Site 49 and throughout the former NSWC White Oak is not used as a potable water source at this time and is unlikely to be used for such purposes in the future. Water for occupants of the former NSWC-White Oak and the surrounding properties is (and is expected to continue to be) supplied by a local municipal water authority. Local ordinances prevent the installation of new private potable supply wells without a permit. Additionally, the rock aquifer matrix within the site is incapable of providing a supply in excess of 1 gpm. Nonetheless, for the purposes of the site risk assessment, the groundwater was evaluated as a potential residential drinking water source.

2.7 SUMMARY OF SITE RISKS

The baseline risk assessment estimates the risks the site would pose if no action were taken. It can provide the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by a remedial action. It can also be used to support the determination that no additional remedial action is necessary to protect human health and the environment. A baseline human health risk assessment was conducted for surface water in Paint Branch and groundwater as part of the Site 49 RI.

Soil was not evaluated in the risk assessment because Site 49 was originally identified as a groundwater contaminant site and during subsequent sampling, none of the chemicals found in the groundwater could be found in soil. Concentrations of compounds found in soil were compared to background soil levels and risk-based guidance criteria and, with one exception, were all found to be below either background levels or levels considered acceptable for soil in a residential setting. Benzo(a)pyrene, a semi-volatile organic compound typically associated with the by-products of burning organic material, was detected above these levels in one of the seven samples. For these reasons, and with the concurrence of the BRAC Cleanup Team (BCT) for NSWC White Oak, potential risks associated with soil were not quantified

Sediment in Paint Branch was not sampled in the RI or evaluated in the risk assessment for Site 49 because a separate RFI and HHRA was already conducted specifically on Paint Branch (TTNUS October 2000). The 2000 RFI did not detect any VOCs (the Site 49-related contaminants) in the sediment or surface water at, or immediately downgradient of, Site 49, and the accompanying HHRA indicated no unacceptable risks from exposure to Paint Branch sediment from any chemicals.

This section of the ROD summarizes the results of these baseline risk assessments. The human health risk assessments contain evaluations of all chemicals of potential concern (COPCs) [also referred to as potential chemicals of concern (PCOCs) in some site reports] and exposure pathways, including those that do not pose unacceptable risks to human health. COPCs are those chemicals that are identified as a potential threat to human health after an initial screening and are evaluated further in the baseline risk assessment. Chemicals of concern (COCs) are a subset of the COPCs that are identified as needing to be addressed by a response action because they exceed risk-based remediation goals or drinking water standards [i.e.: maximum contaminant levels (MCLs)].

Surface water data collected from Paint Branch as part of the Site 49 RI were screened against human health screening criteria, however no COPCs were identified, and therefore no unacceptable risks are associated with surface water.

Several COPCs were identified for Site 49 groundwater and the related risks were found to be unacceptable; therefore, action is warranted for the groundwater to protect human health. The following subsections summarize the various aspects of the risk assessment conducted for groundwater.

2.7.1 Baseline Human Health Risk Assessment Process

2.7.1.1 COPCs

The selection of COPCs is a qualitative screening process that identifies those site-related chemicals that may add to overall potential risks and which therefore should be considered in the risk assessment. The COPC selection process was conservative to ensure selection of the constituents comprising the great majority of the potential risk associated with the site. The maximum detected concentration of each constituent in each medium was compared to a screening value (typically a risk-based concentration determined by EPA Region III) to select the COPCs for the media. USEPA Region III RBCs (USEPA, April 2004) based on non-carcinogenic effects were divided by ten to account for exposure to multiple constituents. RBCs based on carcinogenic effects were used as presented in the RBC Table (USEPA, April 2004). If the maximum concentration of a constituent exceeded the screening value, the constituent was selected as a COPC and retained for the risk evaluation. Chemicals eliminated from further evaluation at this point are assumed to present minimal risks to potential human receptors.

2.7.1.2 Exposure Assessment

The exposure assessment defines and evaluates the type and magnitude of human exposure to the chemicals present at or migrating from a site. The exposure assessment is designed to depict the physical setting of the site, identify potentially exposed populations, and estimate chemical intakes under the identified exposure scenarios. Actual or potential exposures are based on the most likely pathways of contaminant release and transport, as well as human activity patterns. A complete exposure pathway has three components: a source of chemicals that can be released into the environment, a route of contaminant transport through an environmental medium, and an exposure or contact point for a human receptor.

A human health exposure assessment defines and evaluates, quantitatively or qualitatively, the type or magnitude of human exposure to COPCs identified in environmental media at a site under investigation. The potential human receptors evaluated for exposure to groundwater at Site 49 are identified in Section 2.5.2. Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) risk were evaluated for each receptor. The RME scenario represents the highest level of human exposure that could reasonably be expected to occur, and the CTE scenario portrays the average human exposure.

Pathway-specific information for these receptors, such as the values of exposure parameters used to quantify exposure, are presented in the Site 49 RI.

The exposure point concentration (EPC), which is calculated for COPCs only, is a reasonable maximum estimate of the chemical concentration that is likely to be contacted over time and is used to calculate estimated exposure intakes. The 95 percent upper confidence limit (UCL), which is based on the distribution of a data set, is considered to be the best estimate of the exposure concentration for data sets with 10 or more samples. The methodology for calculating the 95 percent UCLs is presented in the Site 49 RI. The 95 percent UCL is used as the EPC for groundwater.

2.7.1.3 Toxicity Assessment

This section provides the methodologies for the characterization of the potential human health risks associated with the potential exposure to media at Site 49. The toxicity assessment identifies the potential adverse health effects in exposed populations. Toxicity values approved by EPA are used to characterize the potential risk.

The toxicity value used to evaluate carcinogenic effects is the cancer slope factor (CSF). The CSF is an upper-bound estimate of the probability that a person will develop cancer over a lifetime based on a given dose. It is based on dose-response data from human and/or animal studies. At this time, slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route.

The toxicity value used to evaluate noncarcinogenic effects is the reference dose (RfD). The RfD is an estimate of the daily exposure level for the human population that is likely to be without appreciable risk during an established period of time; ranging from several weeks to a lifetime depending on the exposure scenario being evaluated. It is based on a review of available animal and/or human toxicity data, with adjustments for various uncertainties associated with the data. As was the case with the carcinogenic compounds, RfDs are not available for the dermal route of exposure. Dermal RfDs can be extrapolated from the oral reference doses by applying an appropriate adjustment factor. Adjustments are particularly important for chemicals with less than 50 percent absorption via the ingestion route.

2.7.1.4 Risk Characterization

Quantitative estimates of risk are calculated using intake and toxicity values according to risk assessment methods outlined in current EPA guidance (USEPA, December 1989). Incremental lifetime cancer risks (ILCRs) are expressed in the form of dimensionless probabilities, which are derived using published CSFs. Noncarcinogenic risk estimates are presented in the form of hazard quotients (HQs) that are derived using published RfDs.

ILCR estimates are generated for each COPC using estimated exposure intakes and published CSFs, as follows:

$$ILCR = (CDI) / (CSF)$$

where:

ILCR = a unitless probability (e.g. 2.0×10^{-5}) of an individual's developing cancer
CDI = chronic daily intake averaged over 70 years (mg/kg-day)
CSF = cancer slope factor, expressed as $(mg/kg\text{-}day)^{-1}$.

An excess ILCR of 1.0×10^{-6} indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess ILCR" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or overexposure to the sun. The chance of an individual's developing cancer from all other causes has been estimated to be as high as one in three.

In order to interpret the quantitative risks and to aid risk managers in determining the need for remediation at a site, quantitative risk estimates are compared to typical benchmarks. EPA has defined the range 1.0×10^{-6} to 1.0×10^{-4} as the ILCR "target range" for most hazardous waste sites addressed under CERCLA. Cumulative ILCRs greater than 1.0×10^{-4} generally will indicate that some degree of remediation is required, and ILCRs below 1.0×10^{-6} normally will not require in remedial efforts. Whenever ILCRs fall between 1.0×10^{-4} and 1.0×10^{-6}, decisions for remediation will be made on a case-specific basis. Individual chemicals contributing significantly to risks above the target range are considered to be contaminants of concern (COCs).

2.7.1.5 Risk Characterization

Noncarcinogenic risks are assessed using the concept of hazard quotients (HQs) and hazard indices (HIs). The HQ for a COPC is the ratio of the estimated intake to the RfD, as follows:

$$HQ = (\text{Estimated Exposure Intake}) / (RfD)$$

Summing the individual HQs for all the COPCs generates an HI. It should be noted that an HI is not a mathematical prediction of the severity of toxic effects and therefore is not a true "risk"; it is simply a numerical indicator of the possibility of the occurrence of noncarcinogenic (threshold) effects.

An HI exceeding unity (one) indicates that there may be potential noncarcinogenic health risks associated with exposure. If an HI exceeds unity, target organ effects from individual COPCs contributing to the risk are considered. Only those chemicals that affect the same target organ(s) or exhibit similar critical effect(s) will be regarded as truly additive. Thus, COPCs contributing to an HI greater than 1.0 on the basis of a single target organ/effect are considered to be chemicals of COCs.

target organ/effect are considered to be chemicals of COCs.

2.7.1.6 Uncertainty Analysis

The risk measures used in site risk assessments are not fully probabilistic estimates of risk but are conditional estimates given that a set of assumptions about exposure and toxicity are used. Thus it is important to specify fully the assumptions and uncertainties inherent in the risk assessment, to place the risk assessments in proper perspective. This process is referred to as an uncertainty analysis. The uncertainties associated with the risk evaluations for groundwater and surface water are discussed in subsequent sections.

2.7.2 Baseline Human Health Risk Assessment Results - Groundwater

The BHHRA presented in the Site 49 RI report was conducted to evaluate risks from exposure to groundwater at Site 49. The BHHRA generated a list of COPCs and quantified worst-case risks to receptors. The Site 49 FS then proposed preliminary remediation goals (PRGs) for each of the COPCs found in the groundwater. PRGs were then compared to the maximum detected contaminant concentration in order to identify contaminants of concern (COCs). For the purpose of the ROD, site-specific risks have been conservatively estimated for groundwater as discussed below.

2.7.2.1 Risks from Site 49 Groundwater

The list of samples used to calculate risks from groundwater is presented in Table 2-1. A summary of the COPC selection process for groundwater at Site 49 is presented in Tables 2-2 and 2-3. COPCs were defined as those chemicals with maximum concentrations greater than the EPA Region III risk-based concentration for tap water in a residential setting. Constituents with maximum detected concentrations below the RBC were not retained as COPCs. Lead concentrations in groundwater were compared with the Safe Drinking Water Act action level. Comparison with background concentrations (to screen out COPCs) were not undertaken at this point in the risk assessment process.

Thirteen COPCs were identified for the groundwater, consisting of seven VOCs and five inorganics which are as follows:

- 1,2-dibromomethane
- chloroform
- tetrachloroethene (PCE)
- trichloroethene (TCE)
- vinyl chloride
- cis-1,2-dichloroethene (cis-DCE)
- trans-1,2-dichloroethene (trans-1,2-DCE)
- aluminum
- chromium
- iron
- manganese
- nickel

The EPCs for COPCs in Site 49 groundwater under a residential use scenario and the oral/dermal and inhalation RfDs and CSFs for each groundwater COPC are presented in the Site 49 RI.

For the purposes of the risk assessment, it was assumed that groundwater from beneath the site would be used as a future residential potable water supply. Therefore, the future child and adult resident were evaluated for potential exposure to groundwater for potable use. Carcinogenic risks were calculated for a lifetime resident instead of for the individual child and adult resident, as directed by EPA Region III risk assessment guidance. The risk assessment also assumed that a future construction worker could be exposed to groundwater in an open excavation during any construction or excavation activities at the site.

HIs from an assumed exposure to groundwater under the RME and CTE conditions are summarized below. The cumulative HIs (the sum of the HQs for each COPC) for the construction worker or adult resident under

CTE conditions does not exceed the EPA target of unity (one), however the cumulative HIs under RME conditions does exceed unity. The cumulative HIs for a child resident exceeds unity for both RME and CTE conditions.

Hazard Index for Site 49 Groundwater (Cumulative Risk Summary)

	Adult Construction Worker	Adult Resident	Child Resident	Life-Time Resident
Total HI - RME	3.7	34	79	NA
Total HI - CTE	0.11	0.79	2.5	NA

ILCRs from exposure to groundwater under RME and CTE conditions are summarized below. The cumulative ILCRs for the construction worker under CTE and RME conditions are within the EPA acceptable target range of 1.0×10^{-4} to 1.0×10^{-6}. The cumulative ILCRs for the life-time resident under both the RME and CTE conditions are greater than the upper bound of the EPA acceptable target range.

Incremental Lifetime Cancer Risks for Site 49 Groundwater (Cumulative Risk Summary)

	Adult Construction Worker	Adult Resident	Child Resident	Life-Time Resident
Total ILCR - RME	9.7E-05	NA	NA	1.3E-01
Total ILCR - CTE	2.7E-06	NA	NA	1.3E-03

Tables 2-4 through 2-7 summarize the contribution of risks (both carcinogenic and noncarcinogenic) from each COPC under the RME conditions. Tables 2-8 through 2-11 summarize the contribution of risks from each COPC under the CTE conditions.

2.7.2.2 Uncertainty Analysis for Groundwater

The maximum detected site concentrations were compared to the 95 percent upper tolerance limits (UTLs) calculated for the background data. Additionally a population-to-population comparison was conducted (background groundwater concentrations to site groundwater concentrations). For the population-to-population comparison, the student-t-test was used since both the background and the site data fit lognormal distributions. This analysis was supplemented with the non-parametric Mann-Whitney U Test.

None of the organic COPC risk drivers were detected in the background samples, and therefore, a background comparison was not performed for these constituents. Chromium and vanadium were not detected in the background set, and are also therefore assumed to be present in the site groundwater at concentrations above background levels. The maximum detected concentrations of iron and manganese, the other two risk drivers, in the filtered site groundwater samples are all greater than the UTLs for the filtered shallow aquifer background samples. The Student t-test showed that both iron and manganese are present in the site groundwater at concentrations statistically greater than the background groundwater. Based on the Mann-Whitney U test, manganese is present in site filtered groundwater at statistically similar concentrations to filtered shallow background groundwater, however, iron is present at concentrations statistically greater than the background concentrations.

2.7.3 Baseline Human Health Risk Assessment Results – Surface Water

A BHHRA was conducted for surface water in Paint Branch, adjacent to Site 49. The samples used to evaluate risks from surface water are listed in Table 2-1. The maximum chemical concentrations in surface water were compared with ten times the EPA Region III tap water RBCs. Constituents with maximum detected concentrations below the RBC were not retained as COPCs. Lead concentrations in surface water were

compared with the Safe Drinking Water Act action level. No COPCs were identified for surface water, therefore exposure to surface water is not a concern under any land use scenario.

2.7.4 Ecological Risk Assessment

The Navy has completed a three-phase base-wide ecological risk assessment (BERA) for NSWC-White Oak (TTNUS, October 1999, TTNUS, July 2000, TTNUS, March 2001) that included an evaluation of surface water and sediment in Paint Branch, including the area of Paint Branch near Site 49. The BERA concluded that the surface water and sediment in Paint Branch did not pose an unacceptable risk to ecological receptors. The chemical concentrations in the surface water samples that were subsequently collected as part of the Site 49 RI were all less than the screening levels established as part of the BERA process.

Groundwater exposure is not associated with any ecological receptors, therefore no ecological risks are posed by Site 49 groundwater. Soil data collected at Site 49 was limited to subsurface soil because of the anticipated nature of any releases. Similarly, no ecological risks are posed by subsurface soil because there are no exposure routes for ecological receptors.

2.7.5 Conclusions of Risk Assessments

Noncarcinogenic and carcinogenic risks for exposure to groundwater under RME conditions exceed EPA target levels under a hypothetical future residential scenario (adult and child) and a future construction worker scenario. Noncarcinogenic risks and carcinogenic risks under CTE conditions also exceed EPA target levels for a hypothetical future residential scenario.

The presence of noncarcinogenic and carcinogenic risks warrants that an evaluation of remedial alternatives be conducted to determine what remedial action or institutional controls are needed to reduce groundwater contaminant concentrations or mitigate exposure.

The baseline human health risk assessment determined that surface water adjacent to Site 49 does not present an unacceptable risk to human health. The ecological risk assessment determined that surface water and sediment adjacent to Site 49 did not pose unacceptable risks to ecological receptors.

2.8 REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) identify receptors, pathways, and action levels. The following RAOs were developed for groundwater at Site 49:

- To prevent unacceptable risks to human receptors from exposure to contaminants in the groundwater.
- Where practicable, to restore contaminated groundwater to a quality amenable to beneficial use (i.e., meet the PRGs identified).
- Prevent further migration of contaminants.

2.8.1 Applicable or Relevant and Appropriate Requirements

Applicable or relevant and appropriate requirements (ARARs) and other to-be-considered (TBC) criteria were identified that pertain to the chemicals, actions, and location at Site 49. These ARARs and TBCs are listed and evaluated for applicability in Tables B-1 through B-3, in Appendix B.

2.8.2 Groundwater COCs and PRGs

Based on the baseline human health risk assessment conducted as part of the RI, twelve COPCs were identified in the Site 49 groundwater. Risk-based preliminary remediation goals (PRGs) were developed for each of those COPCs. These PRGs are applicable for constituents with concentrations contributing appreciably to the calculated risks and hazards from exposure to groundwater within Site 49. PRGs for

groundwater are set with the goal of reducing the cumulative risk from all contaminants to an acceptable level. PRG screening values were developed to ensure that overall risk from COPCs across the site will not exceed the ILCR of $5X10^{-5}$, and the overall HI will not exceed unity. These calculations are presented in Tables 2-12 through 2-15.

The PRGs for each COPC in groundwater is shown in Table 2-16. The PRG is the Safe Drinking Water Act MCL (for those compounds that have MCLs) and the calculated specific risk-based PRG for chemicals that do not have MCLs.

Groundwater PRGs were then compared to the maximum detected contaminant concentration in order to identify COCs. COCs are a subset of the COPCs comprising those chemicals requiring remedial action. In general, if the maximum concentration of a chemical exceeds the PRG then that chemical is considered a COC. Exceptions to this include:

- If a chemical is present at background concentrations;
- If a metal exceeds its PRG in an unfiltered sample but not in a filtered sample, or;
- If a chemical only exceeds a risk based PRG in one or two isolated wells (if a chemical exceeds a MCL based PRG in a well it is considered a COC).

The COPCs that have qualified as COCs are identified in Table 2-16, and are listed below with their respective PRGs.

COC	PRG (µg/L)	Basis
cis-1,2-dichloroethene	70	MCL
trichloroethene	5	MCL
vinyl chloride	2	MCL
iron	4,700	Risk Based

2.8.3 Estimated Volumes of Contaminated Groundwater

The areal extent of the dissolved-phase TCE plume, where concentrations exceed the PRGs, is estimated by the site outline shown in Figure 2-7. No significant or widespread area of soil contamination was encountered above or below the water table that would indicate the presence of nonaqueous phase liquid (NAPL).

The original source of the plume is presumed to be the former leaching well on the west side of Building 427. Paint Branch is the eastern (downgradient) limit of the plume. The plume is estimated to extend to the south of monitoring well 49GW202D, and beyond the property boundary to the north. The estimated lateral target treatment area of the plume is therefore 217,000 square feet or 5 acres.

The Target Remediation Zone (TRZ) is a sub-area of the plume defined by the area estimated to contain greater than 100 µg/L of TCE (see Figure 2-7). The TRZ encompasses approximately 110,000 square feet, or 2.5 acres. The purpose of defining the TRZ is to focus aggressive remedial actions where they can provide the greatest benefit.

The approximate average vertical extent of groundwater contamination is to a depth of 130 feet BGS or approximately 105 feet below the water table. Assuming an effective porosity of 0.05 in fractured rock, an estimated 8,500,000 gallons of contaminated groundwater lies within the plume and 4,250,000 gallons of groundwater lies within the TRZ.

Using average concentrations of TCE, DCE and VC at 1,000 µg/L, 150 µg/L, and 2 µg/L respectively, the contaminated groundwater contains an average of 85 pounds of total VOCs of which 71 pounds are TCE. The great majority of this is present within the TRZ.

2.9 DESCRIPTION OF ALTERNATIVES

Based upon the remedial technology screening presented in the FS, five remedial alternatives and two sub-alternatives were developed to address COCs in groundwater.

- Alternative 1: No Action
- Alternative 2: Institutional Controls (ICs) with Long-term Monitoring (LTM)
- Alternative 3: Groundwater Extraction and Treatment
- Alternative 3A: Groundwater Extraction and Treatment with Pneumatic Fracturing
- Alternative 4: *In-situ* Chemical Oxidation (ISCO)
- Alternative 4A: *In-situ* Chemical Oxidation with Pneumatic Fracturing
- Alternative 5: Enhanced Anaerobic Bioremediation with Pneumatic Fracturing

The following sections outline the components of each of the remedial alternatives.

2.9.1 Alternative 1: No Action

The no-action alternative is required by the NCP and serves as the baseline alternative for comparison purposes. All other remedial action alternatives are judged against the no-action alternative. Under this alternative, no controls or remedial technologies would be implemented. No additional work or monitoring would be performed. There would be no reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, biodegradation, and other attenuating factors. Existing monitoring programs and institutional controls would be discontinued, and the site would be available for unrestricted use.

CERCLA (Section 121(c)), as amended by SARA (1986), requires that, even under the no-action alternative, the site be reviewed every 5 years where unacceptable levels of contamination in the groundwater would remain onsite.

2.9.2 Alternative 2: Institutional Controls (ICs) with Long-term Monitoring (LTM)

The primary components of this alternative are:

- Institutional controls
- Installation of additional monitoring wells to delineate the extent of ICs
- Long-term monitoring of the groundwater

2.9.2.1 Institutional Controls

Institutional controls would be implemented to meet the following LUC Objectives:

- Ensure no withdrawal of groundwater for any purpose (including as drinking water) from within the restricted area shown on Figure 2-7 until the PRGs are met and risks from groundwater use are shown to be reduced to acceptable levels.

- Ensure adequate protection to minimize potentially adverse health and environmental effects of work or development in the restricted area.

- Ensure adequate protection to minimize physical disruption of any remedial equipment, such as monitoring wells, or remedial operations in the restricted area.

- Ensure adequate notification of pertinent use restrictions to current and future owners.

Institutional controls would be maintained until the concentrations of hazardous substances in the groundwater are at such levels as to allow for unrestricted use and exposure.

The Navy is responsible for implementing, inspecting, reporting, and enforcing the LUC Objectives in accordance with a LUC Remedial Design. The LUC Remedial Design would be developed during the design phase, submitted to EPA and MDE within 180 days of signature of this ROD, and would be subject to review and approval by the EPA and MDE.

Although the Navy retains ultimate responsibility for meeting the LUC Objectives, the Navy may arrange, by contract or otherwise, for another party to carry out the LUC Remedial Design implementing actions. In addition, since the particular sites subject to this ROD are presently under the jurisdiction of GSA, the Navy will work with GSA to ensure that the LUC Objectives are met in accordance with the LUC Remedial Design.

Should any LUC Remedial Design implementing action fail or any LUC objective not be met, the Navy would ensure that appropriate actions are taken to reestablish the action and ensure compliance with the LUC Objectives. The Navy may initiate legal action against a third party to compel action and/or to recover the costs for remedying any LUC violation.

2.9.2.2 Long-term Groundwater Monitoring

Under this alternative, groundwater monitoring of the contaminated plume would be performed every 9 months to track contaminant concentrations within and migrating from the current plume. Monitoring would be required as long as contaminants are present above PRGs. Groundwater monitoring on a 9-month schedule allows collection of data in each of the four seasons. This data would be used during 5-year reviews to determine the effectiveness of the controls (i.e., do controls need to be expanded to include a greater area or can they be relaxed?) It was assumed that 5 wells would be sampled for VOCs.

Since contamination would remain on site for a period of longer than 5 years, 5 year reviews would be required.

2.9.3 Alternative 3: Groundwater Extraction and Treatment

This alternative involves installation of a groundwater extraction system to achieve both hydraulic control of the plume and mass removal throughout the plume. It would include a combination of several response actions that were considered during the initial screening: groundwater removal followed by ex-situ treatment to address the contaminants of concern. The primary components of this alternative are:

- Installation, testing and startup of groundwater extraction wells
- Construction of a groundwater conveyance and treatment system for extracted water
- Instrumentation and process control, to monitor and record flow rates and notify maintenance personnel of malfunction
- Discharge of the treated water to Paint Branch under an National Pollutant Discharge Elimination System (NPDES)-permit
- Annual operation and maintenance to monitor performance and assure proper operation
- Groundwater monitoring for contaminant concentrations and hydraulic capture
- Preparation of annual technical memoranda and 5-year report
- Implementation of institutional controls until PRGs are met

Each primary component is discussed below.

2.9.3.1 Installation of Groundwater Extraction Wells

Groundwater extraction serves two purposes: contaminant mass removal and hydraulic containment, by altering the natural hydraulic gradient to prevent contaminated groundwater flow (horizontally or vertically) from migrating outside the current area of the plume. The technology that was retained for consideration for this site during the initial screening process was vertical wells. A network of ten groundwater extraction wells is assumed to be necessary to achieve remedial goals.

In addition, approximately five piezometers would also be installed to monitor water levels around the extraction wells and determine if the necessary capture zones were being established. It is assumed that these piezometers would be constructed identical to 2-inch monitoring wells.

A pre-design aquifer test is recommended for Site 49 to ensure that groundwater can be extracted from the bedrock at a reasonable rate. The test would comprise installing an extraction well and several piezometers in an area with significant levels of contamination and performing and evaluating a pumping test. For cost estimating purposes, a lump sum cost for a predesign pumping test was included.

2.9.3.2 Groundwater Treatment System

Given the uncertainties associated with the fractured bedrock flow system and the low permeabilities, it is difficult to predict the pumping system's performance. Extracted groundwater would be directed to a centralized treatment system consisting of a filter, equalization tank, liquid-phase granular activated carbon (LGAC) system.

LGAC was selected as the preferred technology for groundwater treatment of the COCs due to its low maintenance and relatively good treatment efficiency. Calculations supporting the selection of LGAC are contained in the feasibility study for Site 49. It was assumed that the water would be treated in continuous flow. It was conservatively assumed that approximately 3,800 lb. of LGAC would be consumed annually. This is based on as assumed adsorption rate of 2.8 percent by weight, average influent flow rate of 10 gpm, and an average influent total chlorinated VOC concentration of 1,150 μg/L.

The treatment system would be equipped with instrumentation to record and totalize flow rates and to shut down the system and notify maintenance personnel in the event of malfunction.

2.9.3.3 Discharge of Treated Water

The treated water would be discharged by gravity flow to Paint Branch, under a NPDES-permit. Discharge concentrations would have to meet the State of Maryland surface water discharge requirements.

2.9.3.4 Annual O&M and Groundwater Monitoring

The time estimated to achieve PRGs in the plume via groundwater extraction and treatment is difficult to determine and could range from 10 years to higher than 30 depending on the aquifer's behavior under pumping and the amount of adsorbed-phase contaminant in the rock matrix. An estimate of 10 years was used for the purposes of this FS; based on the assumption that no residual- or adsorbed-phase mass remains as a source.

During this 10-year period, annual O&M and monitoring would be performed. In addition to routine mechanical system maintenance and checks, O&M would include sampling the discharge from each well quarterly and LGAC influent and effluent monthly, and collecting water levels in the surrounding wells and piezometers monthly.

Groundwater monitoring would include collecting groundwater samples from a network of an estimated eight wells quarterly for 2 years and then semiannually for the duration of the remediation (estimated at 10 years). All samples would be analyzed for VOCs and some attenuation parameters.

2.9.3.5 Reporting

A 5-year report would be prepared that documents the effectiveness of the treatment system and meets the requirements of CERCLA. Technical memoranda would be prepared on a quarterly basis during the first 2 years and semiannually thereafter to report treatment performance.

2.9.3.6 Institutional Controls

Institutional controls to prevent groundwater exposure from the site would be the same as included in Alternative 2 including preparation of a LUC Remedial Design Document. These would remain in effect until groundwater PRGs are met and risks to groundwater are shown to be reduced to acceptable levels.

2.9.4 Alternative 3A: Groundwater Extraction and Treatment with Pneumatic Fracturing

In order to enhance the effectiveness of the extraction system, the existing fractures in the bedrock would be expanded using pneumatic fracturing techniques. Pneumatic fracturing would be conducted to create better flow through the existing fracture network. This process involves injecting gas (nitrogen) at high pressures into packered intervals of an open borehole. Existing fractures are widened outward from the borehole to various distances depending on the site geology. Experience indicates that fractures are expanded up-to 30 feet from the borehole. This procedure would allow for a reduction in the time required to achieve PRGs due to the increase in hydraulic conductivity and well yield.

2.9.5 Alternative 4: *In-situ* Chemical Oxidation

In this alternative, an oxidative reagent would be injected and distributed within the TRZ in the aquifer to promote oxidization of the contaminants to innocuous compounds such as carbon dioxide and water. The objective is to oxidize targeted contaminants to meet the PRGs.

The primary components of this alternative are:

- Installation of additional wells to define treatment area, collect oxidant demand samples, and to establish an optimum groundwater monitoring network
- Performance of a source area pilot test
- Installation of injection wells
- Injection of oxidizing reagent
- Groundwater monitoring of baseline and post-injection conditions
- Preparation of a remediation completion report and 5 year reviews
- Long-term monitoring of the plume until PRGs are met
- Implementation of institutional controls until PRGs are met

ISCO is considered an accepted technology for the treatment of chlorinated VOCs. Typical oxidants include potassium and sodium permanganate, Fenton's Reagent (iron and hydrogen peroxide), hydrogen peroxide, sodium persulfate, and ozone. ISCO has been used to successfully treat TCE in groundwater to less than PRGs at multiple sites.

Each primary component is discussed below.

2.9.5.1 Installation of Additional Wells

A design phase investigation involving the installation of an estimated five new monitoring wells would be conducted. The wells would be used to more precisely define the treatment area to avoid injecting oxidant in areas not needing treatment and to monitor current and future conditions in the groundwater. Samples would be collected from aquifer solids and groundwater for natural oxidant demand tests.

2.9.5.2 Installation of Injection Wells and Oxidizing Reagent

A series of 25, 4-inch diameter open boreholes would be installed within the contaminant plume to an average depth of 130 feet bgs. The borings would be placed at 20-foot centers. The potassium permanganate would be pressure injected one well at a time in 3-foot packered intervals working from the bottom of the borehole to the water table.

It is estimated that approximately 307 lbs. of potassium permanganate (mixed to a 3-percent solution) would be required. Groundwater conditions are expected to return to background conditions within several days after injection.

The estimated design parameters are summarized below:

- Size of Target Remediation Zone - 2.5 acres
- Radius of Distribution - 12 feet
- Number of Injection Wells and Spacing - 25 borings (20 feet apart) in two 200 foot-long arrays
- $KMnO_4$ Dose - approx. 100 gallons of 3% solution per boring
- $KMnO_4$ - Requirement 2,500 gallons of 3% solution

A typical industry practice is two chemical treatments, an initial injection followed by a polishing injection within a small fraction of the target treatment zone where monitoring well data shows COC rebound. A polishing injection would typically be required where conditions of solubility and chemical partitioning cause further desorption of the contaminant of concern. Since ISCO is a relatively rapid treatment process, it is assumed that the maximum treatment achievable can be accomplished within four years using one or two injections in the first two years. A range of costs are provided for this alternative with the low end corresponding to one injection and the upper end corresponding to two injections. The borings would be left in the ground after the first treatment so as to be used for the second treatment (and any subsequent treatment) until PRGs are met.

2.9.5.3 Baseline and Post-injection Monitoring

Effectiveness of the treatment would be monitored by collecting and analyzing groundwater samples from selected wells prior to and following the treatment. Sampling and analysis would be conducted to track disappearance of chlorinated VOCs and other chemicals for which PRGs have been established, to determine if additional applications are necessary.

Baseline sampling would be conducted prior to the injection of the oxidant, and then additional rounds of sampling would be performed at 2 to 6 weeks, 6 months, 9 months and 12 months after the initial injection to determine if a second injection is needed. After the final injection, additional sampling rounds would be performed semiannually until PRGs are met (assumed 4 years). Field sampling efforts to support the injection effort would include testing monitoring wells for the oxidant concentration, temperature, pH, dissolved oxygen (DO), oxidation reduction potential (ORP), and specific conductance using standard field instrumentation. Laboratory samples would be collected from the monitoring wells and analyzed for chlorinated VOCs. The frequency of sampling events may be adjusted based on the results of the early sampling events.

2.9.5.4 Reporting

A closeout report would be generated to document the result of the ISCO treatment. Technical memoranda would also be generated to document the results of the out-year verification sampling rounds. 5-year reports would be generated if PRGs are not met within 5 years.

2.9.5.5 Institutional Controls

Institutional controls to prevent groundwater exposure from the site would be the same as included in Alternative 2 including preparation of a LUC Remedial Design Document. These would remain in effect until groundwater PRGs are met and risks to groundwater are shown to be reduced to acceptable levels.

2.9.6 Alternative 4A: In-Situ Chemical Oxidation with Pneumatic Fracturing

Pneumatic fracturing would be conducted to create better flow and chemical distribution throughout the existing fractured bedrock. This process involves injecting gas (nitrogen) at high pressures into packered intervals of an open borehole. Existing fractures are widened outward from the borehole to various distances depending on the site geology. Experience indicates that fractures are expected to be expanded up-to 30 feet

from the borehole. It is assumed that the oxidizing reagent can then be injected out to at least a 20+ foot radius. Under current conditions, a twelve-foot radius is expected.

By increasing the radius of influence of the injection wells to 20 feet or more, the spacing between wells can be increased from 20 to 40 feet (allowing for overlap). This leads to a reduction in the number of injection wells. It is expected that 13 injection wells will be sufficient to reach the same coverage if fracturing is used.

2.9.7 Alternative 5: Enhanced Anaerobic Bioremediation with Pneumatic Fracturing

The primary components of this alternative are:

- Installation of additional wells to define treatment area and establish an optimum groundwater monitoring network
- Installation of injection wells, pneumatic fracturing and injection of electron donor in the contaminated aquifer
- Groundwater monitoring of baseline and post-injection conditions
- Preparation of annual technical memoranda and 5-year report
- Implementation of institutional controls until PRGs are met

In this alternative, the naturally occurring process of biological decomposition of site contaminants under reducing conditions would be enhanced through injection and distribution of an electron donor or co-substrate (food source) to increase the biodegradation rates of the contaminants by indigenous microorganisms. Reagents such as acetate, molasses, sodium lactate, or the proprietary agent Hydrogen Release Compound (HRC) by Regenesis (also a lactate-based reagent) are possible electron donor candidates for this type of application. Sodium lactate or HRC appears to be the most promising. HRC is used for costing purposes because its use and costs are better documented; lactate would be slightly less expensive. Numerous field studies have indicated that HRC may be used to promote reductive dechlorination of TCE. Complete biodegradation would transform the contaminants to innocuous compounds such as carbon dioxide and water.

The major components of this alternative are discussed below.

2.9.7.1 Installation of Additional Monitoring Wells

Five additional wells would be installed at Site 49 to assist with design, and provide an optimum monitoring network for enhanced bioremediation.

2.9.7.2 Installation of Injection Wells, Pneumatic Fracturing and Injection of HRC

HRC is a proprietary polylactate ester that, upon being deposited into the subsurface, slowly releases lactate. Lactate is metabolized by naturally occurring microorganisms, resulting in the creation of anaerobic aquifer conditions and the production of hydrogen. HRC is manufactured as a viscous gel that can be injected into the saturated zone for plume remediation.

An HRC slurry would be injected along two 200-foot long treatment arrays each consisting of 6 open-cased boreholes, one additional borehole would be placed at the former leaching well.

Pneumatic fracturing would first be conducted to create more permeable conditions and better electron donor distribution throughout the existing fractured bedrock. This process involves injecting gas (nitrogen) at high pressures into packered intervals of an open borehole. Existing fractures are widened outward from the borehole to various distances depending on the site geology. Experience indicates that fractures are expected to be expanded up-to 30 feet from the borehole. It is assumed that the electron donor can then be injected out to at least a 20+ -foot radius. Under current conditions, twelve-foot radius is expected.

By increasing the radius of influence of the injection boreholes to 20 feet or more, the spacing between boreholes can be set at 40 feet (allowing for overlap). It is expected that 13 injection wells will be sufficient to attain the desired coverage.

The boreholes would be 130 ft deep on average. The HRC will be heated for injection using a heated grout pump, to reduce the viscosity and allow better migration of the HRC into the formation. The estimated HRC application configuration is summarized as follows:

- Size of Target Remediation Zone - 2.5 acres
- Radius of Influence - 20 feet
- Number of Injection Wells and Spacing - 13 wells (at 40 feet apart) in two 200 foot-long arrays
- Dose Rate in lbs/vertical ft of Injection - 4 pounds/linear foot
- Material Requirement - 12,480 pounds

The duration of an enhanced *in-situ* bioremediation is difficult to predict due to uncertainty about the total contaminant mass and site specific biodegradation rates that can be achieved. Based on previous studies and the site hydrogeological conditions, the remediation goals may be achieved in 4 years. For costing purposes, it is assumed that the maximum attainable remediation will take 5 to 6 years.

2.9.7.3 Baseline and Post-injection Monitoring

Bioremediation effectiveness would be monitored by collecting and analyzing groundwater samples from selected wells prior to, and throughout the duration of, the treatment. Sampling and analysis would be conducted to track the degradation of contaminants and byproduct generation, and the dispersion of the electron donor, to determine effectiveness and if additional applications are necessary.

The scope of each sampling event would be similar to that described in Alternative 4, with modifications to better understand the effectiveness of the electron donor injection. Laboratory analysis of the initial sampling rounds would involve analysis of additional parameters, particularly metabolic organic acids, to track the degradation of the HRC material.

Baseline sampling would be conducted prior to the injection of the electron donor, quarterly for the first year, and then semiannually until PRGs are achieved. Field sampling efforts may be conducted more frequently for parameters such as metabolic acids, DO and ORP. The frequency of sampling events may be adjusted based on the results of the early sampling events. It is estimated that sampling would be performed at eight wells during each round.

2.9.7.4 Reporting

A closeout report would be generated to document the result of the treatment. Technical memoranda would also be generated to document the results of the out-year verification sampling rounds. Five-year reports would be prepared as required by CERCLA to document the effectiveness of the remedy, if PRGs are not met within 5 years.

2.9.7.5 Institutional Controls

Institutional controls to prevent exposure to contaminated groundwater at the site would be the same as those included in Alternative 2 including preparation of a LUC Remedial Design Document. These would remain in effect until groundwater PRGs are met throughout the plume and risks to groundwater are shown to be reduced to acceptable levels.

2.9.8 Common Elements and Distinguishing Features of Each Alternative

The one significant element which is common to all alternatives is that hazardous substances would remain on site for some time at concentrations above those protective of unrestricted use. Therefore each alternative would require institutional controls. However, a distinguishing feature of Alternatives 3 through 5A is the use of active remediation to accelerate the removal of COCs from groundwater. Another distinguishing feature of Alternatives 4 through 5 is that active remediation would occur *in-situ*.

2.9.9 Expected Outcome of Each Alternative

Under Alternative 1, potential unacceptable risks to human health and the environment would continue indefinitely.

The primary differences between the outcomes of Alternatives 2 through 5 are:

1. The estimated time that it will take before PRGs are met and land-use restrictions can be lifted and monitoring stopped.
2. The rate at which contaminant mass will be removed from the aquifer.

When considering the expected outcomes of each alternative it should be noted that, given the extreme heterogeneity of fractured rock aquifers that are present at the site, there is significant uncertainty that any of the alternatives are technically capable of achieving PRGs throughout the aquifer. The actual outcomes of these alternatives will be limited by the ability of the technologies to extract groundwater or inject reagents into all of the rock fractures that contain significant concentrations of TCE. These uncertainties are discussed in section 2.12.2.7 as they apply to the selected remedy.

With this in mind, Alternative 2 is estimated to take 30 to 100 years to meet PRGs, and mass removal would be slow. Alternatives 3 and 3A are estimated to take 10 years and 6 years respectively to either achieve PRGs or reach their technical limitations. Mass removal rates would be relatively moderate and would decline with time rapidly at first and then gradually until asymptotic concentrations are reached. If Alternative 5 is effective at establishing viable microbial colonies, it is expected to take approximately 5 years to reach PRGs or the technical limitations of the alternative. Mass removal rates would be slow at first and then accelerate as the microbes get established. Alternatives 4 and 4A would reach PRGs or their technical limits in less than 5 years. Most of the mass reduction would occur within the first few months after each injection.

2.10 SUMMARY OF COMPARATIVE ANALYSIS

The NCP outlines the approach for comparing remedial alternatives. Evaluation of the alternatives uses "threshold", "primary balancing", and "modifying" criteria. To be considered for remedy selection, an alternative must first meet the two following threshold criteria:

1. Overall protection of human health and the environment
2. Compliance with ARARs

The primary balancing criteria are then considered to determine which alternative provides the best combination of attributes. The primary balancing criteria are:

1. Long-term effectiveness and permanence
2. Reduction in toxicity, mobility, or volume through treatment
3. Implementability
4. Short-term effectiveness
5. Cost

A comparative evaluation for these 7 criteria was conducted in the Site 49 FS for the five remedial alternatives and two sub-alternatives. A summary of the evaluation is provided in Table 2-17. The cost information is repeated below for ease of comparison. The five alternatives and two sub-alternatives were then ranked relative to each other and given a relative score. This ranking is provided in Table 2-18.

	Capital Cost	O&M Cost	Net Present Worth
Alternative 1	$0	$0 - $6000	$17,000
Alternative 2	$65,000	$13,000	$312,000
Alternative 3	$717,000	$83,000	$1,506,000
Alternative 3A	$1,126,000	$89,000	$1,716,000
Alternative 4	$590,000	$21,000	$833,000 - $983,000
Alternative 4A	$938,000	$22,000	$1,175,000 - $1,275,000
Alternative 5	$1,020,000	$43,000	$1,341,000

Based on the criteria evaluation and ranking, Alternative 4A was identified as the preferred remedy and was presented to the State of Maryland and the public as such in the Proposed Plan. Comments on the Proposed Plan have been used as the basis for evaluating the selected remedy further against two modifying criteria:

1. Acceptance by the State
2. Acceptance by the community

State Acceptance

The State of Maryland has gone on record in the Proposed Plan as supporting the selection of Alternative 4A as the selected remedy.

Community Acceptance

Based on comments expressed at the public meeting and received during the public comment period, the community generally agrees with the selected remedy for groundwater, Alternative 4A. Specific responses to public comments are in the Responsiveness Summary section of this ROD.

2.11 PRINCIPAL THREAT WASTES

The NCP establishes an expectation that treatment will be used to address the principal threats posed by a site wherever practicable [40 CFR 300.430(a)(1)(iii)(A)]. Principal threat wastes include non-aqueous phase liquids in the environment, drums of liquids containing the COCs for the site, and drummed non-liquid waste or soil containing significant concentrations of highly toxic materials. Based on available information and on results of remedial investigations, Site 49 contains no principal threat wastes as defined by the NCP.

2.12 SELECTED REMEDY

This section expands upon the details of the selected remedy for Site 49.

2.12.1 Summary of the Rationale for the Selected Remedy

The selected remedy for Site 49 at the former NSWC White Oak is Alternative 4A, *In-Situ* Chemical Oxidation (ISCO) with Pneumatic Fracturing. This alternative includes institutional controls and long-term monitoring as components. This alternative will be protective of human health and the environment by preventing exposure to contaminated groundwater while reducing the concentrations of COCs to the PRGs, or as close to the PRGs as technically practicable in an acceptable time frame. Decreases in concentrations of COCs will be monitored and it is expected that ISCO will achieve its maximum treatment capability within five years; therefore a formal five year site review is not anticipated. There is a high likelihood that neither Alternative 4A nor any of the other alternatives will be able to meet PRGs everywhere throughout the fractured rock aquifer. If PRGs are not met within five years, five year reviews would take place until groundwater PRGs are attained.

Alternative 4A was selected over Alternative 4 because, even though the costs for Alternative 4 are 30 percent less, there is significant uncertainty that the chemical oxidant can be distributed to any satisfactory degree without fracturing and pressure injecting. Alternative 5, Enhanced Anaerobic Bioremediation with Pneumatic Fracturing, was the third highest ranking alternative behind Alternatives 4A and 4. However, as there are low levels of vinyl chloride and ethene in the groundwater and field measurements indicate relatively high DO and ORP, it is unlikely that the correct microorganisms are present. Added to this is the difficulty of establishing a microbial population that can interface with the groundwater in a fractured rock medium. The addition of a chemical oxidant (Alternative 4A) will further increase the levels of DO and ORP while rapidly oxidizing groundwater contaminants.

Alternatives 3 through 5 scored equally for the criteria of protection of human health and the environment and compliance with ARARs. However, Alternative 4A scored the highest for reduction in toxicity, mobility or volume and for short term effectiveness.

2.12.2 Description of the Selected Remedy

The selected remedy consists of the following major components:

- Installation of additional wells to define treatment area, collect oxidant demand samples, and to establish an optimum groundwater monitoring network
- Performance of a source area pilot test or bench-scale test
- Installation of injection wells and pneumatic fracturing
- Injection of oxidizing reagent
- Groundwater monitoring of baseline and post-injection conditions
- Preparation of a remediation completion report and 5 year reviews
- Long-term monitoring of the plume until PRGs are met
- Implementation of institutional controls until PRGs are met

The major components are discussed below.

2.12.2.1 Installation of Additional Wells

A design phase investigation involving the installation of an estimated five monitoring wells will be conducted. The wells will be used to more precisely define the treatment area and to monitor current and future conditions in the groundwater. Samples will be collected from aquifer solids and groundwater for bench-scale natural oxidant demand tests.

2.12.2.2 Installation of Injection Wells, Pneumatic Fracturing and Injection of Oxidizing Reagent

Pneumatic fracturing will be conducted at some locations where it is technically possible and appropriate. Fracturing will create better flow and chemical distribution throughout the existing fractured bedrock. This process involves injecting gas (nitrogen) at high pressures into packered intervals of an open borehole. Existing fractures are widened outward from the borehole to various distances depending on the site geology. Experience indicates that fractures are expected to be expanded up-to 30 feet from the borehole. It is assumed that the oxidizing reagent can then be injected out to at least a 20+ foot radius. Without fracturing, a twelve-foot radius is expected.

By increasing the radius of influence of the injection borings to 20 feet or more, the borings can be spaced at 40 feet (allowing for overlap). It is expected that 13 injection borings will be sufficient to reach the same coverage if fracturing is used. Conceptual locations of the injection boreholes are shown in Figure 2-7.

It is estimated that approximately 307 lbs. of potassium permanganate (diluted to a 3-percent solution) will be required. Groundwater conditions are expected to return to background conditions within several days after injection. The oxidant/catalyst solution will destroy dissolved and adsorbed chlorinated VOCs.

The estimated design parameters are summarized below.

- Size of Target Remediation Zone - 2.5 acres
- Radius of Influence - 20 to 30 feet
- Number of Injection Borings and Spacing - 13 wells (40 feet apart) along two 200 foot-long arrays
- $KMnO_4$ Dose and Concentration - approx. 200 gallons of 3% solution per boring
- $KMnO_4$ Requirement - 2,600 gallons of 3% solution

A typical industry practice is to conduct two chemical treatments, an initial injection followed by a polishing injection within the portion of the target remediation zone where monitoring well data shows contaminant of concern (COC) rebound. A polishing injection would typically be required where conditions of solubility and chemical partioning cause further desorption of the COC. Since ISCO is a relatively rapid treatment process, it is assumed that the site can be treated to PRGs or as close to PRGs as technically practicable within four years using one or two injections in the first two years to obtain the necessary treatment. A range of costs are

provided for this alternative with the low end corresponding to one injection and the upper end corresponding to two injections. The borings will be left in the ground after the first treatment so as to be used for the second treatment if necessary.

2.12.2.3 Baseline and Post-injection Monitoring

Effectiveness of the treatment will be monitored by collecting and analyzing groundwater samples from selected wells prior to and following the treatment. Sampling and analysis will be conducted to track the reduction of chlorinated VOCs and iron (the site COCs), to determine if an additional application is necessary.

Baseline sampling will be conducted prior to the injection of the oxidant, and then additional rounds of sampling will be conducted at 2 to 6 weeks, 6 months, 9 months and 12 months after the initial injection to determine if a second injection is needed. After the final injection, additional sampling rounds will be performed semiannually until PRGs are met, or it is determined that the technology has achieved its maximum treatment capabilities (assumed 4 years). Field sampling efforts to support the remedy will include testing monitoring wells for the oxidant concentration, temperature, pH, DO, ORP, and specific conductance using standard field instrumentation. Laboratory samples will be collected from the monitoring wells and analyzed for chlorinated VOCs. Field sampling efforts may be conducted more frequently for parameters such as oxidant concentration, DO, and ORP. The frequency of sampling events may be adjusted based on the results of the early sampling events. The sampling locations and parameters will be finalized during the design process, and a sampling and analysis plan for ISCO will be developed in concert with EPA and MDE.

2.12.2.4 Reporting

A closeout report would be generated to document the result of the treatment. Technical memoranda would also be generated to document the results of the out-year verification sampling rounds. It is assumed that a 5-year review would not be required because the remedy will be successful at reaching PRGs in less time. The closeout report would evaluate the protectiveness and effectiveness of the remedy. If PRGs are not met within five years, 5-year reviews would take place until groundwater PRGs are attained, or the Navy, EPA, and MDE determine that it is technically impracticable to reach the PRGs.

2.12.2.5 Institutional Controls

Institutional controls would be implemented to meet the following LUC Objectives:

- Ensure no withdrawal of groundwater for any purpose (including as drinking water) from within the restricted area shown on Figure 2-7 until the PRGs are met and risks from groundwater use are shown to be reduced to acceptable levels.

- Ensure adequate protection to minimize potentially adverse health and environmental effects of work or development in the restricted area.

- Ensure adequate protection to minimize physical disruption of any remedial equipment, such as monitoring wells, or remedial operations in the restricted area.

- Ensure adequate notification of pertinent use restrictions to current and future owners.

Institutional controls will be maintained until the concentrations of hazardous substances in the groundwater are at such levels as to allow for unrestricted use and exposure.

The Navy is responsible for implementing, inspecting, reporting, and enforcing the LUC Objectives in accordance with a LUC Remedial Design. The LUC Remedial Design will be developed during the design phase, submitted to EPA and MDE within 180 days of signature of this ROD, and will be subject to review and approval by the EPA and MDE.

Although the Navy retains ultimate responsibility for meeting the LUC Objectives, the Navy may arrange, by contract or otherwise, for another party to carry out the LUC Remedial Design implementing actions. In

addition, since the particular sites subject to this ROD are presently under the jurisdiction of GSA, the Navy will work with GSA to ensure that the LUC Objectives are met in accordance with the LUC Remedial Design.

Should any LUC Remedial Design implementing action fail or any LUC objective not be met, the Navy will ensure that appropriate actions are taken to reestablish the action and ensure compliance with the LUC Objectives. The Navy may initiate legal action against a third party to compel action and/or to recover the costs for remedying any LUC violation.

2.12.2.6 Uncertainty

Like any *in-situ* technology, the effectiveness of ISCO will be limited by the subsurface heterogeneities present at the site and the treatment system's ability to deliver the oxidant throughout the heterogeneous formation. Groundwater flow through a formation composed of unconsolidated sediment can be well characterized in terms of direction and magnitude at the macro-level as well as smaller scales. However, the fractured bedrock flow system at Site 49 is less easily characterized. At the largest scale, it is known that groundwater flows from west to east and discharges to Paint Branch. Beyond this, not much is known about flow paths. The effectiveness and radius of distribution achieved at one injection boring will not be necessarily predictive of others, and it will not be possible to confirm or even estimate what radius has been achieved. The term "radius of distribution" is also somewhat imprecise because distribution will be governed by the number and continuity of the fractures that are intercepted by an injection boring and will not be comparable from boring to boring, at different depths within the same boring, nor even in all directions at a particular depth in a boring. Because of these inherent properties of fractured rock it is highly unlikely that all fractures containing impacted groundwater will be treated under this alternative.

It has been observed at other sites that after the injection of the treatment fluid, some trace metals (iron, chromium, mercury, potassium, and manganese) are released from the formation into the groundwater. Elevated concentrations of manganese, potassium, chromium, and mercury could be drawn out by permanganate reagent. In addition, elevated concentrations of metals like iron, occur through reactions of the treatment fluid with the aquifer matrix. Manganese dioxide usually precipitates on existing manganese or iron oxide coatings on fracture surfaces. Metals previously sorbed to these surfaces are displaced by the manganese dioxide surface precipitation reaction, releasing metals into the surrounding groundwater. Regardless of the mechanism that results in the elevated metals (iron, chromium, and mercury), their concentrations within the treatment area would remain elevated above background concentrations only as long as permanganate persists. However, based on the small volume of chemical oxidant required to treat the TCE and overcome the demands of the natural carbon content of the formation, it is considered unlikely that an increase in soluble metals in the groundwater or Paint Branch surface water will occur.

2.12.2.7 Exit Strategy

During implementation of the remedy, information gathered may identify trends that provide significant information as to the site's restoration potential and in particular whether achieving the RAOs is technically practicable from an engineering perspective. Due to the hydrogeological constraints of remediating groundwater within an heterogeneous fractured rock medium, it is necessary to develop a strategy to prevent excessive financial obligation where achievement of RAOs is technically impracticable.

Following the injection of a chemical oxidant into the contaminated aquifer, groundwater contaminant levels will continue to be monitored until RAOs have been attained. Should contaminant levels rebound or plateau and remain above RAOs, a subsequent polishing injection of a chemical oxidant may be required.

Following a polishing injection, should levels of groundwater contamination not decline to below RAOs and remain below RAOs within a reasonable timeframe, a third injection of a chemical oxidant will not occur as it is not expected to produce further contaminant reductions. In this situation, an alternative remedial strategy, which may consist of institutional controls and long-term monitoring, or (considering the small size of the site, and the low yield of the rock aquifer (less than 1 gpm)), a risk management solution may be warranted. Any significant revision to the selected remedy will be made in accordance with 40 CFR 300.430(a)(1)(iii)(F).

2.13 STATUTORY DETERMINATIONS

The selected remedy satisfies the statutory requirements of Section 121 of CERCLA, 42 U.S.C. Section 9621. Under CERCLA, remedial action sites must achieve protection of human health and the environment, comply with federal and state ARARs, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element are preferred. The following discussion addresses how these statutory requirements and preferences are met by the selected remedy.

2.13.1 Protection of Human Health and the Environment

The selected remedy will be protective of human health and the environment. Institutional controls will minimize the risk of direct exposure to the contaminated groundwater until concentrations of COCs have been reduced to PRGs through *in-situ* chemical oxidation. There are no short-term threats associated with the selected remedy that cannot be readily controlled. In addition, no adverse cross-media impacts are expected from the selected remedy. Monitoring will ensure that the chemical oxidation process is effective and that the COCs are not migrating.

2.13.2 Compliance with ARARs

The selected remedy (which includes institutional controls and monitoring) will comply with all chemical- and action-specific ARARs. The selected remedy's compliance with ARARs is summarized in Table B-1 through B-3 in Appendix B.

2.13.3 Cost Effectiveness

In the Navy and EPA's judgment, the selected remedy is cost effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used (40 CFR 300.430(f)(1)(ii)(D)): "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." The Navy and EPA made this determination by evaluating the "overall protectiveness" of *in-situ* chemical oxidation, which satisfied the threshold criteria (i.e., it was both protective of human health and the environment and complies with ARARs). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, or volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of the selected remedial alternative was determined to be proportional to its costs; therefore, the selected remedy represents a reasonable value for the money to be spent.

The estimated net present worth (NPW) of the selected remedy (Alternative 4A) is $1,175,000 - $1,275,000.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Possible

The Navy and EPA, with MDE concurrence, has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner at the site. The Navy and EPA have determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria. The Navy and EPA also considered the statutory preference for treatment as a principal element, the bias against off-site treatment and disposal, and state and community acceptance.

2.13.5 Preference for Treatment as a Principal Element

In-situ chemical oxidation satisfies the statutory preference for treatment as a principal element over the TRZ.

2.13.6 Five Year Review Requirements

If the selected remedy is not successful in reducing concentrations of COCs in the groundwater to PRGs in fewer than 5 years, a 5-year report will be prepared. If PRGs are met within 5 years, the closeout report will serve as the 5-year report.

2.14 DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for Site 49 groundwater at the former NSWC White Oak, Silver Spring, Maryland was released for public comment on July 01, 2004. The Proposed Plan identified *in-situ* chemical oxidation with pneumatic fracturing along with institutional controls and monitoring as the preferred alternative for groundwater. The Navy reviewed all comments received during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

3. RESPONSIVENESS SUMMARY

3.1 OVERVIEW

This Responsiveness Summary provides a summary of comments received during the public comment period for Site 49 groundwater, along with responses to those comments. The public comment period for the proposed remedy for Site 49 groundwater began on July 01, 2004 and ended on July 30, 2004. A public meeting was held on July 13, 2004 at the Village Square at Riderwood Village in Silver Spring, Maryland to describe the proposed remedy and to solicit and accept either written comments or verbal comments. This Responsiveness Summary was prepared in accordance with guidance in "Community Relations in Superfund: A Handbook" [Office of Solid Waste and Emergency Response (OSWER) Directive 9320.3B, January 1992].

3.2 BACKGROUND ON COMMUNITY INVOLVEMENT

The Navy has had a comprehensive community relations program for NSWC-White Oak since research activities commenced at the facility. Recent community relations activities have been conducted in accordance with the NSWC-White Oak Community Relations Plan, originally developed in 1991 and revised in 1998, 2000, and 2003. These activities have included regular technical and Restoration Advisory Board (RAB) meetings with local officials, the distribution of fact sheets, site tours for the community, the establishment of the information repository at the local library, and the development of a web-page for the dissemination of information to the White Oak community.

The Navy organized a Technical Review Committee (TRC) in 1989 to review and discuss the NSWC-White Oak environmental issues with local community officials and concerned citizens. The TRC was reorganized into the RAB in 1995. The RAB consists of representatives of the Navy, EPA, MDE, the Prince George's County Health Department, Maryland-National Park and Planning Commission, and members of the community. The RAB has met frequently since its inception and now meets quarterly. The RAB has been assisting in the planning and review of environmental investigation, remedial alternative evaluation, and remediation activities. The Remedial Investigation and Proposed Plan for Site 49 groundwater were discussed at the RAB meetings.

RAB meeting minutes and reports presenting the findings of the investigations are maintained at the local information repository. The repository is located at the Montgomery County Public Library, White Oak Branch, located at 11701 New Hampshire Avenue, Silver Spring, Maryland. The Administrative Record for NSWC-White Oak is located at the Naval Facilities Engineering Command Washington, Washington Navy Yard, 1314 Harwood Street, S.E, Washington, District of Columbia.

Community relations activities for the final selected remedy include the items below:

- The documents concerning the investigation and analysis of Site 49 were presented at the RAB meetings and copies were provided to RAB members for review, discussion, and comment.

- The documents concerning the investigation and analysis of Site 49 as well as copies of the Proposed Plan, were placed in the information repository.

- The Navy mailed copies of the Proposed Plan to members of the RAB.

- Newspaper announcements on the availability of documents and the public meeting and comment period were published in the *Washington Post, Burtonsville Gazette, College Park Gazette,* and *Silver Spring Gazette.*

- The Navy established a 30-day public comment period for this Proposed Plan starting July 01, 2004 and ending July 30, 2004

- A public meeting was held on July 13, 2003 to present the Proposed Plan and to answer questions concerning Site 49 groundwater and soil.

3.3 SUMMARY OF COMMENTS RECEIVED DURING THE PUBLIC COMMENT PERIOD AND NAVY RESPONSES

Questions were received during the public meeting of July 13, 2004. Additional comments were received during the public comment period. A summary of the questions and responses is provided below. A copy of the transcript of the open discussion portion of the public meeting is provided as Appendix C.

The Navy and the EPA have taken the comments received at the public meeting into consideration and continue to believe that *in-situ* chemical oxidation with institutional controls and monitoring adequately and appropriately addresses the risks posed by the groundwater in a cost-effective and responsible manner.

Questions and Comments from the July 13, 2004 Public Meeting

Comment 1: If you use potassium permanganate to oxidize the chlorinated compounds, what is the fate of the manganese? Manganese can be a contaminant of concern also.

Response 1: The by-products of the reaction of potassium permanganate and trichloroethene are shown below.

$$2KMnO_4 + C_2HCl_3 \rightarrow 2CO_2 + 2MnO_2 + 3Cl^- + H^+ + 2K^+$$

Yan and Schwartz (1999) identified the intermediate reaction of TCE oxidation using permanganate ion as being ephemeral, and consisting mainly of esters and short chain acids. Carbon dioxide (CO_2) exists naturally in the subsurface from biological processes and bicarbonate partitioning in the groundwater. Manganese dioxide (MnO_2) is a natural mineral already found in the soils in many parts of the country. If the precipitation of manganese dioxide in the soils is excessive, it can reduce the permeability of the soil, thus limiting injection of the aqueous oxidant. Although the manganese dioxide is insoluble in groundwater, manganate (Mn^{+4}) may be reduced to dissolved divalent manganese (Mn^{+2}) under low pH or redox conditions.
So while we expect that most of the manganese injected into the subsurface will remain insoluble, we may see increases in the dissolved manganese in the groundwater as a result of the injection.
It should be noted that the amount of KMnO4 to be injected is very small compared to most applications. We will inject a total of 307 pounds compared to 10,000's of pounds typically injected at highly contaminated sites. This equates to slightly more than 100 pounds of manganese. If under an extreme worst case, all of the manganese were to become soluble at once, it would temporarily raise the manganese concentration in the groundwater by an average concentration of only 1.7 mg/L, which is about two times the risk-based guidance criteria for tap water (0.73 mg/L) and is well below the ecological risk-based concentration for Paint Branch of 14.5 mg/L

Comment 2: Is the Navy proposing alternative 4 or alternative 4a?

Response 2: The Navy and EPA with the concurrence of MDE are proposing Alternative 4A – *In-situ* Chemical Oxidation with Rock Fracturing. This alternative includes institutional controls and long term monitoring as components.

Comment 3: Under Alternatives 4A and 5, fractures in the rock will be expanded by injecting high pressure nitrogen gas. Except for the medium to be injected which is potassium permanganate in Alternative 4A and a reagent to enhance biodegradation in Alternative 5, what is the difference in alternatives?

Response 3: Pneumatic fracturing of the bedrock is a component of both Alternative 4A - *In-situ* Chemical Oxidation with Rock Fracturing, and Alternative 5 – Enhanced Anaerobic Bioremediation with Rock Fracturing. The significant difference between Alternative 4A and Alternative 5 is the medium to be injected and the mechanism that would be employed to destroy the contaminants. Under Alternative 4A, potassium permanganate, a strong chemical oxidizer would be injected into the subsurface, this would chemically

breakdown contaminants by oxidizing organic compounds. Alternative 5 is distinct as it is biologically rather than chemically mediated. Under this alternative naturally occurring processes of biodegradation would be enhanced through the injection of an electron donor (food source) to stimulate the indigenous organisms. Reagents such as molasses, sodium lactate and vegetable oil can be used for this process.

Comment 4: By fracturing the rock you believe that you will get better distribution and you will therefore not need as many boreholes. However, if drilling more boreholes is $400k cheaper, why not drill more boreholes?

Response 4: In fractured bedrock the native fractures are typically random causing preferential flow paths which tend to isolate pockets of contamination. Purely by installing a greater number of wells does not necessarily increase the efficiency of the treatment as these pockets of contamination may still be restricted. However, the use of technologies such as pneumatic fracturing whilst enhancing the permeability of the medium provides a greater possibility of accessing these previously restricted pockets of contamination and thus enhancing the overall effectiveness of the treatment. So while the cost of Alternative 4A is greater than Alternative 4, we also believe that the effectiveness of 4A is significantly greater than that of Alternative 4.

Comment 5: What does present worth cost mean?

Response 5: Present worth cost is the total 30 year cost of the alternative, including capital costs, operation and maintenance costs and all cost associated with the remedy. This figure is presented in today's dollars.

Comment 6: Are future costs likely to be less under alternative 4a than they would be under alternative 4?

Response 6: As presented in the proposed plan for Site 49, annual operation and maintenance (O&M) costs are comparable under the two alternatives, with annual O&M costs of $21,000 and $22,000 for Alternatives 4 and 4A respectively. However, a subsequent injection of chemical oxidant may be required under Alternative 4 to effectively remediate the groundwater, as the distribution of the reagent within the fractured rock medium would be limited. This additional injection would add substantial cost to Alternative 4 which may not be required under Alternative 4A due to the enhanced permeability created in the bedrock by pneumatic fracturing.

Comment 7: In the text of the proposed plan could you explain why the present worth cost under alternative 4 and 4a is $830,000 - $980,000 and $1,200,000 - $1,300,000 respectively, while in Table 1 – Relative ranking of Remedial Alternatives the cost under alternatives 4 and 4a is $830,000 and $1,100,000 respectively?

Response 7:. The cost shown in Table 1 of the proposed plan represents the lower end of the range of the estimated present worth costs shown in the text. The value shown in Table 1 under Alternative 4A of $1,100,000 is a typographical error which should read $1,200,000.

Comment 8: In the long term what are the cost differences between alternative 4 and alternative 4a, and does alternative 4a have a higher probability of success?

Response 8: The present worth cost of Alternative 4 and 4A is $830,000 - $980,000 and $1,200,000 - $1,300,000 respectively. Therefore, it is estimated that Alternative 4A will cost approximately $320,000 - $370,000 more.

The White Oak BCT believes that Alternative 4A, with pneumatic fracturing of the rock will have a much higher degree of success than Alternative 4. As previously explained, in fractured bedrock the native fractures are typically random, causing preferential groundwater flow paths which tends to isolate pockets of contamination. By expanding the already existing bedrock fractures using pneumatic fracturing, and focusing the injection of chemical oxidant in these fractures, the transport limitations inherent in fractured bedrock are somewhat overcome, which provides for a greater possibility of accessing these previously restricted pockets of contamination and thus enhancing the overall effectiveness of the treatment.

Written Questions and Comments Received During the 30-Day Public Comment Period (July 1 – July 30, 2004)

Comment 9: If you use potassium permanganate to oxidize the chlorinated compounds, what is the fate of the manganese? Can't manganese be a contaminant of concern also.

Response 9: See response to Comment 1

LIST OF ACRONYMS AND ABBREVIATIONS

AEDC	Arnold Engineering Development Center
ARAR	Applicable or relevant and appropriate requirement
BCT	BRAC clean-up team
BERA	Baseline ecological risk assessment
bgs	Below ground surface
BRAC	Base realignment and closure
B&R Environmental	Brown & Root Environmental
CDI	Chronic daily intake
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CMS	Corrective measures study
COC	Chemical of concern
COPC	Chemicals of potential concern
CSF	Cancer slope factor
CSM	Conceptual site model
CTE or CT	Central tendency exposure
DCA	Dichloroethane
DCE	Dichloroethylene or Dichloroethene
DO	Dissolved oxygen
EPA	United States Environmental Protection Agency
EPC	Exposure point concentration
FDA	United States Food and Drug Administration
FS	Feasibility study
gpm	Gallon(s) per minute
GSA	General Services Administration
HHRA	Human Health Risk Assessment
HI	Hazard index
HQ	Hazard quotient
HRC®	Hydrogen release compound
ICs	Institutional controls
ILCR	Incremental lifetime cancer risk
IM	Interim measures
IRP	Installation restoration program
ISCO	*In-situ* chemical oxidation
LGAC	Liquid-phase granular activated carbon
LTM	Long-term monitoring
LUCs	Land use controls
MCL	Maximum contaminant level (EPA's)

MDE	Maryland Department of the Environment
mg/L	Milligram(s) per liter
mg/kg	Milligram(s) per kilogram
µg/L	Microgram(s) per liter
µg/kg	Microgram(s) per kilogram
msl	Mean sea level
NAPL	Nonaqueous-phase liquid
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPW	Net present worth
NSWC	Naval Surface Warfare Center
O&M	Operation and maintenance
ORP	Oxidation/reduction potential
PCE	Tetrachloroethylene or Tetrachloroethene
PRG	Preliminary remediation goal
RAB	Restoration Advisory Board
RAO	Remedial action objective
RBC	Risk-based concentration (EPA's)
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfD	Reference dose
RFI	RCRA Feasibility Investigation
RI	Remedial investigation
RME	Reasonable maximum exposure
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act
SSLs	Soil screening levels
SVOC	Semivolatile organic compound
TBC	To be considered (requirement)
TCE	Trichloroethylene or Trichloroethene
TRC	Technical Review Committee
TRZ	Target remediation zone
TTNUS	Tetra Tech NUS, Inc.
UCL	95% Upper Confidence Limit of the Mean
UTL	Upper Tolerance Limit
WSSC	Washington Suburban Sanitation Commission
VOCs	Volatile organic compounds

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Tables

Table 2-1
Samples Evaluated in Human Health Risk Assessment
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Surface Water	Groundwater
PBSW2100001	049GW2020001
PBSW2110001	049GW2029901[2]
PBSW2119901[1]	049GW2030001
PBSW2120001	049GW2000001
PBSW2130001	049GW201S001
	049GW201D001
	049GW2030002
	049GW2020002
	049GW201S002
	049GW201S9902[3]
	049GW2000002
	049GW201D002
	049GW202D001
	049GW206D001
	049GW206D9901[4]
	049GW206M001
	049GW206S0001
	049GW201DD001

[1] duplicate of PBSW2110001
[2] duplicate of 049GW2020001
[3] duplicate of 049GW201S001
[4] duplicate of 049GW206D001

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Bedrock Aquifer - Tap Water	71-55-6	1,1,1-Trichloroethane	1.2 J	1.2 J	UG/L	049GW202D001	1/16	0.5 - 50	1.2		317 N			NO	BSL
	75-34-3	1,1-Dichloroethane	1.1	1.9 K	UG/L	049GW201D002	2/16	0.5 - 50	1.9		79.8 N			NO	BSL
	75-35-4	1,1-Dichloroethene	0.21 J	11 K	UG/L	049GW201D002	7/16	0.5 - 50	11		35.3 N			NO	BSL
	106-93-4	1,2-Dibromoethane	65 J	65 J	UG/L	049GW2000001	1/16	0.5 - 50	65		7.52E-04 C			YES	ASL
	67-64-1	Acetone	2.7 J	2.7 J	UG/L	049GW2029901	1/8	5 - 250	2.7		550 N			NO	BSL
	75-25-2	Bromoform	0.23 J	0.23 J	UG/L	049GW2029901	1/16	0.5 - 50	0.23		8.48 C			NO	BSL
	74-83-9	Bromomethane	0.26 K	0.26 K	UG/L	049GW201D002	1/16	0.5 - 50	0.26		0.852 N			NO	BSL
	67-66-3	Chloroform	2.6 J	37	UG/L	049GW206D001 049GW206D9901	4/16	0.5 - 50	37		0.15 C			YES	ASL
	110-82-7	Cyclohexane	0.88 J	0.88 J	UG/L	049GW2020001	1/16	0.5 - 50	0.88		1,200 N			NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	1.3 J	1.3 J	UG/L	049GW206D001	1/16	0.5 - 50	1.3		2.6 C			NO	BSL
	100-42-5	Styrene	41 J	41 J	UG/L	049GW2000001	1/16	0.5 - 50	41		162 N			NO	BSL
	127-18-4	Tetrachloroethene	0.48 J	1.1 J	UG/L	049GW206S0001	2/16	0.5 - 50	1.1		0.1 C			YES	ASL
	108-88-3	Toluene	1.5 J	1.8 J	UG/L	049GW201DD001	2/16	0.5 - 50	1.8		74.7 N			NO	BSL
	79-01-6	Trichloroethene	6.5 J	4,400	UG/L	049GW201D002	16/16	0.5 - 100	4400		0.026 C			YES	ASL
	75-01-4	Vinyl chloride	0.57	5.7 K	UG/L	049GW201D002	4/16	0.5 - 50	5.7		0.015 C			YES	ASL
	156-59-2	cis-1,2-Dichloroethene	1.3 J	1,100	UG/L	049GW201D002	16/16	0.5 - 50	1100		6.08 N			YES	ASL
	156-60-5	trans-1,2-Dichloroethene	3.1 J	46 K	UG/L	049GW201D002	8/16	0.5 - 50	46		12.2 N			YES	ASL
	83-32-9	Acenaphthene	2.8 J	2.8 J	UG/L	049GW2030001	1/4	5.3 - 5.3	2.8		36.5 N			NO	BSL
	131-11-3	Dimethyl phthalate	7.1	7.1	UG/L	049GW2000001	1/4	5.3 - 5.3	7.1		36,500 N			NO	BSL
	85-01-8	Phenanthrene	1.3 J	1.3 J	UG/L	049GW2030001	1/4	5.3 - 5.3	1.3		18.3 N			NO	BSL
	7429-90-5	Aluminum	46 J	6,800	UG/L	049GW206M001	3/10	200 - 200	6800		3,650 N			YES	ASL
	7440-39-3	Barium	24.2 J	101 J	UG/L	049GW2000001	10/10	200 - 200	101		256 N			NO	BSL
	7440-43-9	Cadmium	0.24 J	0.35 J	UG/L	049GW2000001 049GW201S001	3/10	5 - 5	0.35		1.83 N			NO	BSL
	7440-70-2	Calcium	9,140	54,300	UG/L	049GW2000001	10/10	5000 - 5000	54300		NA			NO	NUT
	7440-47-3	Chromium	0.74 J	75.5	UG/L	049GW206M001	3/10	10 - 10	75.5		11.0 N			YES	ASL
	7440-48-4	Cobalt	0.57 J	10.6 J	UG/L	049GW206M001	5/10	50 - 50	10.6		73 N			NO	BSL
	7440-50-8	Copper	6.8 J	28.6	UG/L	049GW206M001	2/10	25 - 25	28.6		146 N			NO	BSL
	7439-89-6	Iron	42.7 J	14,100	UG/L	049GW206M001	8/10	100 - 100	14100		1,100 N			YES	ASL
	7439-92-1	Lead	2.9 J	13.9 L	UG/L	049GW202D001	4/10	3 - 10	13.9		15			NO	BSL
	7439-95-4	Magnesium	4,360 J	13,800	UG/L	049GW2000001	10/10	5000 - 5000	13800		NA			NO	NUT
	7439-96-5	Manganese	17.1	2,290	UG/L	049GW2030001	10/10	15 - 15	2290		73 N			YES	ASL
	7440-02-0	Nickel	2.8 J	81	UG/L	049GW206M001	9/10	40 - 40	81		73 N			YES	ASL
	7440-09-7	Potassium	3,240 J	11,300	UG/L	049GW206M001	10/10	5000 - 5000	11300		NA			NO	NUT
	7782-49-2	Selenium	5.3	5.3	UG/L	049GW206D001	1/10	5 - 5	5.3		18.3 N			NO	BSL
	7440-23-5	Sodium	11,800	132,000 K	UG/L	049GW206D001	10/10	5000 - 5000	132000		NA			NO	NUT
	7440-62-2	Vanadium	10 J	20.6 J	UG/L	049GW206D001	2/10	50 - 50	20.6		3.7 N			YES	ASL
	7440-66-6	Zinc	8.6 J	47.5	UG/L	049GW2020001	5/10	20 - 20	47.5		1,095 N			NO	BSL

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Bedrock Aquifer - Water in Excavation Pit	71-55-6	1,1,1-Trichloroethane	1.2 J	1.2 J	UG/L	049GW202D001	1/16	0.5 - 50	1.2		317 N			NO	BSL
	75-34-3	1,1-Dichloroethane	1.1	1.9 K	UG/L	049GW201D002	2/16	0.5 - 50	1.9		79.8 N			NO	BSL
	75-35-4	1,1-Dichloroethene	0.21 J	11 K	UG/L	049GW201D002	7/16	0.5 - 50	11		35.3 N			NO	BSL
	106-93-4	1,2-Dibromoethane	65 J	65 J	UG/L	049GW2000001	1/16	0.5 - 50	65		7.52E-04 C			YES	ASL
	67-64-1	Acetone	2.7 J	2.7 J	UG/L	049GW2029901	1/8	5 - 250	2.7		550 N			NO	BSL
	75-25-2	Bromoform	0.23 J	0.23 J	UG/L	049GW2029901	1/16	0.5 - 50	0.23		8.48 C			NO	BSL
	74-83-9	Bromomethane	0.26 K	0.26 K	UG/L	049GW201D002	1/16	0.5 - 50	0.26		0.852 N			NO	BSL
	67-66-3	Chloroform	2.6 J	37	UG/L	049GW206D001 049GW206D9901	4/16	0.5 - 50	37		0.15 C			YES	ASL
	110-82-7	Cyclohexane	0.88 J	0.88 J	UG/L	049GW2020001	1/16	0.5 - 50	0.88		1,200 N			NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	1.3 J	1.3 J	UG/L	049GW206D001	1/16	0.5 - 50	1.3		2.6 C			NO	BSL
	100-42-5	Styrene	41 J	41 J	UG/L	049GW2000001	1/16	0.5 - 50	41		162 N			NO	BSL
	127-18-4	Tetrachloroethene	0.48 J	1.1 J	UG/L	049GW206S0001	2/16	0.5 - 50	1.1		0.1 C			YES	ASL
	108-88-3	Toluene	1.5 J	1.8 J	UG/L	049GW201DD001	2/16	0.5 - 50	1.8		74.7 N			NO	BSL
	79-01-6	Trichloroethene	6.5 J	4,400	UG/L	049GW201D002	16/16	0.5 - 100	4400		0.026 C			YES	ASL
	75-01-4	Vinyl chloride	0.57	5.7 K	UG/L	049GW201D002	4/16	0.5 - 50	5.7		0.015 C			YES	ASL
	156-59-2	cis-1,2-Dichloroethene	1.3 J	1,100	UG/L	049GW201D002	16/16	0.5 - 50	1100		6.08 N			YES	ASL
	156-60-5	trans-1,2-Dichloroethene	3.1 J	46 K	UG/L	049GW201D002	8/16	0.5 - 50	46		12.2 N			YES	ASL
	83-32-9	Acenaphthene	2.8 J	2.8 J	UG/L	049GW2030001	1/4	5.3 - 5.3	2.8		36.5 N			NO	BSL
	131-11-3	Dimethyl phthalate	7.1	7.1	UG/L	049GW2000001	1/4	5.3 - 5.3	7.1		36,500 N			NO	BSL
	85-01-8	Phenanthrene	1.3 J	1.3 J	UG/L	049GW2030001	1/4	5.3 - 5.3	1.3		18.3 N			NO	BSL
	7429-90-5	Aluminum	88.8 J	35,600 J	UG/L	049GW206M001	7/10	200 - 200	35600		3,650 N			YES	ASL
	7440-38-2	Arsenic	2.8 J	8.7 J	UG/L	049GW206M001	3/10	10 - 10	8.7		0.0446 C			YES	ASL
	7440-39-3	Barium	26.6 J	225 J	UG/L	049GW206M001	10/10	200 - 200	225		256 N			NO	BSL
	7440-41-7	Beryllium	0.14 J	1.9 J	UG/L	049GW206M001	4/10	5 - 5	1.9		7.3 N			NO	BSL
	7440-43-9	Cadmium	0.21 J	0.46 J	UG/L	049GW2000001	2/10	5 - 5	0.46		1.83 N			NO	BSL
	7440-70-2	Calcium	8,510 J	54,700 J	UG/L	049GW2000001	10/10	5000 - 5000	54700		NA			NO	NUT
	7440-47-3	Chromium	12.7 J	910 J	UG/L	049GW2020001	7/10	10 - 10	910		11.0 N			YES	ASL
	7440-48-4	Cobalt	0.71 J	42.5 J	UG/L	049GW206M001	8/10	50 - 50	42.5		73 N			NO	BSL
	7440-50-8	Copper	10.2 J	166 J	UG/L	049GW206M001	4/10	25 - 25	166		146 N			YES	ASL
	7439-89-6	Iron	778 J	72,400 J	UG/L	049GW206M001	8/10	100 - 100	72400		1,100 N			YES	ASL
	7439-92-1	Lead	4.7 J	20.3 J	UG/L	049GW202D001	5/10	3 - 10	20.3		15			YES	ASL
	7439-95-4	Magnesium	4,150 J	19,600 J	UG/L	049GW206M001	10/10	5000 - 5000	19600		NA			NO	NUT
	7439-96-5	Manganese	9.1 J	2,250 J	UG/L	049GW2030001	10/10	15 - 15	2250		73 N			YES	ASL
	7440-02-0	Nickel	10.8 J	625 J	UG/L	049GW2020001	9/10	40 - 40	625		73 N			YES	ASL
	7440-09-7	Potassium	3,320 J	21,900 J	UG/L	049GW206M001	10/10	5000 - 5000	21900		NA			NO	NUT
	7782-49-2	Selenium	4.8 J	4.8 J	UG/L	049GW206D001	1/10	5 - 5	4.8		18.3 N			NO	BSL
	7440-23-5	Sodium	11,300 J	136,000 J	UG/L	049GW206D001	10/10	5000 - 5000	136000		NA			NO	NUT
	7440-62-2	Vanadium	0.9 J	62.5 J	UG/L	049GW206M001	7/10	50 - 50	62.5		3.7 N			YES	ASL
	7440-66-6	Zinc	12.3 J	185 J	UG/L	049GW206M001	8/10	20 - 20	185		1,095 N			NO	BSL

Table 2.2

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection

A review of the filtered and unfiltered data determined there was a notable disparity, therefore, the filtered results were used for the tap water exposure.
Total metals used for water in the excavation pit because the Construction Worker would not be exposed to water that was filtered.

[1] Minimum/Maximum detected concentrations.
[2] Maximum concentration is used for screening.
[3] Background values not available.
[4] Risk-Based Concentration Table, April 14, 2004, U.S. EPA Region III, Jennifer Hubbard. Tap Water RBC.
RBC value for pyrene used as surrogate for phenanthrene.
RBC value for Chromium VI used for total chromium.
Lead screening toxicity value is 15 ug/L, the EPA tap water screening level for lead.
RBC value for manganese-nonfood used as surrogate for manganese.
RBC value for Chromium VI used for total chromium.
[5] Lead screening toxicity value is 400 mg/kg, the EPA residential soil screening level for lead.

Rationale Codes

Selection Reason: Above Screening Levels (ASL)
Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered
J = Estimated Value
K = Biased High
L = Biased Low
C = Carcinogenic
N = Noncarcinogenic

Table 2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection
Bedrock Aquifer - Water Vapors at Showerhead	71-55-6	1,1,1-Trichloroethane	1.2 J	1.2 J	UG/L	049GW202D001	1/16	0.5 - 50	1.2		317 N			NO	BSL
	75-34-3	1,1-Dichloroethane	1.1	1.9 K	UG/L	049GW201D002	2/16	0.5 - 50	1.9		79.8 N			NO	BSL
	75-35-4	1,1-Dichloroethene	0.21 J	11 K	UG/L	049GW201D002	7/16	0.5 - 50	11		35.3 N			NO	BSL
	106-93-4	1,2-Dibromoethane	65 J	65 J	UG/L	049GW2000001	1/16	0.5 - 50	65		7.52E-04 C			YES	ASL
	67-64-1	Acetone	2.7 J	2.7 J	UG/L	049GW2029901	1/8	5 - 250	2.7		550 N			NO	BSL
	75-25-2	Bromoform	0.23 J	0.23 J	UG/L	049GW2029901	1/16	0.5 - 50	0.23		8.48 C			NO	BSL
	74-83-9	Bromomethane	0.26 K	0.26 K	UG/L	049GW201D002	1/16	0.5 - 50	0.26		0.852 N			NO	BSL
	67-66-3	Chloroform	2.6 J	37	UG/L	049GW206D001 049GW206D9901	4/16	0.5 - 50	37		0.15 C			YES	ASL
	110-82-7	Cyclohexane	0.88 J	0.88 J	UG/L	049GW2020001	1/16	0.5 - 50	0.88		1200 N			NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	1.3 J	1.3 J	UG/L	049GW206D001	1/16	0.5 - 50	1.3		2.6 C			NO	BSL
	100-42-5	Styrene	41 J	41 J	UG/L	049GW2000001	1/16	0.5 - 50	41		162 N			NO	BSL
	127-18-4	Tetrachloroethene	0.48 J	1.1 J	UG/L	049GW206S0001	2/16	0.5 - 50	1.1		0.1 C			YES	ASL
	108-88-3	Toluene	1.5 J	1.8 J	UG/L	049GW201DD001	2/16	0.5 - 50	1.8		74.7 N			NO	BSL
	79-01-6	Trichloroethene	6.5 J	4,400	UG/L	049GW201D002	16/16	0.5 - 100	4400		0.026 C			YES	ASL
	75-01-4	Vinyl chloride	0.57	5.7 K	UG/L	049GW201D002	4/16	0.5 - 50	5.7		0.015 C			YES	ASL
	156-59-2	cis-1,2-Dichloroethene	1.3 J	1,100	UG/L	049GW201D002	16/16	0.5 - 50	1100		6.08 N			YES	ASL
	156-60-5	trans-1,2-Dichloroethene	3.1 J	46 K	UG/L	049GW201D002	8/16	0.5 - 50	46		12.2 N			YES	ASL
	83-32-9	Acenaphthene	2.8 J	2.8 J	UG/L	049GW2030001	1/4	5.3 - 5.3	2.8		36.5 N			NO	BSL
Bedrock Aquifer - Water Vapors at Excavation	71-55-6	1,1,1-Trichloroethane	1.2 J	1.2 J	UG/L	049GW202D001	1/16	0.5 - 50	1.2		317 N			NO	BSL
	75-34-3	1,1-Dichloroethane	1.1	1.9 K	UG/L	049GW201D002	2/16	0.5 - 50	1.9		79.8 N			NO	BSL
	75-35-4	1,1-Dichloroethene	0.21 J	11 K	UG/L	049GW201D002	7/16	0.5 - 50	11		35.3 N			NO	BSL
	106-93-4	1,2-Dibromoethane	65 J	65 J	UG/L	049GW2000001	1/16	0.5 - 50	65		7.52E-04 C			YES	ASL
	67-64-1	Acetone	2.7 J	2.7 J	UG/L	049GW2029901	1/8	5 - 250	2.7		550 N			NO	BSL
	75-25-2	Bromoform	0.23 J	0.23 J	UG/L	049GW2029901	1/16	0.5 - 50	0.23		8.48 C			NO	BSL
	74-83-9	Bromomethane	0.26 K	0.26 K	UG/L	049GW201D002	1/16	0.5 - 50	0.26		0.852 N			NO	BSL
	67-66-3	Chloroform	2.6 J	37	UG/L	049GW206D001 049GW206D9901	4/16	0.5 - 50	37		0.15 C			YES	ASL
	110-82-7	Cyclohexane	0.88 J	0.88 J	UG/L	049GW2020001	1/16	0.5 - 50	0.88		1200 N			NO	BSL
	1634-04-4	Methyl-tert-butyl ether (MTBE)	1.3 J	1.3 J	UG/L	049GW206D001	1/16	0.5 - 50	1.3		2.6 C			NO	BSL
	100-42-5	Styrene	41 J	41 J	UG/L	049GW2000001	1/16	0.5 - 50	41		162 N			NO	BSL
	127-18-4	Tetrachloroethene	0.48 J	1.1 J	UG/L	049GW206S0001	2/16	0.5 - 50	1.1		0.1 C			YES	ASL
	108-88-3	Toluene	1.5 J	1.8 J	UG/L	049GW201DD001	2/16	0.5 - 50	1.8		74.7 N			NO	BSL
	79-01-6	Trichloroethene	6.5 J	4,400	UG/L	049GW201D002	16/16	0.5 - 100	4400		0.026 C			YES	ASL
	75-01-4	Vinyl chloride	0.57	5.7 K	UG/L	049GW201D002	4/16	0.5 - 50	5.7		0.015 C			YES	ASL
	156-59-2	cis-1,2-Dichloroethene	1.3 J	1,100	UG/L	049GW201D002	16/16	0.5 - 50	1100		6.08 N			YES	ASL
	156-60-5	trans-1,2-Dichloroethene	3.1 J	46 K	UG/L	049GW201D002	8/16	0.5 - 50	46		12.2 N			YES	ASL
	83-32-9	Acenaphthene	2.8 J	2.8 J	UG/L	049GW2030001	1/4	5.3 - 5.3	2.8		36.5 N			NO	BSL

Table 2.3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Point	CAS Number	Chemical	Minimum [1] Concentration Qualifier	Maximum [1] Concentration Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Detection Limits	Concentration [2] Used for Screening	Background [3] Value	Screening [4] Toxicity Value	Potential ARAR/TBC Value	Potential ARAR/TBC Source	COPC Flag	Rationale for [5] Contaminant Deletion or Selection

[1] Minimum/Maximum detected concentrations.

[2] Maximum concentration is used for screening.

[3] Background values not available.

[4] Risk-Based Concentration Table, April 25, 2003, U.S. EPA Region III, Jennifer Hubbard. Tap Water RBC.

RBC value for hexane used as surrogate for cyclohexane.

RBC value for pyrene used as surrogate for phenanthrene.

RBC value for Chromium VI used for total chromium.

Lead screening toxicity value is 15 ug/L, the EPA tap water screening level for lead.

RBC value for manganese-nonfood used as surrogate for manganese.

RBC value for Chromium VI used for total chromium.

[5] Lead screening toxicity value is 400 mg/kg, the EPA residential soil screening level for lead.

Rationale Codes

Selection Reason: Above Screening Levels (ASL)

Deletion Reason: No Toxicity Information (NTX)
Essential Nutrient (NUT)
Below Screening Level (BSL)

SQL = Sample Quantification Limit

COPC = Chemical of Potential Concern

ARAR/TBC = Applicable or Relevant and Appropriate Requirement/ To Be Considered

J = Estimated Value

K = Biased High

L = Biased Low

C = Carcinogenic

N = Noncarcinogenic

TABLE 2.4.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR ADULT RESIDENTS
REASONABLE MAXIMUM EXPOSURE
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane					NA	NA		NA	0.0E+00
			Chloroform					Liver	6.8E-02		6.2E-03	7.4E-02
			Tetrachloroethene					Liver,Weight Gain	3.0E-03		1.8E-03	4.8E-03
			Trichloroethene					Liver, Kidney, Fetus	2.0E+01		3.5E+00	2.4E+01
			Vinyl chloride					Liver	5.2E-02		4.6E-03	5.7E-02
			cis-1,2-Dichloroethene					Blood	3.0E+00		2.7E-01	3.3E+00
			trans-1,2-Dichloroethene					Blood	4.3E-02		3.9E-03	4.7E-02
			Aluminum					Central Nervous System	1.4E-01		7.1E-04	1.4E-01
			Chromium					NOAEL	6.9E-01		2.9E-01	9.8E-01
			Iron					Gastrointestinal	1.3E+00		6.7E-03	1.3E+00
			Manganese					Central Nervous System	3.1E+00		4.1E-01	3.5E+00
			Nickel					Decreased Weight	7.9E-02		2.1E-03	8.1E-02
			Vanadium					Kidney	4.6E-01		9.2E-02	5.5E-01
			Chemical Total						2.9E+01		4.6E+00	3.4E+01
		Exposure Point Total					0.0E+00					3.4E+01
	Exposure Medium Total						0.0E+00					3.4E+01
Groundwater	Air	Bedrock Aquifer - Water Vapors at Showerhead	1,2-Dibromoethane					Sperm		1.6E-02		1.6E-02
			Chloroform					Liver, Kidney		9.1E-05		9.1E-05
			Tetrachloroethene					Liver, Whole Body		3.8E-07		3.8E-07
			Trichloroethene					NA		NA		0.0E+00
			Vinyl chloride					Liver		1.4E-05		1.4E-05
			cis-1,2-Dichloroethene					NA		NA		0.0E+00
			trans-1,2-Dichloroethene					NA		NA		0.0E+00
			Chemical Total							1.7E-02		1.7E-02
		Exposure Point Total					0.0E+00					1.7E-02
	Exposure Medium Total						0.0E+00					1.7E-02
Medium Total							0.0E+00					3.4E+01
Receptor Total							0.0E+00				Receptor HI Total	3.4E+01

TABLE 2.4.

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR ADULT RESIDENTS

REASONABLE MAXIMUM EXPOSURE

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Total Liver HI Across All Media =	2.4E+01
Total Weight Gain HI Across All Media =	4.8E-03
Total Kidney HI Across All Media =	2.4E+01
Total Blood HI Across All Media =	3.3E+00
Total CNS HI Across All Media =	3.7E+00
Total NOAEL HI Across All Media =	9.8E-01
Total Gastrointestinal HI Across All Media =	1.3E+00
Total Decreased Weight HI Across All Media =	8.1E-02
Total Sperm HI Across All Media =	1.6E-02
Total Whole Body HI Across All Media =	3.8E-07
Total Endocrine System HI Across All Media =	0.0E+00

TABLE 2.5.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CHILD RESIDENTS
REASONABLE MAXIMUM EXPOSURE
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane					NA	NA		NA	0.0E+00
			Chloroform					Liver	1.6E-01		1.4E-02	1.7E-01
			Tetrachloroethene					Liver,Weight Gain	7.0E-03		4.0E-03	1.1E-02
			Trichloroethene					Liver, Kidney, Fetus	4.7E+01		7.8E+00	5.5E+01
			Vinyl chloride					Liver	1.2E-01		1.4E-02	1.4E-01
			cis-1,2-Dichloroethene					Blood	7.0E+00		6.0E-01	7.6E+00
			trans-1,2-Dichloroethene					Blood	1.0E-01		8.7E-03	1.1E-01
			Aluminum					Central Nervous System	3.2E-01		2.1E-03	3.2E-01
			Chromium					NOAEL	1.6E+00		8.5E-01	2.5E+00
			Iron					Gastrointestinal	3.0E+00		2.0E-02	3.0E+00
			Manganese					Central Nervous System	7.3E+00		1.2E+00	8.5E+00
			Nickel					Decreased Weight	1.8E-01		6.1E-03	1.9E-01
			Vanadium					Kidney	1.1E+00		2.7E-01	1.3E+00
			Chemical Total						6.8E+01		1.1E+01	7.9E+01
		Exposure Point Total					0.0E+00					7.9E+01
	Exposure Medium Total						0.0E+00					7.9E+01
Medium Total							0.0E+00					7.9E+01
Receptor Total							0.0E+00				Receptor HI Total	7.9E+01

Total Liver HI Across All Media =	5.5E+01
Total Weight Gain HI Across All Media =	1.1E-02
Total Kidney HI Across All Media =	5.6E+01
Total Blood HI Across All Media =	7.7E+00
Total CNS HI Across All Media =	8.8E+00
Total NOAEL HI Across All Media =	2.5E+00
Total Gastrointestinal HI Across All Media =	3.0E+00
Total Decreased Weight HI Across All Media =	1.9E-01

TABLE 2.6.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR LIFETIME RESIDENTS
REASONABLE MAXIMUM EXPOSURE
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane	4.2E-02		7.9E-02	1.2E-01					
			Chloroform	NA		NA	0.0E+00					
			Tetrachloroethene	8.9E-06		2.4E-04	2.5E-04					
			Trichloroethene	7.2E-04		5.8E-03	6.5E-03					
			Vinyl chloride	3.3E-04		3.6E-05	3.7E-04					
			cis-1,2-Dichloroethene	NA		NA	0.0E+00					
			trans-1,2-Dichloroethene	NA		NA	0.0E+00					
			Aluminum	NA		NA	0.0E+00					
			Chromium	NA		NA	0.0E+00					
			Iron	NA		NA	0.0E+00					
			Manganese	NA		NA	0.0E+00					
			Nickel	NA		NA	0.0E+00					
			Vanadium	NA		NA	0.0E+00					
			Chemical Total	4.3E-02		8.5E-02	1.3E-01					
		Exposure Point Total					1.3E-01					0.0E+00
	Exposure Medium Total						1.3E-01					0.0E+00
Groundwater	Air	Bedrock Aquifer - Water Vapors at Showerhead	1,2-Dibromoethane		2.4E-07		2.4E-07					
			Chloroform		3.5E-08		3.5E-08					
			Tetrachloroethene		3.6E-10		3.6E-10					
			Trichloroethene		4.7E-07		4.7E-07					
			Vinyl chloride		2.0E-09		2.0E-09					
			cis-1,2-Dichloroethene		NA		0.0E+00					
			trans-1,2-Dichloroethene		NA		0.0E+00					
			Chemical Total		7.5E-07		7.5E-07					0.0E+00
		Exposure Point Total					7.5E-07					0.0E+00
	Exposure Medium Total						7.5E-07					0.0E+00
Medium Total							1.3E-01					0.0E+00
Receptor Total							1.3E-01				Receptor HI Total	0.0E+00

TABLE 2.7.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CONSTRUCTION WORKERS
REASONABLE MAXIMUM EXPOSURE
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Water in Excavation Pit	1,2-Dibromoethane			9.4E-05	9.4E-05	NA			NA	0.0E+00
			Chloroform			NA	0.0E+00	Liver			2.7E-03	2.7E-03
			Tetrachloroethene			6.1E-08	6.1E-08	Liver,Weight Gain			7.9E-04	7.9E-04
			Trichloroethene			1.5E-06	1.5E-06	Liver, Kidney, Fetus			1.5E+00	1.5E+00
			Vinyl chloride			2.3E-07	2.3E-07	Liver			7.5E-03	7.5E-03
			cis-1,2-Dichloroethene			NA	0.0E+00	Blood			1.2E-02	1.2E-02
			trans-1,2-Dichloroethene			NA	0.0E+00	Blood			1.7E-04	1.7E-04
			Aluminum			NA	0.0E+00	Central Nervous System			8.4E-03	8.4E-03
			Arsenic			3.6E-08	3.6E-08	Skin, Vascular			5.6E-03	5.6E-03
			Chromium			NA	0.0E+00	NOAEL			8.5E-01	8.5E-01
			Copper			NA	0.0E+00	Gastrointestinal			1.2E-03	1.2E-03
			Iron			NA	0.0E+00	Gastrointestinal			5.7E-02	5.7E-02
			Manganese			NA	0.0E+00	Central Nervous System			6.6E-01	6.6E-01
			Nickel			NA	0.0E+00	Decreased Weight			3.7E-02	3.7E-02
			Vanadium			NA	0.0E+00	Kidney			5.1E-01	5.1E-01
			Chemical Total			9.6E-05	9.6E-05				3.7E+00	3.7E+00
		Exposure Point Total					9.6E-05					3.7E+00
	Exposure Medium Total						9.6E-05					3.7E+00
Groundwater	Air	Bedrock Aquifer - Water Vapors at Excavtion Pit	1,2-Dibromoethane		3.3E-07		3.3E-07	Sperm		5.3E-02		5.3E-02
			Chloroform		2.6E-08		2.6E-08	Liver, Kidney		1.6E-03		1.6E-03
			Tetrachloroethene		2.6E-10		2.6E-10	Liver, Whole Body		6.5E-06		6.5E-06
			Trichloroethene		3.3E-07		3.3E-07	NA		NA		0.0E+00
			Vinyl chloride		1.3E-09		1.3E-09	Liver		2.2E-04		2.2E-04
			cis-1,2-Dichloroethene		NA		0.0E+00	NA		NA		0.0E+00
			trans-1,2-Dichloroethene		NA		0.0E+00	NA		NA		0.0E+00
			Chemical Total		6.9E-07		6.9E-07			5.5E-02		5.5E-02
		Exposure Point Total					6.9E-07					5.5E-02
	Exposure Medium Total						6.9E-07					5.5E-02
Medium Total							9.7E-05					3.7E+00
Receptor Total							9.7E-05				Receptor HI Total	3.7E+00

TABLE 2.7.

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CONSTRUCTION WORKERS

REASONABLE MAXIMUM EXPOSURE

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Total Liver HI Across All Media =	1.6E+00
Total Weight Gain HI Across All Media =	7.9E-04
Total Kidney HI Across All Media =	2.0E+00
Total Blood HI Across All Media =	1.2E-02
Total Skin HI Across All Media =	5.6E-03
Total Vascular HI Across All Media =	5.6E-03
Total CNS HI Across All Media =	9.6E-03
Total NOAEL HI Across All Media =	8.5E-01
Total Gastrointestinal HI Across All Media =	5.8E-02
Total Decreased Weight HI Across All Media =	3.7E-02
Total Sperm HI Across All Media =	5.3E-02
Total Whole Body HI Across All Media =	6.5E-06
Total Endocrine System HI Across All Media =	0.0E+00

TABLE 2.8.

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR ADULT RESIDENT

CENTRAL TENDENCY

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane					NA	NA		NA	0.0E+00
			Chloroform					Liver	2.3E-03		2.0E-04	2.5E-03
			Tetrachloroethene					Liver,Weight Gain	1.5E-03		8.5E-04	2.4E-03
			Trichloroethene					Liver, Kidney, Fetus	4.8E-01		7.8E-02	5.6E-01
			Vinyl chloride					Liver	8.2E-03		4.4E-04	8.6E-03
			cis-1,2-Dichloroethene					Blood	6.1E-02		5.1E-03	6.7E-02
			trans-1,2-Dichloroethene					Blood	2.3E-03		1.9E-04	2.5E-03
			Aluminum					Central Nervous System	6.1E-04		2.0E-06	6.1E-04
			Chromium					NOAEL	6.1E-03		1.6E-03	7.7E-03
			Iron					Gastrointestinal	1.5E-02		5.0E-05	1.5E-02
			Manganese					Central Nervous System	9.6E-02		7.7E-03	1.0E-01
			Nickel					Decreased Weight	6.1E-03		9.9E-05	6.2E-03
			Vanadium					Kidney	9.8E-03		1.2E-03	1.1E-02
			Chemical Total						6.9E-01		9.6E-02	7.9E-01
		Exposure Point Total					0.0E+00					7.9E-01
	Exposure Medium Total						0.0E+00					7.9E-01
Groundwater	Air	Bedrock Aquifer - Water Vapors at Showerhead	1,2-Dibromoethane					Sperm		4.6E-04		4.6E-04
			Chloroform					Liver, Kidney		4.4E-06		4.4E-06
			Tetrachloroethene					Liver, Whole Body		2.7E-07		2.7E-07
			Trichloroethene					NA		NA		0.0E+00
			Vinyl chloride					Liver		3.1E-06		3.1E-06
			cis-1,2-Dichloroethene					NA		NA		0.0E+00
			trans-1,2-Dichloroethene					NA		NA		0.0E+00
			Chemical Total							4.7E-04		4.7E-04
		Exposure Point Total					0.0E+00					4.7E-04
	Exposure Medium Total						0.0E+00					4.7E-04
Medium Total							0.0E+00					7.9E-01
Receptor Total							0.0E+00				Receptor HI Total	7.9E-01

TABLE 2.8.

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR ADULT RESIDENT

CENTRAL TENDENCY

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total

Total Liver HI Across All Media =	5.7E-01
Total Weight Gain HI Across All Media =	2.4E-03
Total Kidney HI Across All Media =	5.6E-01
Total Blood HI Across All Media =	6.9E-02
Total CNS HI Across All Media =	1.0E-01
Total NOAEL HI Across All Media =	7.7E-03
Total Gastrointestinal HI Across All Media =	1.5E-02
Total Decreased Weight HI Across All Media =	6.2E-03
Total Sperm HI Across All Media =	4.6E-04
Total Whole Body HI Across All Media =	2.7E-07
Total Endocrine System HI Across All Media =	0.0E+00

TABLE 2.9.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CHILD RESIDENTS
CENTAL TENDENCY
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane					NA	NA		NA	0.0E+00
			Chloroform					Liver	7.6E-03		3.8E-04	8.0E-03
			Tetrachloroethene					Liver,Weight Gain	5.1E-03		1.7E-03	6.7E-03
			Trichloroethene					Liver, Kidney, Fetus	1.6E+00		1.5E-01	1.8E+00
			Vinyl chloride					Liver	2.7E-02		1.0E-03	2.8E-02
			cis-1,2-Dichloroethene					Blood	2.0E-01		1.0E-02	2.1E-01
			trans-1,2-Dichloroethene					Blood	7.8E-03		3.8E-04	8.1E-03
			Aluminum					Central Nervous System	2.0E-03		4.4E-06	2.0E-03
			Chromium					NOAEL	2.0E-02		3.6E-03	2.4E-02
			Iron					Gastrointestinal	5.1E-02		1.1E-04	5.2E-02
			Manganese					Central Nervous System	3.2E-01		1.7E-02	3.4E-01
			Nickel					Decreased Weight	2.0E-02		2.2E-04	2.1E-02
			Vanadium					Kidney	3.3E-02		2.7E-03	3.5E-02
			Chemical Total						2.3E+00		1.9E-01	2.5E+00
		Exposure Point Total					0.0E+00					2.5E+00
	Exposure Medium Total						0.0E+00					2.5E+00
Medium Total							0.0E+00					2.5E+00
Receptor Total							0.0E+00				Receptor HI Total	2.5E+00

Total Liver HI Across All Media =	1.8E+00
Total Weight Gain HI Across All Media =	6.7E-03
Total Kidney HI Across All Media =	1.8E+00
Total Blood HI Across All Media =	2.2E-01
Total CNS HI Across All Media =	3.4E-01
Total NOAEL HI Across All Media =	2.4E-02
Total Gastrointestinal HI Across All Media =	5.2E-02
Total Decreased Weight HI Across All Media =	2.1E-02

TABLE 2.10.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR LIFETIME RESIDENTS
CENTRAL TENDENCY
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Tap Water	1,2-Dibromoethane	6.3E-04		4.3E-04	1.1E-03					
			Chloroform	NA		NA	0.0E+00					
			Tetrachloroethene	3.4E-06		6.5E-05	6.9E-05					
			Trichloroethene	1.3E-05		7.3E-05	8.7E-05					
			Vinyl chloride	9.9E-05		3.8E-06	1.0E-04					
			cis-1,2-Dichloroethene	NA		NA	0.0E+00					
			trans-1,2-Dichloroethene	NA		NA	0.0E+00					
			Aluminum	NA		NA	0.0E+00					
			Chromium	NA		NA	0.0E+00					
			Iron	NA		NA	0.0E+00					
			Manganese	NA		NA	0.0E+00					
			Nickel	NA		NA	0.0E+00					
			Kidney	NA		NA	0.0E+00					
			Chemical Total	7.4E-04		5.7E-04	1.3E-03					
		Exposure Point Total					1.3E-03					0.0E+00
	Exposure Medium Total						1.3E-03					0.0E+00
Groundwater	Air	Bedrock Aquifer - Water Vapors at Showerhead	1,2-Dibromoethane		NA		0.0E+00					
			Chloroform		6.4E-10		6.4E-10					
			Tetrachloroethene		9.8E-11		9.8E-11					
			Trichloroethene		6.1E-09		6.1E-09					
			Vinyl chloride		1.7E-10		1.7E-10					
			cis-1,2-Dichloroethene		NA		0.0E+00					
			trans-1,2-Dichloroethene		NA		0.0E+00					
			Chemical Total		7.0E-09		7.0E-09					0.0E+00
		Exposure Point Total					7.0E-09					0.0E+00
	Exposure Medium Total						7.0E-09					0.0E+00
Medium Total							1.3E-03					0.0E+00
Receptor Total							1.3E-03				Receptor HI Total	0.0E+00

TABLE 2.11.
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CONSTRUCTION WORKERS
CENTRAL TENDENCY
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Bedrock Aquifer - Water in Excavation Pit	1,2-Dibromoethane			2.0E-06	2.0E-06	NA			NA	0.0E+00
			Chloroform			NA	0.0E+00	Liver			1.4E-04	1.4E-04
			Tetrachloroethene			4.7E-08	4.7E-08	Liver,Weight Gain			6.1E-04	6.1E-04
			Trichloroethene			5.3E-08	5.3E-08	Liver, Kidney, Fetus			5.6E-02	5.6E-02
			Vinyl chloride			3.9E-08	3.9E-08	Liver			1.3E-03	1.3E-03
			cis-1,2-Dichloroethene			NA	0.0E+00	Blood			3.6E-04	3.6E-04
			trans-1,2-Dichloroethene			NA	0.0E+00	Blood			1.4E-05	1.4E-05
			Aluminum			NA	0.0E+00	Central Nervous System			7.7E-05	7.7E-05
			Arsenic			5.1E-09	5.1E-09	Skin, Vascular			8.0E-04	8.0E-04
			Chromium			NA	0.0E+00	NOAEL			7.0E-03	7.0E-03
			Copper			NA	0.0E+00	Gastrointestinal			1.8E-05	1.8E-05
			Iron			NA	0.0E+00	Gastrointestinal			7.7E-04	7.7E-04
			Manganese			NA	0.0E+00	Central Nervous System			2.8E-02	2.8E-02
			Nickel			NA	0.0E+00	Decreased Weight			6.9E-04	6.9E-04
			Vanadium			NA	0.0E+00	Kidney			1.1E-02	1.1E-02
			Chemical Total			2.1E-06	2.1E-06				1.1E-01	1.1E-01
		Exposure Point Total					2.1E-06					1.1E-01
	Exposure Medium Total						2.1E-06					1.1E-01
Groundwater	Air	Bedrock Aquifer - Water Vapors at Excavtion Pit	1,2-Dibromoethane		6.8E-09		6.8E-09	Sperm		1.1E-03		1.1E-03
			Chloroform		9.2E-10		9.2E-10	Liver, Kidney		5.7E-05		5.7E-05
			Tetrachloroethene		7.0E-11		7.0E-11	Liver, Whole Body		3.5E-06		3.5E-06
			Trichloroethene		5.7E-07		5.7E-07	NA		NA		0.0E+00
			Vinyl chloride		2.2E-10		2.2E-10	Liver		3.6E-05		3.6E-05
			cis-1,2-Dichloroethene		NA		0.0E+00	NA		NA		0.0E+00
			trans-1,2-Dichloroethene		NA		0.0E+00	NA		NA		0.0E+00
			Chemical Total		5.8E-07		5.8E-07			1.2E-03		1.2E-03
		Exposure Point Total					5.8E-07					1.2E-03
	Exposure Medium Total						5.8E-07					1.2E-03
Medium Total							2.7E-06					1.1E-01
Receptor Total							2.7E-06				Receptor HI Total	1.1E-01

TABLE 2.11.

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs IN GROUNDWATER FOR CONSTRUCTION WORKERS

CENTRAL TENDENCY

Site 49 ROD

NSWC - White Oak

Silver Spring, Maryland

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk				Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
											Total Liver HI Across All Media =	5.8E-02
											Total Weight Gain HI Across All Media =	6.1E-04
											Total Kidney HI Across All Media =	6.7E-02
											Total Blood HI Across All Media =	3.8E-04
											Total Skin HI Across All Media =	8.0E-04
											Total Vascular HI Across All Media =	8.0E-04
											Total CNS HI Across All Media =	9.5E-05
											Total NOAEL HI Across All Media =	7.0E-03
											Total Gastrointestinal HI Across All Media =	7.9E-04
											Total Decreased Weight HI Across All Media =	6.9E-04
											Total Sperm HI Across All Media =	1.1E-03
											Total Whole Body HI Across All Media =	3.5E-06
											Total Endocrine System HI Across All Media =	0.0E+00

Table 2-12
Preliminary Remediation Goals
Groundwater
Adult Residential Scenario
White Oak Site 49 ROD

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Noncarcinogen Screen PRG (mg/kg)	Noncarcinogen Screen Target HQ[1] (mg/kg)
VOCs							
1,2-Dibromoethane	NA	NA	5.70E-05	reproductive	2.8E-06	1.4E+00	1.00
Chloroform	1.00E-02	1.00E-02	8.60E-05	liver, kidney	5.9E-06	6.6E-02	0.25
cis-1,2-Dichloroethene	1.00E-02	1.00E-02	NA	blood	3.9E-05	1.3E-01	0.50
trans-1,2-Dichloroethene	2.00E-02	2.00E-02	NA	blood	1.1E-05	3.3E-01	0.50
Tetrachloroethene	1.00E-02	1.00E-02	1.40E-01	liver	3.4E-06	8.8E-02	0.25
Trichloroethene	6.00E-03	4.80E-03	NA	liver, kidney	5.8E-06	5.1E-02	0.25
Vinyl Chloride	3.00E-03	3.00E-03	2.80E-02	liver	5.8E-06	2.6E-02	0.25
Metals							
Aluminium	1.00E+00	1.00E+00	NV	CNS	2.0E-07	1.8E+01	0.50
Chromium	3.00E-03	3.00E-03	NV	NOAEL	4.0E-07	1.1E-01	1.00
Iron	3.00E-01	3.00E-01	NV	GI	2.0E-07	1.1E+01	1.00
Manganese	2.00E-02	8.00E-04	NV	CNS	2.0E-07	3.5E-01	0.50
Nickel	2.00E-02	8.00E-04	NV	decreased weight	4.0E-08	7.2E-01	1.00

Noncarcinogenic calculations:

Groundwater Risk-Based PRG (mg/L) = $\frac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn + Cn)}$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

Cn = 1/RfDi x Shower Exposure

EXPOSURE ASSUMPTIONS

BW - Body weight (kilograms)
ATnc - Averaging time for noncarcinogens (days)
ATc - Averaging time for carcinogens (days)
EF - Exposure frequency (days/year)
ED - Exposure duration (year)
IR - Ingestion rate (L/day)
SA - Skin surface area (cm^2)

NA - No reference dose or slope factor available.
NV - Not volatile.
1 Applicable HQ calculated so that total HQ for a target organ does not exceed 1.

Table 2-13
Preliminary Remediation Goals
Groundwater
Child Residential Scenario
White Oak Site 49 ROD

Chemical	Chronic Oral RfD (RfDo) (mg/kg-day)	Chronic Dermal RfD (RfDd) (mg/kg-day)	Chronic Inhalation RfD (RfDi) (mg/kg-day)	Target Organ	DAevent (L/cm^2-day)	Noncarcinogen PRG PRG (mg/kg)	Noncarcinogen PRG Target HQ[1] (mg/kg)
VOCs							
1,2-Dibromoethane	NA	NA	5.70E-05	reproductive	3.5E-06		
Chloroform	1.00E-02	1.00E-02	8.60E-05	liver, kidney	7.6E-06	3.7E-02	0.25
cis-1,2-Dichloroethene	1.00E-02	1.00E-02	NA	blood	5.0E-05	5.6E-02	0.50
trans-1,2-Dichloroethene	2.00E-02	2.00E-02	NA	blood	1.5E-05	1.4E-01	0.50
Tetrachloroethane	1.00E-02	1.00E-02	1.40E-01	liver	4.4E-06	3.8E-02	0.25
Trichloroethene	6.00E-03	4.80E-03	NA	liver, kidney	7.4E-06	2.2E-02	0.25
Vinyl Chloride	3.00E-03	3.00E-03	2.80E-02	liver	7.4E-06	1.1E-02	0.25
Metals							
Aluminium	1.00E+00	1.00E+00	NV	CNS	3.3E-07	7.8E+00	0.50
Chromium	3.00E-03	3.00E-03	NV	NOAEL	6.6E-07	4.7E-02	1.00
Iron	3.00E-01	3.00E-01	NV	NOAEL	3.3E-07	4.7E+00	1.00
Manganese	2.00E-02	8.00E-04	NV	GI	3.3E-07	1.5E-01	0.50
Nickel	2.00E-02	8.00E-04	NV	CNS	6.6E-08	3.1E-01	1.00

Noncarcinogenic calculations:

Groundwater Risk-Based PRG (mg/L) $= \dfrac{THQ \times BW \times AT_n}{EF \times ED \times (An + Bn)}$

An = 1/RfDo x IR

Bn = 1/RfDd x SA x DAevent

EXPOSURE ASSUMPTIONS	
BW - Body weight (kilograms)	15
ATnc - Averaging time for noncarcinogens (days)	2,190
ATc - Averaging time for carcinogens (days)	25,550
EF - Exposure frequency (days/year)	350
ED - Exposure duration (year)	6
IR - Ingestion rate (L/day)	1
SA - Skin surface area (cm^2)	7,930

NA - No reference dose or slope factor available.
NV - Not volatile.
1 Applicable HQ calculated so that total HQ for a target organ does not exceed 1.

Table 2.14
Preliminary Remediation Goals
Groundwater
Lifetime Residential Scenario
White Oak Site 49 ROD

Chemical	Oral Slope Factor (CSFo) (kg-day/mg)	Dermal Slope Factor (CSFd) (kg-day/mg)	Inhalation Slope Factor (CSFi) (kg-day/mg)	DAevent-a (L/cm^2-day)	DAevent-c (L/cm^2-day)	Shower Exposure (L/day)	Carcinogen Screening Value Risk = 1E-06 (mg/L)	Risk = 1E-05 (mg/L)	Risk = 1E-04 (mg/L)
VOCs									
1,2-Dibromoethane	8.50E+01	8.5E+01	7.60E-01	2.8E-06	3.5E-06	3.0E-03	7.7E-07	7.7E-06	7.7E-05
Chloroform	NA	NA	8.10E-02	5.9E-06	7.6E-06	5.4E-03	4.9E-01	4.9E+00	4.9E+01
cis-1,2-Dichloroethene	NA	NA	NA	3.9E-05	5.0E-05	6.1E-03			
trans-1,2-Dichloroethene	NA	NA	NA	1.1E-05	1.5E-05	6.1E-03			
Tetrachloroethene	5.40E-01	5.4E-01	2.00E-02	3.4E-06	4.4E-06	5.0E-03	1.2E-04	1.2E-03	1.2E-02
Trichloroethene	1.10E-02	1.1E-02	6.00E-03	5.8E-06	7.4E-06	5.5E-03	5.7E-03	5.7E-02	5.7E-01
Vinyl Chloride	1.40E+00	1.4E+00	3.10E-02	5.8E-06	7.4E-06	7.2E-03	4.5E-05	4.5E-04	4.5E-03
Metals									
Aluminium	NA	NA	NV	2.0E-07	3.3E-07				
Chromium	NA	NA	NV	4.0E-07	6.6E-07				
Iron	NA	NA	NV	2.0E-07	3.3E-07				
Manganese	NA	NA	NV	2.0E-07	3.3E-07				
Nickel	NA	NA	NV	4.0E-08	6.6E-08				

Carcinogen calculations:

Groundwater Risk-Based PRG (mg/L) = $\frac{TR \times AT_c}{EF \times (Ac + Bc + Cc)}$

Ac = CSFo x IRadj

Bc = CSFd x [(SAa x DAevent-a x EDa)/BWa + (SAc x DAevent-c X EDc)/BWc]

Cc = CSFi x Shower Exposure x EDa x 1/BWa

EXPOSURE ASSUMPTIONS	Lifetime	Adult (a)	Child (c)
BW - Body weight (kilograms)		70	15
ATnc - Averaging time for noncarcinogens (days)		8,760	2,190
ATc - Averaging time for carcinogens (days)		25,550	25,550
EF - Exposure frequency (days/year)		350	350
ED - Exposure duration (year)		24	6
IR - Ingestion rate (L/day)		2	1
IRdj - Ingestion rate (L-year/kg-day)	1.09		
SA - Skin surface area (cm^2)		20,000	7,930
ET - Exposure Time (hours/day)		0.20	0.33

NA - No reference dose or slope factor available.

Table 2.15
Preliminary Remediation Goals
Groundwater
Residential Scenario
White Oak Site 49 ROD

Chemical	Risk-Based PRG		MCL (mg/L)
	Value (mg/L)	Basis	
VOCs			
1,2-Dibromoethane	7.7E-06	Lifetime, CR = 10^{-5}	
Chloroform	3.7E-02	Child, HQ=0.25	8.00E-02
cis-1,2-Dichloroethene	5.6E-02	Child, HQ=0.5	7.00E-02
trans-1,2-Dichloroethene	1.4E-01	Child, HQ=0.5	1.00E-01
Tetrachloroethene	1.2E-03	Lifetime, CR = 10^{-5}	5.00E-03
Trichloroethene	2.2E-02	Child, HQ=0.25	5.00E-03
Vinyl Chloride	4.5E-04	Lifetime, CR = 10^{-5}	2.00E-03
Metals			
Aluminium	7.8E+00	Child, HQ=0.5	
Chromium	4.7E-02	Child, HQ=1	1.00E-01
Iron	4.7E+00	Child, HQ=1	
Manganese	1.5E-01	Child, HQ=0.5	
Nickel	3.1E-01	Child, HQ=1	

Child scenario selected for noncarcinogenic PRG since child scenario is more conservative (lower value).
For constituents with basis of CR = 10^{-5}, the PRG for CR =10^{-5} is less than PRG for applicable HQ.
Used CR of 10^{-5} to keep overall carcinogenic risk below 10^{-4}.
Applicabe HQ chosen to keep total HI for each target organ below 1.

Table 2-16
PRGs for Chemicals of Potential Concern in Groundwater.
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Attainment Area/Chemical	Proposed PRG (mg/L)	Source[A]	Max Conc. (mg/L)	COC?
Site 49 PRG Attainment Area				
VOCs				
1,2-Dibromoethane			6.50E-02	No[B]
Chloroform	8.00E-02	M	3.80E-02	No[C]
cis-1,2-Dichloroethene	7.00E-02	M	1.10E+00	Yes
trans-1,2-Dichloroethene	1.00E-01	M	4.60E-02	No[C]
Tetrachloroethene	5.00E-03	M	1.10E-03	No[C]
Trichloroethene	5.00E-03	M	4.40E+00	Yes
Vinyl Chloride	2.00E-03	M	5.70E-03	Yes
Metals				
Aluminium (Dissolved)	7.80E+00	RB	6.80E+00	No[C]
Chromium	1.00E-01	M	7.50E-03	No[C]
Iron (Dissolved)	4.70E+00	RB	1.41E+01	Yes
Manganese (Dissolved)	1.50E-01	RB	2.29E+00	No[D]
Nickel (Dissolved)	3.10E-01	RB	8.10E-03	No[C]

Footnotes:
[A] M=Proposed PRG is based on MCL, RB=proposed PRG is based on calculated risk-based PRG (HI=0.5 for aluminum and manganese, HI=1 for iron and nickel)
[B] Chemical is not considered a COC because it was only found in one groundwater sample at concentrations above the risk-based PRG
[C] Chemical is not considered a COC because maximum concentration does not exceed PRG
[D] Chemical is not considered a COC because it is present at concentrations similar to background.
Boldface chemicals are those considered chemicals of concern because maximum concentration exceeds the PRG

TABLE 2-17
Detailed Analysis of Site 49 Groundwater Remediation Alternatives
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

	CERCLA Criteria	ALT-1 – No Action	ALT-2 – Institutional Controls with LTM	ALT-3 – Groundwater Extraction and Treatment	ALT-3A – Groundwater Extraction and Treatment with Fracturing
Threshold Criteria	Protection of Human Health and the Environment	NOT PROTECTIVE – This alternative does not provide any increased protection of human health and the environment. However there are no current risks and there are local ordinances that prevent the private use of groundwater for drinking water purposes.	PROTECTIVE – Site specific administrative measures would be used to prevent exposure to contaminated groundwater.	PROTECTIVE – Plume migration would be controlled and mass removed from the site via dissolution and pumping. There is significant uncertainties as to whether ARARs can be met, and the theoretical time to remediation which varies widely (10 year estimate).	PROTECTIVE – See ALT-3
	Compliance with ARARs	NOT COMPLIANT– Groundwater above MCLs would be left in-place.	NOT COMPLIANT – Contaminant concentrations exceeding MCLs would persist in the groundwater, however monitoring would be implemented assess contaminant trends over time.	COMPLIANT – P&T systems are effective at plume control, but LESS effective at returning groundwater to MCLs. Ex-situ granular activated carbon treatment systems have been proven highly reliable to treat the extracted groundwater to surface water discharge criteria over the long-term.	COMPLIANT – See ALT- 3
Balancing Criteria	Long-term Effectiveness and Permanence	NONE (0) – No measures would be taken to manage contamination left in-place. No site-specific restrictions would be put in place to prevent future exposure..	MODERATE (3) – Administrative measures can be effective, but only if long-term site access is managed diligently. Sale or reuse of the land would be affected by restrictions on use of groundwater.	MODERATE (3) – The P&T system would remove the contaminants from the subsurface yielding low residual risk levels. However, as with use of any in-situ treatment technology, small pockets of undetected contamination may remain after treatment and pose a small risk. Rebound effects are also common in pump and treat applications.	MODERATE (3-4) – Effectiveness and performance are improved over alternative 3.
	Reduction in Toxicity, Mobility, or Volume	NONE (0) – The site would be left as is and only the relatively slow natural processes of dilution, volatilization, biodegradation, adsorption, and dispersion would act to reduce the levels of groundwater contamination.	NONE (0) – The site would be left as is and only the relatively slow natural processes of dilution, volatilization, biodegradation, adsorption, and dispersion would act to reduce the levels of groundwater contamination.	MODERATE (3) – The P&T system would be very effective at controlling migration of the contaminants in the groundwater. It would, however, be slow at mass removal. Contaminants that are removed would be transferred to the carbon.	MODERATE (4) – Mass removal rates are increased compared to alternative 3.
	Short-term Effectiveness	NONE (0) – no remediation activity, however the remediation timeframe is estimated at over 30 years depending on NA processes' effectiveness.	LOW to MODERATE (2) - There is no increased risk during implementation however the remediation timeframe is estimated to be greater than 30 years depending on the NA processes' effectiveness.	MODERATE (3) – There is a relatively long remediation time frame, between 10 and 30 years depending on system performance. Since the P&T system removes mass through dissolution only, it requires an extended remediation timeframe if NAPL or significant adsorbed phase is present. The ability of the P&T system to meet MCLs in a reasonable timeframe is uncertain. It would depend upon the presence of residual-NAPL stringers that would act as long-term sources of contamination. Risks to workers and the community during construction are minimal since it involves well, piping, and equipment installation only. P&T would not adversely affect downgradient attenuation of the dissolved contaminant plume.	MODERATE (3-4) – Since system performance is improved, six years is more achievable compared to alternative 3.
	Implementability	HIGH (5) – Nothing to implement.	HIGH (5) - While this alternative is highly feasible on a technical basis, it may present administrative issues if controls are to be in place in perpetuity.	MODERATE (3) – A National Pollutant Discharge Elimination System (NPDES) permit would be required to discharge treated water to a nearby surface water stream. The facility already holds NPDES permit for an existing P&T system, therefore, this is not expected to be difficult to obtain. P&T system components are all readily accessible.	MODERATE (3) – See alternative 3.

TABLE 2-17
Detailed Analysis of Site 49 Groundwater Remediation Alternatives
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

CERCLA Criteria	ALT-1 – No Action	ALT-2 – Institutional Controls with LTM	ALT-3 – Groundwater Extraction and Treatment	ALT-3A – Groundwater Extraction and Treatment with Fracturing
Cost *	LOW (5) - $ 17,000 present worth cost - $ 0.00 capital cost - $ 5,500 Five-Year Review - $ 0.00 post-closure cost	LOW to MODERATE (4) - $ 312,000 present worth cost - $ 65,000 capital cost - $ 13,000 annual O&M cost	HIGH (1) - $ 1,506,000 present worth cost - $ 717,000 capital cost - $ 83,000 annual O&M - $ 76,000 post-closure cost	HIGH (0) - $ 1,716,000 present worth cost - $ 1,126,000 capital cost - $ 89,000 annual O&M - $ 76,000 post-closure cost

* The cost estimates provided are to an accuracy of +50 percent to -30 percent and are prepared for the sole purpose of alternative comparison. The alternative cost estimates are in 2003 dollars and are based on conceptual design from information available at the time of this study. The actual cost of the project would depend on the final scope and design of the selected remedial action, the schedule of implementation, competitive market conditions, and other variables.

TABLE 2-17 (CONTINUED)
Detailed Analysis of Site 49 Groundwater Remediation Alternatives
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

	CERCLA Criteria	ALT-4 – In- Situ Chemical Oxidation	ALT-4 A– In- Situ Chemical Oxidation with Fracturing	ALT-5 – Enhanced Anaerobic Bioremediation with Rock Fracturing
Threshold Criteria	Protection of Human Health and the Environment	PROTECTIVE – Human health and the environment would be protected through permanent in-situ destruction of the contamination. ICs would be used to control exposure to contamination during implementation of the remedy.	PROTECTIVE – See Alternative 4.	PROTECTIVE – Human health and the environment would be protected through treatment of the contamination. Groundwater monitoring would be performed to track the plume during treatment. ICs would be used to control exposure to contamination during implementation of the remedy. While there a significant uncertainties as to whether ARARs can be met, the theoretical time to remediation is moderately fast. A pilot test would be warranted.
	Compliance with ARARs	COMPLIANT – Theoretically, ISCO should be able to treat the TCE in groundwater to MCLs. However, there are few site case studies where MCLs have been achieved.	COMPLIANT – Oxidant delivery problems should be solved with pneumatic fracturing.	COMPLIANT – ERD is primarily effective at treating dissolved contamination and may treat residual NAPL. The ability of ERD to meet ARARs (i.e., MCLs) would depend on the ability to deliver the electron donor to the aquifer effectively through the rock formation. If residual NAPL is present, then ERD alone would likely not meet MCLs in a reasonable timeframe.
Balancing Criteria	Long-term Effectiveness and Permanence	MODERATE (3) – Contaminants are destroyed in place through permanent, rapid, irreversible reactions. However adequate distribution into fractures is doubtful so rebound may be likely.	MODERATE TO HIGH(4) – See alternative 4. Pneumatic pressure injection provides significant benefit in distribution of oxidant into fractures.	MODERATE to HIGH (4) - The mechanisms of ERD would act to convert the contaminants to harmless by-products. Therefore, assuming MCLs would be met and there would be no rebound effects, the residual risk level would be low. However, as with use of any in-situ treatment technology, small pockets of contamination may remain after treatment and pose a small risk. Use of the land would be unrestricted after treatment.
	Reduction in Toxicity, Mobility, or Volume	MODERATE to HIGH (4) – TCE and other alkenes would be destroyed in-situ through chemical oxidation to harmless by-products. However adequate distribution into fractures is doubtful so significant volume may remain.	HIGH (5) – See alternative 4. Pneumatic pressure injection provides significant benefit in distribution of oxidant into fractures to achieve greater TCE volume reduction.	MODERATE to HIGH (4) – The effect of ERD on reduction of TCE is similar to the Alternative 2, however the enhancement of the biological process would likely make it more dominant than would otherwise be experienced in ALT 2. (more degradation and less dispersion and dilution). The expedited remediation timeframe, would lessen the risk for potential plume migration.
	Short-term Effectiveness	MODERATE TO HIGH (4) - Remediation timeframe is relatively fast if ISCO is effective: an estimated 1-2 years. ISCO is effective at treating residual TCE NAPL, if present, and therefore, can greatly reduce the remediation timeframe. Handling of hazardous chemicals presents a minimal risk to workers, but can be simply controlled using proper equipment and trained personnel. ISCO would likely negatively impact MNA by consuming electron donor and raising redox conditions, however rebound of favorable conditions would be expected in a relatively quick time frame (less than a year after ISCO treatment stops).	HIGH (4 -5)– Effectiveness and performance are improved by using rock fracturing.	MODERATE (3) – The remediation timeframe is estimated at 5 years for the Target Remediation Zone (TRZ), Significant uncertainties are present due to the low permeability of the rock. Chemical handling of the electron donor is not especially hazardous and can be performed using typical injection wells and pumps.
	Implementability	MODERATE (3) – A class V injection permit may be required for treatment using ISCO. Many states allow injection of ISCO chemicals, therefore, it is not expected to be a problem since the chemicals are for treatment and would be consumed as part of the process. ISCO chemicals are readily available. Successful implementation of this remedy requires delivery of reagent to and mixing with contaminants. Given the uncertainties associated with the fractured bedrock flow system and the low permeability of the bedrock, delivery efficiency is expected to be low, requiring dense injection well grids, uncertainty in time to achieve RAOs and high contingency costs. Pilot test may be warranted.	MODERATE (3) – Pneumatic fracturing is relatively innovative and would add complexity to alternative 4. Pneumatic fracturing would improve the delivery efficiency of the reagent. Pilot test may be warranted to measure the effectiveness of rock fracturing.	MODERATE (3) – A subsurface injection permit would be required for treatment using ERD. Many states allow injection of ERD chemicals, therefore, it is not expected to be a problem since the chemicals are generally harmless and would be consumed as part of the process. ERD chemicals are readily available. Successful implementation of this remedy requires delivery of reagent to and mixing with contaminants. Given the uncertainties associated with the fractured bedrock flow system and the low permeability of the bedrock, delivery efficiency is expected to be low, requiring dense injection well grids, uncertainty in time to achieve RAOs and high contingency costs.. Pilot test would be warranted.

TABLE 2-17 (CONTINUED)
Detailed Analysis of Site 49 Groundwater Remediation Alternatives
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

CERCLA Criteria	ALT-4 – In- Situ Chemical Oxidation	ALT-4 A– In- Situ Chemical Oxidation with Fracturing	ALT-5 – Enhanced Anaerobic Bioremediation with Rock Fracturing
Cost	LOW TO MODERATE (3-4) - $ 833,000 – 983,000 present worth cost (depending on second injection) - $ 590,000 capital cost - $ 21,000 annual O&M - $ 68,000 post-closure cost	MODERATE (3) - $ 1,175,000 – 1,275,000 present worth (Depending on second injection) - $ 938,000 capital cost - $ 22,000 annual O&M - $ 57,000 post-closure cost	MODERATE TO HIGH (2) - $ 1,341,000 present worth cost - $ 1,020,000 capital cost - $ 43,000 annual O&M cost - $ 51,000 post-closure cost

TABLE 2-18
Summary of Detailed Alternatives Analysis for Site 49 Groundwater
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

	CERCLA Criteria	Site 49 Groundwater Remediation Alternatives						
		ALT-1 **No Further Action**	**ALT-2** **Institutional Controls**	**ALT-3** **Pump &Treat**	**ALT-3A** **Pump &Treat with Fracturing**	**ALT-4** **In-situ Chemical Oxidation**	**ALT-4A** **In-situ Chemical Oxidation with Fracturing**	**ALT-5** **Enhanced Anaerobic Bioremediation with Fracturing**
Threshold criteria	Protection of Human Health and the Environment	No	Yes	Yes	Yes	Yes	Yes	Yes
	Compliance with ARARs	No	No	Yes	Yes	Yes	Yes	Yes
Balancing criteria	Long-term Effectiveness and Permanence[1]	0	3	3	3-4	3	4	4
	Reduction in Toxicity, Mobility, or Volume[1]	0	0	3	4	4	5	4
	Short-term Effectiveness[1]	0	2	3	3-4	4	4-5	3
	Implementability[1]	5	5	3	3	3	3	3
	Cost [2]	5	4	1	0	3-4	3	2
	TOTAL SCORE	10	14	13	13-15	17-18	19-20	16

NOTES:
1 - Alternatives are ranked relative to each other in each category with zero (0) the lowest ranking and five (5) the highest ranking. A numeric range is provided in parenthesis where significant uncertainty exists.
2 - The ranking for cost is reversed, an assessed quality of Low Cost is equivalent to the highest score of five (5).
3 – Shaded columns failed one or both of the threshold criteria

Figures

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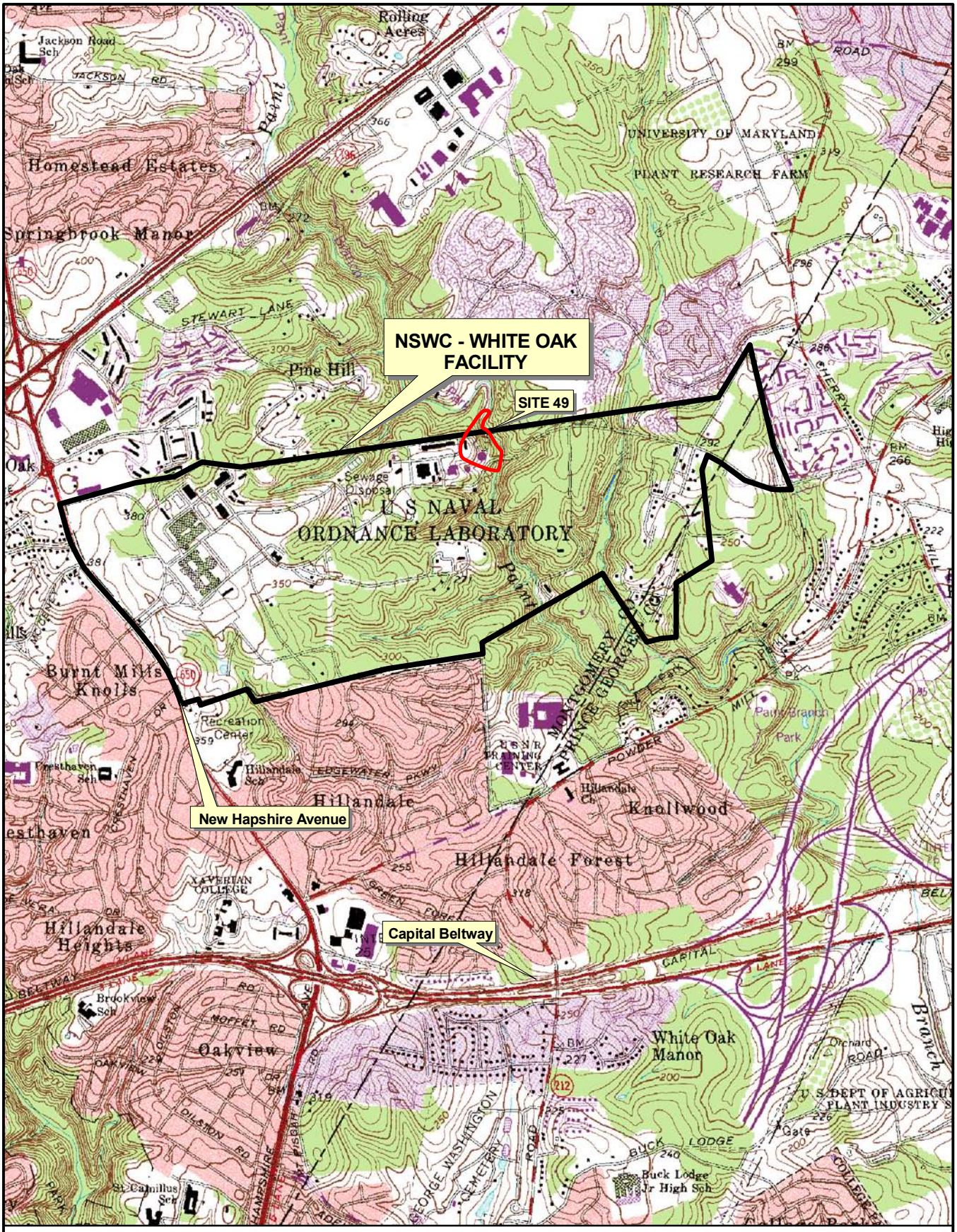

LEGEND

- Site 49 Boundary
- Base Boundary

N

0 1000 2000 Feet

Figure 2-1
Site Vicinity Map
Site 49 ROD
Former NSWC White Oak, Silver Spring, MD

Source: Modified from USGS Beltsville, MD Quad

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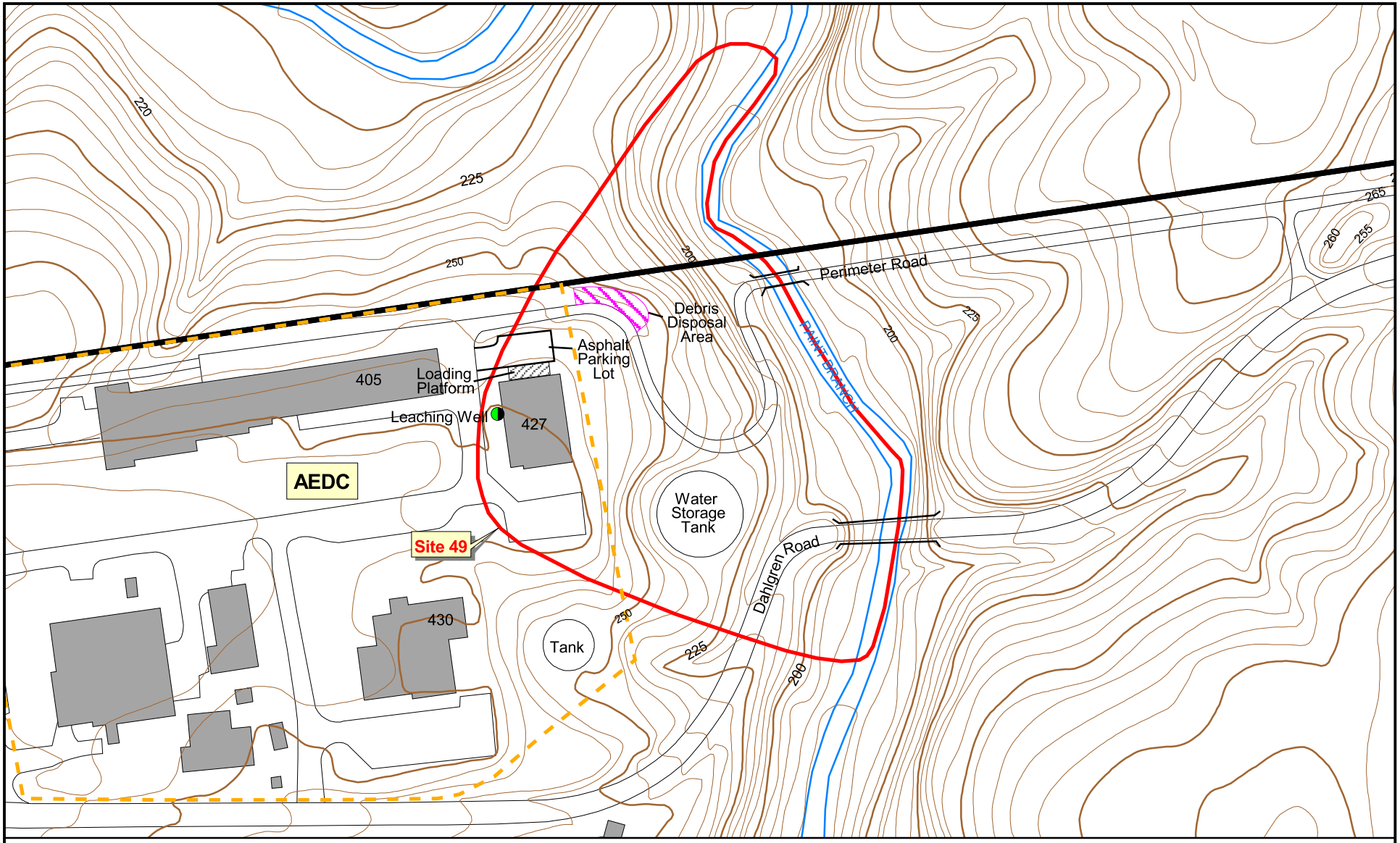

LEGEND

- Buildings (427=Building Number)
- Site 49 Area
- AEDC Fence Line
- Stream
- Base Boundary
- Topographic Contour Lines '250' (feet above mean sea level, 5 foot intervals)

N

0 200 400 Feet

Figure 2-2
Site 49 Site Map
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

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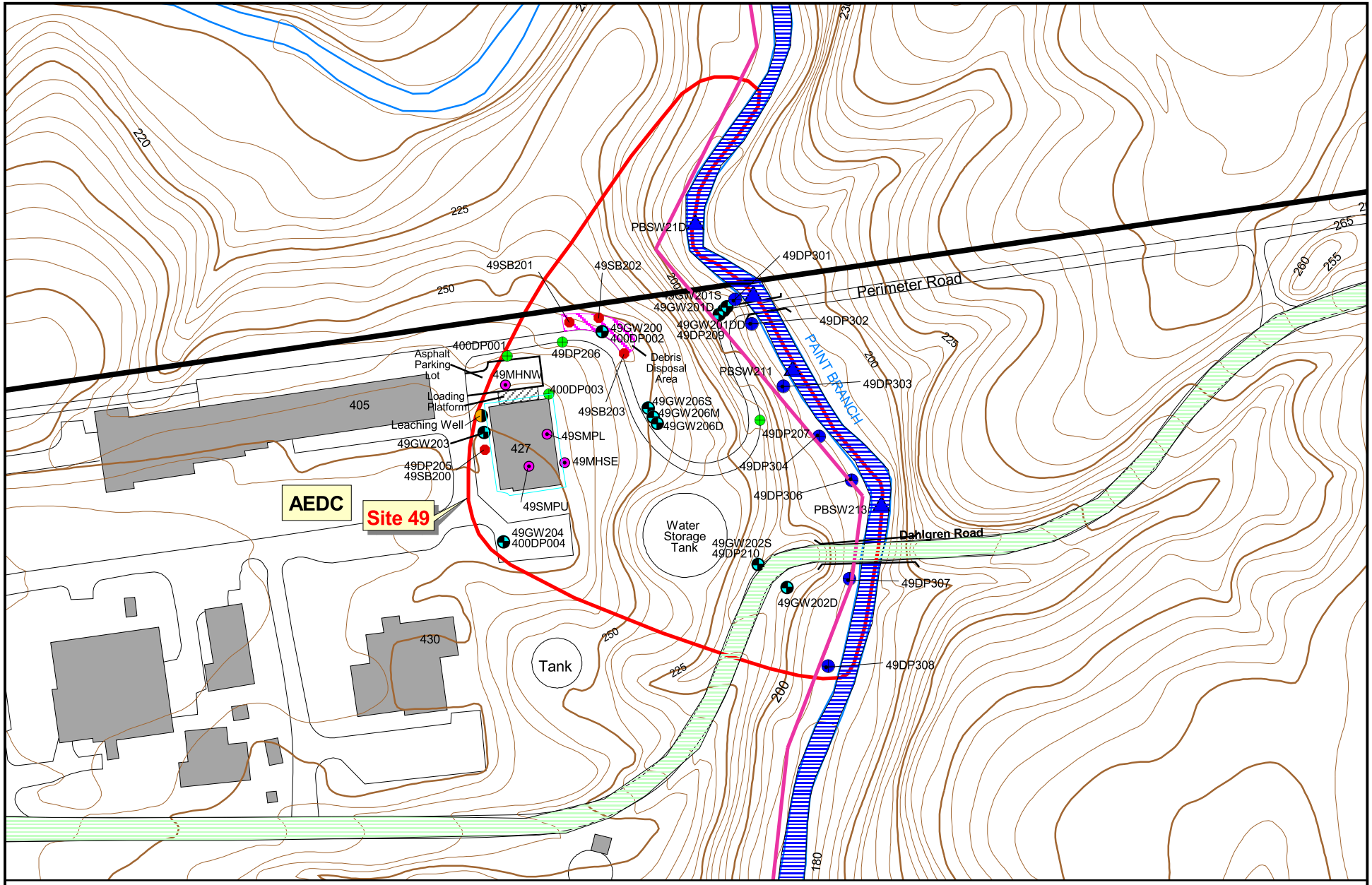

LEGEND

- Buildings (427=Building Number)
- Site 49
- AEDC Fence Line
- Stream
- Base Boundary
- Sewer Line
- Monitoring Well Location
- Temporary Well Sample Location
- Leaching Well Location
- Surface Water Sample Location
- Manhole Location
- Soil Borring
- Direct Push Groundwater Sample
- '250' Topographic Contour Lines (feet above mean sea level, 5 foot intervals)

N

0 150 300 Feet

Figure 2-3
Site 49 RI Sampling Locations
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

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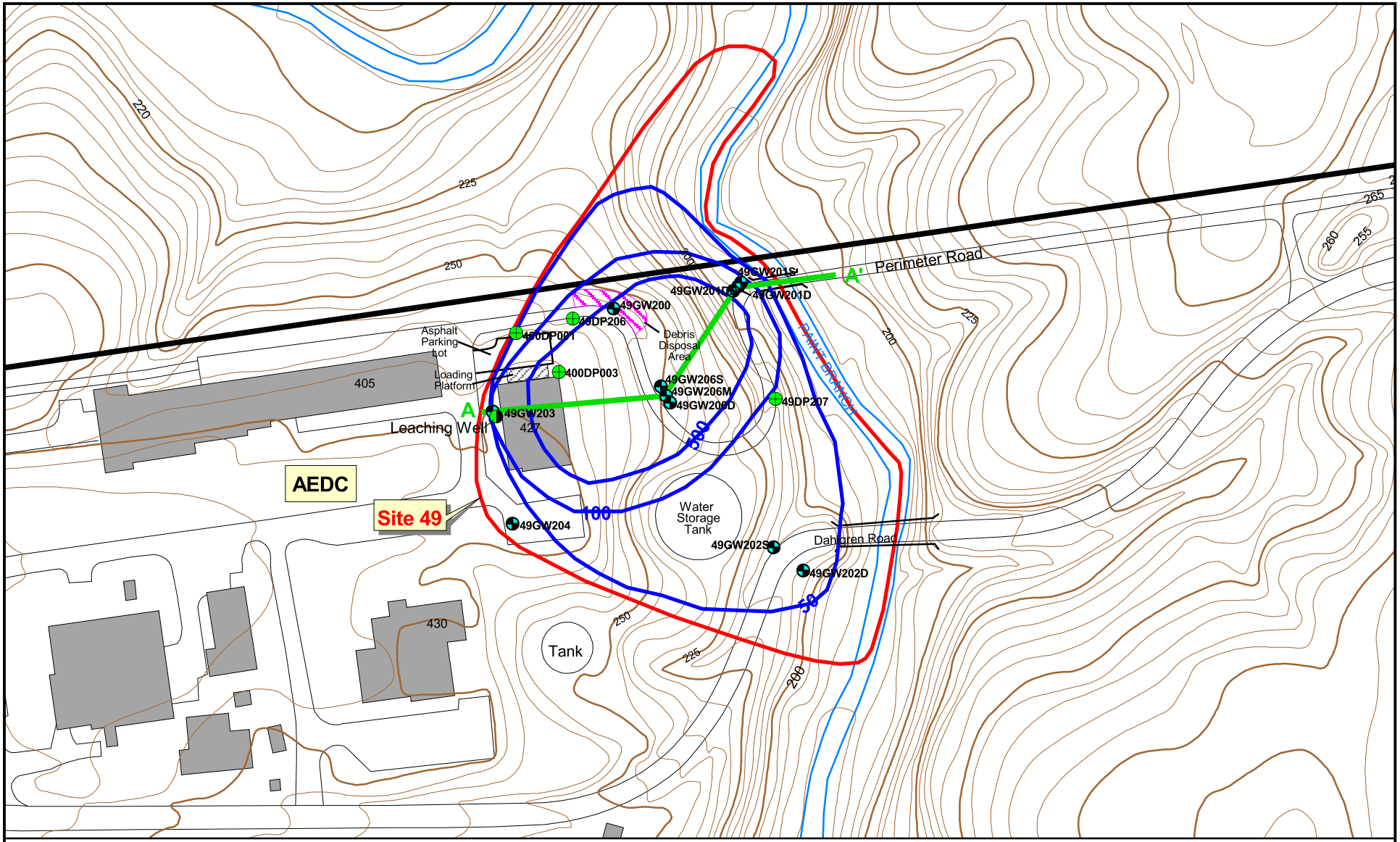

LEGEND

- Buildings (427=Building Number)
- Site 49 Area
- AEDC Fence Line
- Stream
- Base Boundary
- Monitoring Well Location
- Temporary Well Sample Location
- Cross-section Location
- TCE Concentrations in µg/L
- Topographic Contour Lines '250' (feet above mean sea level, 5 foot intervals)

N

0 200 400 Feet

Figure 2-4
Site 49 Conceptual Isoconcentrations for TCE in Shallow Groundwater
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

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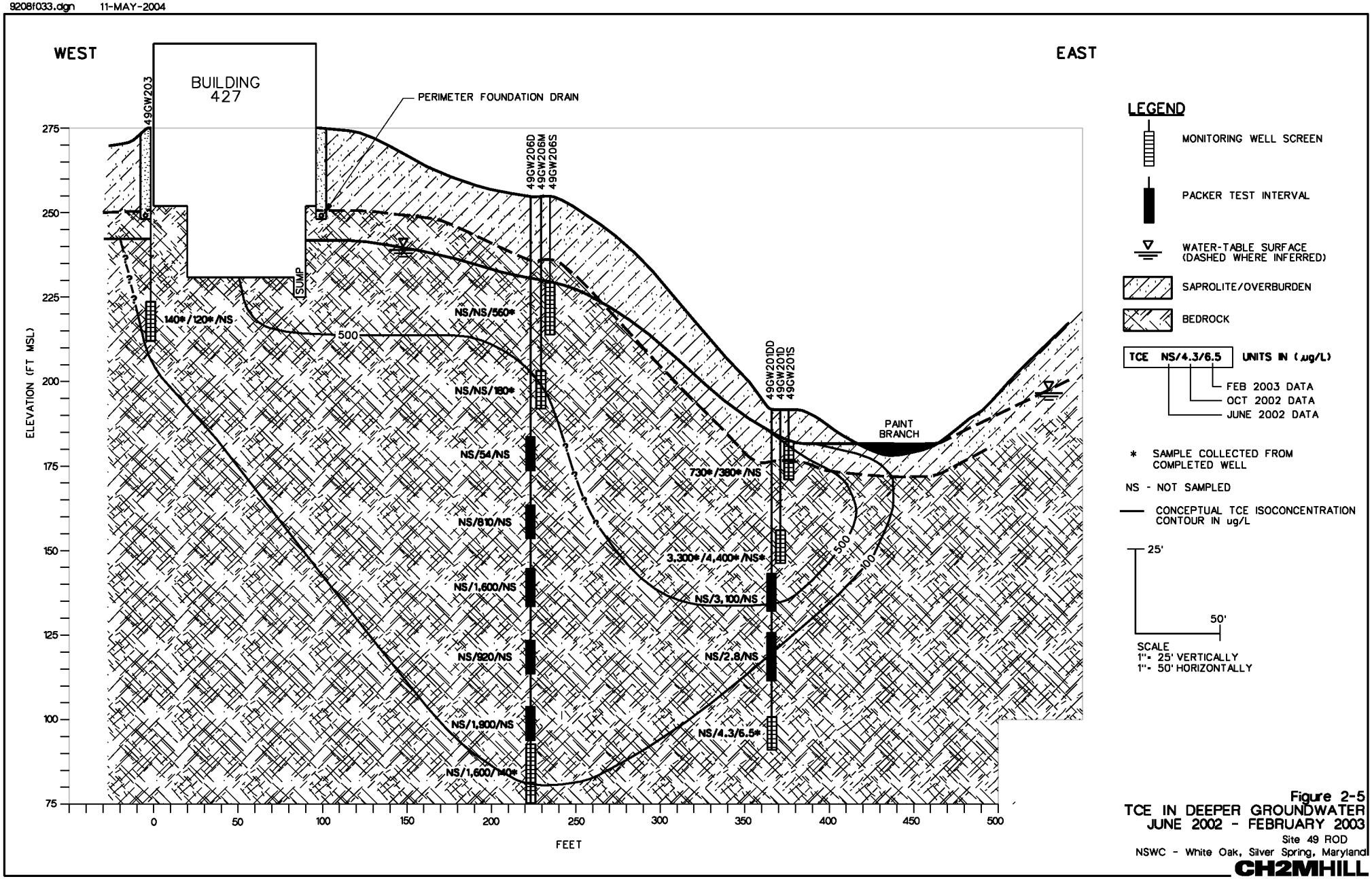

Figure 2-5
TCE IN DEEPER GROUNDWATER
JUNE 2002 - FEBRUARY 2003
Site 49 ROD
NSWC - White Oak, Silver Spring, Maryland
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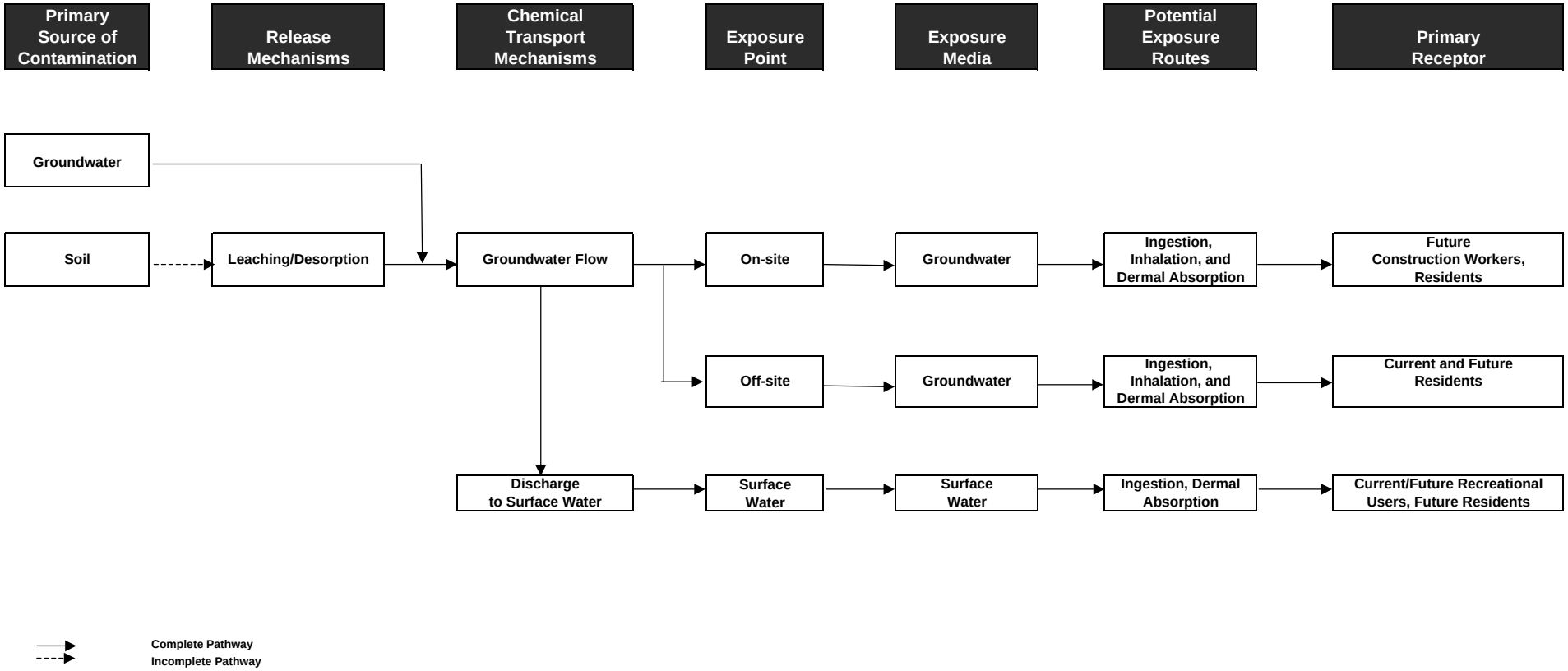

Figure 2-6
Conceptual Site Model for Potential Human Exposures-Site 49 ROD
NSWC-White Oak
Silver Spring , Maryland

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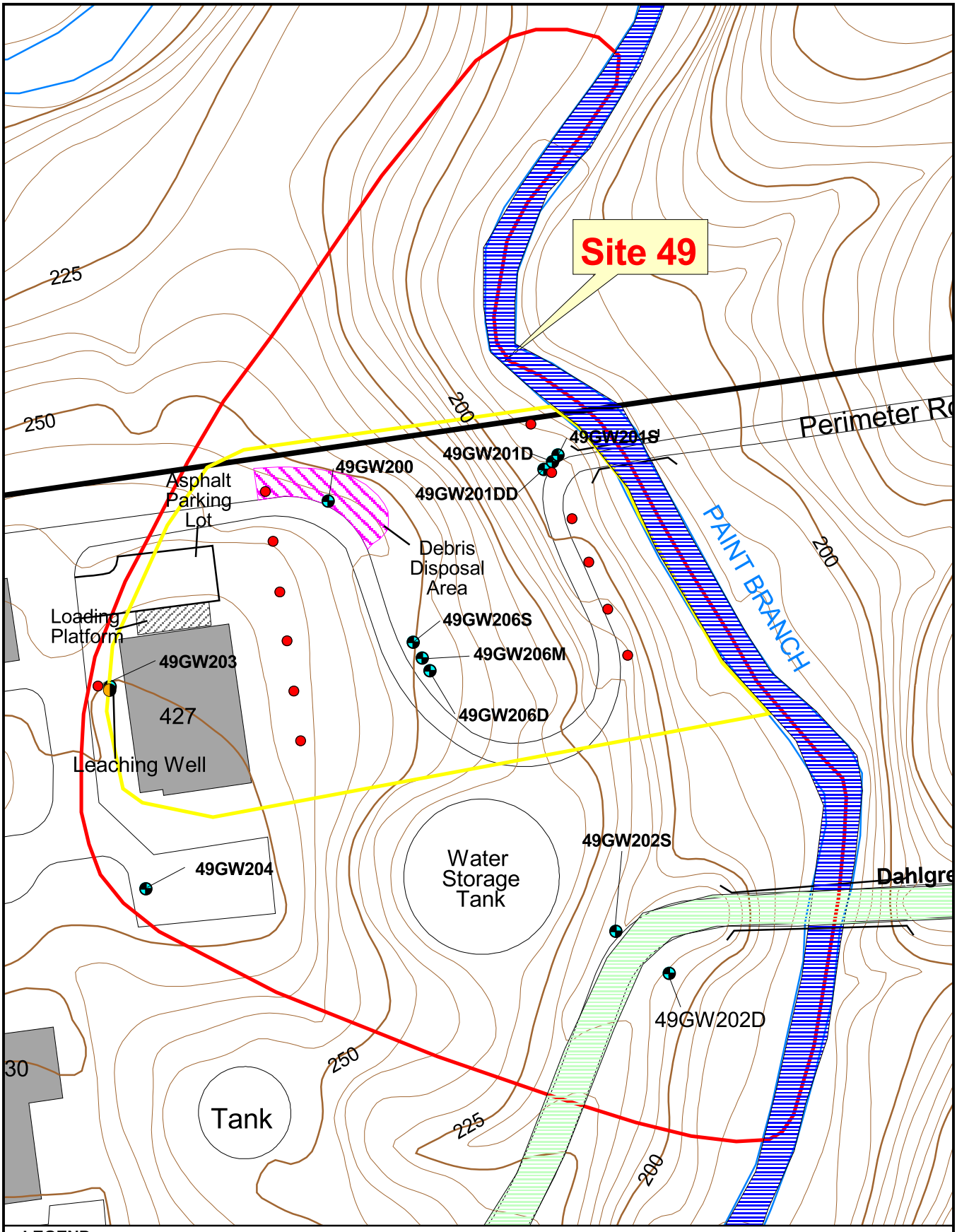

LEGEND

- Buildings (427=Building Number)
- Groundwater PRG Attainment Area and Area of Land Use Controls
- AEDC Fence Line
- Stream
- Base Boundary
- Target Remediation Zone
- Monitoring Well Location
- Leaching Well Location
- Proposed Excavation well
- '250' Topographic Contour Lines (feet above mean sea level, 5 foot intervals)

N

0 100 200 Feet

Figure 2-7
Site 49
Target Remediation Zone and
Conceptual Injection Well Layout
Site 49 ROD
NSWC - White Oak
Silver Spring, Maryland

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Appendix A

Maryland Department of Environment

Concurrence Letter

MARYLAND DEPARTMENT OF THE ENVIRONMENT
1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101

Robert L. Ehrlich, Jr.
Governor

Michael S. Steele
Lt. Governor

Kendl P. Philbrick
Secretary

Jonas A. Jacobson
Deputy Secretary

September 30, 2004

Mr. Walter Legg
Naval Facilities Engineering Command Washington
Washington Navy Yard, Building 212
1314 Harwood Street SE
Washington D.C. 20374-5018

RE: 1) Final Record of Decision Former Naval Surface Warfare Center--White Oak Site 9 Groundwater and Soil Silver Spring, Maryland, September 16, 2004.

2) Final Record of Decision Former Naval Surface Warfare Center--White Oak Site 3—Pistol Range Landfill Silver Spring, Maryland, September 27, 2004.

3) Final Record of Decision Former Naval Surface Warfare Center--White Oak Site 49, September 24, 2004.

Dear Mr. Legg:

The Federal Facilities Division (FFD) of the Maryland Department of the Environment's Hazardous Waste Program has reviewed the above referenced submittals. The Record of Decision (ROD) for Site 9 presents the determination that *in-situ* enhanced anaerobic bioremediation and monitored natural attenuation with institutional controls is selected to address groundwater contamination. The Site 9 ROD also presents the determination that excavation with off-site disposal is needed to address soil at this site in order to eliminate its potential to act as a source of contamination to groundwater. The Site 3 ROD presents the determination that no further action is necessary. The Site 49 ROD presents the determination that *in-situ* chemical oxidation with pneumatic fracturing along with institutional controls and long-term monitoring is selected to address groundwater contamination.

The Navy and EPA have also taken the comments received during the public comment period into consideration and continue to believe that the determinations stated above adequately and appropriately address Sites 9, 3, and 49 in a cost-effective and responsible manner. Based upon the acceptable level of protection to human health and the environment, the FFD concurs with the selected remedies for Sites 9, 3 and 49.

If you should have any questions, please contact me at (410) 537-3419.

Sincerely,

A. Zarins

Andrew Zarins
Remedial Project Manager
Federal Facilities Division

AZ:mh

cc: Mr. Bruce Beach
Mr. Horacio Tablada
Mr. Harold Dye, Jr.

Appendix B

ARAR Tables

Table B-1
Chemical-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Chemicals & Relevant Media	Requirement	Prerequisites	Citation	ARAR or TBC	Comments
Groundwater, residential water supplies	Meet National Primary Standards for maximum contaminant levels (MCLs).	Drinking water source or potential source	Safe Drinking Water Act (SDWA): 40 CFR 141 National Primary Drinking Water Regulations.	Applicable	Regulation does not apply where groundwater quality has concentrations of total dissolved solids (TDS) greater than 2,500 mg/L. In these instances, the Medium-Specific Concentration for groundwater may be multiplied by 100. MCLs are used as PRGs for Site 49 groundwater.
Surface water	Water Management Program approval for short-term discharges and NPDES for long-term discharges.	Surface water discharges	CWA: 40 CFR 122-123 NPDES permit program	Applicable	An NPDES permit is not required; however, substantive provisions of the CWA must be complied with.
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges. Limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the State's surface waters	COMAR 26.08, chapters 1 through 7	Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland, in this case Paint Branch
Surface water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water or aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	These regulations were used in the development of PRGs for Site 49.
Carcinogens in groundwater and surface water	Not to exceed media-specific concentration that causes a lifetime cancer risk of between 1 in 10,000 and 1 in 100,000.	Potential exposure	CERCLA, NCP 400CFR300.430 (e)(2)(i)(A)(2)	TBC	Use to calculate site-specific PRGs for Site 49 groundwater.
Systemic toxicants in groundwater and surface water	Not to exceed media-specific levels where people could be exposed by direct ingestion or inhalation on a daily basis without appreciable risk of deleterious effects.	Potential exposure	CERCLA, NCP 400CFR300.430 (e)(2)(i)(A)(1)	TBC	Use to calculate site-specific PRGs for groundwater.
Air	Emissions limitations related to attainment of National Ambient Air Quality Standards and Emission Standards for Hazardous Air Pollutants.	Air emissions	Clean Air Act (CAA) Parts 50 and 61. Annotated code of Maryland Title 2	Applicable	Treatment alternatives such as air stripping, soil vapor extraction, or air sparging would involve air emissions.

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
EPA - U.S. Environmental Protection Agency
NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered

Table B-2
Location-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Federal Location-Specific ARARs					
Historic Sites, Buildings, and Antiquities Act					
Historic sites	Avoid undesirable impacts on landmarks.	Areas designated as historic sites.	16 USC 461-467; 40 CFR 6.301 (a)	To be considered	The regulations are relevant and appropriate in situations where remedial actions may adversely affect any historical structures located on Site 49. No historical structures have been identified on Site 49.
Endangered Species Act of 1973					
Critical habitat upon which endangered species or threatened species depend.	Action to conserve endangered species or threatened species, including consultation with the Department of the Interior. Reasonable mitigation and enhancement measures must be taken, including live propagation, transplantation, and habitat acquisition and improvement.	Determination of effect upon endangered or threatened species or their habitat by conducting biological assessments.	16 USC 1531; 16 USC 1536(a); 50 CFR 81, 225, 402	Potentially applicable	There are no records of federal endangered plant and animal species located at White Oak.
Fish and Wildlife Coordination Act, Fish and Wildlife Improvement Act of 1978, Fish and Wildlife Conservation Act of 1980					
Area affecting streams or other water body	Provides protection for actions that would affect streams, wetlands, other water bodies or protected habitats. Any action taken should protect fish or wildlife.	Diversion, channeling or other activity that modifies a stream or other water body and affects fish or wildlife.	16 USC 661; 16 USC 662; 16 USC 742a; 16 USC 2901; 50 CFR 83	Applicable	Response actions will incorporate protection against any area water body, wetlands, or protected habitats.
Procedures for Implementing the Requirements of the Council on Environmental Quality on the National Environmental Policy Act and Executive Order 11990, Protection of Wetlands					
Wetland	Action to minimize the destruction, loss, or degradation of wetlands. Wetlands of primary ecological significance must not be altered so that ecological systems in the wetlands are unreasonably disturbed.	Wetlands as defined by Executive Order 11990 Section 7.	40 CFR 6, Appendix A, excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	To be considered	This regulation may be an ARAR for activities occurring in areas that meet the definition of a wetland. Remedial activities must minimize the destruction, loss, or degradation of the wetlands.
Clean Water Act, Section 404					
Wetland	The degradation Section requires degradation or destruction of wetlands and other aquatic sites be avoided to the extent possible. Dredged or fill material must not be discharged to navigable waters if the activity: contributes to the violation of Maryland water quality standards; CWA Sec. 307; jeopardizes endangered or threatened species; or violates requirements of the Title III of the Marine Protection, Research, and Sanctuaries Act of 1972.	Wetland as defined by Executive Order 11990 Section 7.	40 CFR 230.10; 40 CFR 231 (231.1, 231.2, 231.7, 231.8)	To be considered	Wetlands and navigable waters are present in the vicinity of Site 49. Remedial activities will comply with the requirements of this section of the Clean Water Act.
Surface Water	Ambient Water Quality Criteria established to protect aquatic life and human consumers of water aquatic life.	Activities that affect or may affect the surface water onsite	40 CFR 129	Applicable	These regulations were used in the development of the PRGs for Site 49.
Hazardous Waste Control Act (HWCA)					
Within 100-year floodplain	Facility must be designed, constructed, operated, and maintained to avoid washout.	RCRA hazardous waste; treatment, storage, or disposal of hazardous waste.	40 CFR 264.18 (b)	To be considered	Portions of Site 49 are within the 100-year flood zones. However, actions are not expected to involve hazardous waste. This would be TBC for nonhazardous waste.
Executive Order 11988, Protection of Floodplains					
Within floodplain	Actions taken should avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.	Action that will occur in a floodplain, i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas.	40 CFR 6, Appendix A; excluding Sections 6(a)(2), 6(a)(4), 6(a)(6); 40 CFR 6.302	To be considered	Portions of Site 49 are within the 100-year flood zones, therefore the requirements of this regulation are applicable for any response actions that might involve the use of these areas.
State Location-Specific ARARs					
Threatened and Endangered Species					
Critical habitat upon which endangered species or threatened species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on. Construction or other activties may not reduce the likelihood of either the survival or recovery of a listed species in the wild by reducing the reproduction, numbers or distribution of a listed species or otherwise adversely affect the species.	Determination of effect upon endangered or threatened species or its habitat.	COMAR 08.03.08	Potentially applicable	There are no records of state or federal endangered or threatened plant and animal species located within White Oak, based on inquiries to the Maryland DNR. These regulations might be applicable if this situation changes.

Table B-2
Location-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Location	Requirement	Prerequisite	Citation	Applicability Determination	Comments
Threatened and Endangered Fish Species					
Critical habitat upon which endangered or threatened fish species depend.	Requires action to conserve endangered or threatened fish species and the critical habitats they depend on.	Determination of effect upon endangered or threatened fish species or its habitat.	COMAR 08.02.12	Potentially applicable	These regulations are applicable if remedial actions may jeopardize endangered or threatened fish species. Currently, there are no federal or state endangered fish species at White Oak.
Fish and Fisheries					
Fisheries, locations where species of fish exist	Requirements to conserve species of fish for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon fish species or its habitat.	Annotated Code of Maryland Title 4	Applicable	Fish species inhabit Paint Branch. If response actions affect these species, the requirements of this title are applicable.
Wildlife					
Areas inhabited by wildlife	Requirements to conserve species of wildlife for human enjoyment, for scientific purposes and to ensure their perpetuation as viable components of their ecosystems.	Determination of effect upon wildlife species or its habitat.	Annotated Code of Maryland Title 10	Applicable	Wildlife species are present at White Oak. If response actions may affect these species, the requirements of this title are applicable.
Nontidal Wetlands Protection Act, Maryland Nontidal Wetlands Regulations					
Wetland	Provides regulations for activities on or near nontidal wetlands (an area that is inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions). Must obtain a permit from the State in order to conduct certain regulated activities in a nontidal wetland, or within a buffer or an expanded buffer.	Activities that will occur on or near nontidal wetlands.	COMAR 26.23; Annotated Code of Maryland, Title 5; Code of MD, Title 8-1201;	Applicable	Nontidal wetlands are present at White Oak. A letter of exemption from the Department of Natural Resources is required if remedial activities involve activities on or in nontidal wetlands.
Wetlands and Riparian Rights					
Wetlands	Requirements to preserve wetlands and prevent their destruction; requires a license for dredging or filling of wetlands.	Activities that can affect the integrity of wetlands, such as dredging or filling.	Annotated Code of Maryland Title 16	Applicable	Wetlands (tidal and nontidal) are present at White Oak. The requirements of this title are applicable for any response actions that may affect the integrity of these wetlands.
Construction on Nontidal Waters and Floodplains					
Nontidal waters and floodplains	Protect and maintain nontidal waterways and/or state of Maryland floodplains must follow these regulations	Activities that affect nontidal waterways and floodplains	COMAR 08.05.03	Potentially Applicable	Any remedial actions involving alteration to the streams bounding Site 49 or floodplains (including temporary construction) are subject to these requirements.
Water Pollution Control Law					
Waters of the State	Establishes effective programs and provides additional and cumulative remedies to prevent, abate, and control pollution of the waters in the state.	Activities that will pollute the waters in the state.	COMAR 9, Parts 301-351	Applicable	This regulation is applicable for remedial actions that may affect water quality in the streams around Site 49.
Maryland Water Pollution Control Regulations					
Surface waters of the State	Protect and maintain the quality of surface water in the State of Maryland. Criteria and standards for discharges limitations and policy for antidegradation of the State's limitations and policy for antidegradation of the State's surface water.	Activities that will pollute the surface waters of the state.	COMAR 26.08, Chapters 01-07	Applicable	This regulation is applicable for remedial actions that may affect surface water quality in the State of Maryland.
Water Management					
Water resources of the State	Provides for the conservation and protection of the water resources of the State by requiring that any land-clearing, grading, or other earth disturbances require an erosion- and sediment-control plan. Also provides that stormwater must be managed to prevent offsite sedimentation and maintain current site conditions.	Activities that affect the water resources of the State.	COMAR 26.17.01 COMAR 26.17.02, Annotated Code of Maryland Title 4	Applicable	The design for the remedial actions will incorporate the requirements of this regulation.

ARARs - Applicable or relevant and appropriate requirements.
RCRA - Resource Conservation and Recovery Act.
CFR - Code of Federal Regulations.
CWA- Clean Water Act.
DON - Department of Navy.
EO - Executive Order
FR - Federal Register.
HWCA - Hazardous Waste Control Act.
USC - United States Code.
TBC - To Be Considered.

Table B-3
Action-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Federal Action-Specific ARARs					
Resource Conservation and Recovery Act (RCRA) 42 USC 6901 et seq.*					
Onsite waste generation	Waste generator shall determine if waste is hazardous waste.	Generator of hazardous waste.	40 CFR 262.10 (a), 262.11	Applicable	Applicable for any operation where waste is generated. Remedial alternatives for Site 49 may generate contaminated wastes.
Hazardous waste accumulation	Generator may accumulate waste on site for 90 days or less or must comply with requirements for operating a storage facility.	Accumulate hazardous waste.	40 CFR 262.34	Potentially applicable	If waste generated at White Oak is determined to be hazardous, any storage of the hazardous waste will not exceed 90 days. Accumulation of hazardous wastes onsite for longer than 90 days would be subject to the substantive RCRA requirements for storage facilities.
Recordkeeping	Generator must keep records.	Generate hazardous waste.	40 CFR 262.40	Potentially applicable	Administrative requirements are not ARARs for onsite CERCLA actions.
Excavation	Movement of excavated materials to new location and placement in or on land will trigger land disposal restrictions for the excavated waste or closure requirements for the unit in which the waste is being placed.	Materials containing RCRA hazardous wastes subject to land disposal restrictions are placed in another unit.	40 CFR 268.40	Potentially applicable	Applicable to disposal of soil to a new location and placement in or on land containing land-disposal-restricted RCRA hazardous waste. The wastes generated from response actions at White Oak may be RCRA hazardous wastes.
Safe Drinking Water Act					
Actions that affect drinking water supply	Calls for National Primary Drinking Water Standard Maximum Contaminant Levels (MCLs)	Actions that affect drinking water supply	40 CFR 141	Relevant and appropriate	These regulations are ARARs for remedial actions at Site 49 that affect the groundwater.
U.S. Department of Transportation, 49 USC 1802, et seq.*					
Hazardous Materials Transportation	No person shall represent that a container or package is safe unless it meets the requirements of 49 USC 1802, et seq. or represent that a hazardous material is present in a package or motor vehicle if it is not.	Interstate carriers transporting hazardous waste and substances by motor vehicle. Transportation of hazardous material under contract with any department of the executive branch of the Federal Government.	49 CFR 171.2(f)	Potentially applicable	Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	No person shall unlawfully alter or deface labels, placards, or descriptions, packages, containers, or motor vehicles used for transportation of hazardous materials.		49 CFR 171.2(g)	Potentially applicable	
Hazardous Materials Marking, Labeling, and Placarding	Each person who offers hazardous material for transportation or each carrier that transports it shall mark each package, container, and vehicle in the manner required.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.300	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	Each person offering non-bulk hazardous materials for transportation shall mark the proper shipping name and identification number (technical name) and consignee's name and address.		49 CFR 172.301	Potentially applicable	

Table B-3
Action-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Hazardous Materials Marking, Labeling, and Placarding (cont.)	Hazardous materials for transportation in bulk packages must be labeled with proper identification (ID) number, specified in 49 CFR 172.101 table, with required size of print. Packages must remain marked until cleaned or refilled with material requiring other marking.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.302	Potentially applicable	
	No package marked with a proper shipping name or ID number may be offered for transport or transported unless the package contains the identified hazardous material or its residue.		49 CFR 172.303	Potentially applicable	To be determined. Offsite transport of hazardous materials must comply with both substantive and administrative requirements.
	The marking must be durable, in English, in contrasting colors, unobscured, and away from other markings.		49 CFR 172.304	Potentially applicable	
	Labeling of hazardous material packages shall be as specified in the list.	Person who offers hazardous material for transportation; carries hazardous material; or packages, labels, or placards hazardous material.	49 CFR 172.400	Potentially applicable	
	Non-bulk combination packages containing liquid hazardous materials must be packed with closures upward, and marked with arrows pointing upward.		49 CFR 172.312	Potentially applicable	
	Each bulk packaging or transport vehicle containing any quantity of hazardous material must be placarded on each side and each end with the type of placards listed in Tables 1 and 2 of 49 CFR 172.504.		49 CFR 172.504	Potentially applicable	
State Action-Specific ARARs					
Maryland Hazardous Waste Regulations					
Storage, treatment or disposal, and transportation of hazardous waste	Regulations and procedures for the identifications, listing, transportation, treatment, storage, and disposal of hazardous wastes must be met.	Handling of hazardous wastes	COMAR 26.13.01 through COMAR 26.13.04, Annotated Code of Maryland Title 7	Potentially Applicable	Any hazardous waste found during site remediation will be disposed of according to regulations. Any residues or by-products from treatment systems that are hazardous must be disposed of properly.
Solid Waste and Water Supply Regulations					
Well Construction and Abandonment	Specifications for well construction and abandonment must be met. Also provides a mechanism to provide the State of Maryland with a database of existing and abandoned wells. Permits are required for well construction.		COMAR 26.04.03 (A&D); COMAR 26.04.04	Applicable	The requirements of this regulation are applicable to the response actions at White Oak if monitoring wells have to be installed or abandoned.

Table B-3
Action-Specific ARARs and Performance Standards
Site 49 ROD
Former NSWC White Oak, Silver Spring, Maryland

Action	Requirement	Prerequisite	Citation	ARAR Determination	Comments
Stormwater Management					
Design and construction	Regulations require the design and construction of a system necessary to control stormwater.	Design and construction activities	COMAR 26.17.02	Applicable	The remedial action will incorporate measures to control and manage stormwater as necessary.
Erosion and Sediment Control					
Land clearing, grading, and earth disturbances	Regulations require the preparation and implementation of a plan to control erosion and sediment for activities involving land clearing, and grading and earth disturbances. Erosion and sediment control criteria are also established.	Land clearing, grading, and earth disturbances	COMAR 26.17.01	Potentially Applicable	The remedial action will incorporate the standards required for clearing, grading, and other earth disturbances, including compliance with county and municipal erosion and sediment control ordinances, and the Commission's erosion- and sedimentation-control regulations.
Maryland Drinking Water Law					
Actions that affect state drinking water	Ensures that the State has the primary enforcement responsibility for drinking water standards under the Federal Safe Drinking Water Act.	Action causing pollution of drinking water supply	COMAR 9.04, Parts 401-413	Applicable	This regulation may be an ARAR for Site 49 if activities that affect water quality are conducted.
Occupational, Industrial, and Residential Hazards					
Action that will generate noise	Limits set on the levels of noise must be met; these limits are protective of the health, welfare, and property of the people in the State of Maryland. The maximum permitted levels for construction activities may not exceed 90 dBA during the day and 75 dBA during night.	Action that will generate noise	COMAR 26.02.03.02A (2) and B(2), COMAR 26.02.03.02.03A, Annotated Code of Maryland Title 3	Applicable	During site remediation work, the maximum allowable noise levels will not be exceeded at site boundaries.
Air Quality					
Actions that involve emissions to air	Provides ambient air quality standards, general emissions standards, and restrictions for air emissions from construction activities, vents, and treatment technologies such as incinerators. Also includes nuisance and odor control. Construction activities may emit particulate matter into the ambient air. Remedial activities must follow regulations.	Actions that involve emissions to air above specific limits.	COMAR 26.11	Applicable	May apply to airstrippers, SVE, or air sparging alternatives.

Statutes and policies, and their citations, are provided as headings to identify general categories of potential ARARs. Specific potential ARARs are addressed in the table below each heading
Acronyms used in the table:

ARAR - Applicable or relevant and appropriate requirement
CAA - Clean Air Act
RCRA - Resource Conservation and Recovery Act
CFR - Code for Federal Regulations
CWA - Clean Water Act
DOT - U.S. Department of Transportation
EPA - U.S. Environmental Protection Agency
NPDES - National Pollutant Discharge Elimination System.
OSHA - Occupational Safety and Health Administration
CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act
SDWA - Safe Drinking Water Act
SMCLs - Secondary Maximum Contaminant Levels
TBC - To be considered
USC - United States Code

Appendix C

Transcript from Open Discussion at Public Information Session for Proposed Plan, July 13, 2004

Former Naval Surface Warfare Center (NSWC) White Oak, Silver Spring, Maryland

Public Meeting for the Proposed Plan for IR Site 49

A hearing in the above-titled matter was held on Tuesday July 13, 2004 at the Village Square Music Room, Riderwood Village, 3110 Gracefield Road, Silver Spring, Maryland 20850, before:

Navy Co-Chair: Mr. Walter Legg

Appearances

Bruce Beach
Scott MacEwen
Andy Zarins
Scott Nesbit
Bob Ridgeway

PROCEEDINGS

MR. WALTER LEGG: Okay, I guess we're ready to go with the proposed plan public meeting for Site 49. I guess we can skip through some of the introductory stuff. The topic here is the Site 49, the trichloroethene groundwater pollution in the 400 area. Questions and comments regarding the Site 49 proposed plan are the scope of this meeting. Any other questions or comments regarding other sites or other environmental investigations and remediation at White Oak can be addressed during the regular Restoration Advisory Board meeting, which again is tomorrow.

SLIDE PRESENTATION OF THE PROPOSED PLAN FOR SITE 49 (NOT PROVIDED)

MR. WALTER LEGG: Again, community acceptance is part of the evaluation criteria. All comments will be reviewed and the preferred alternative may be revised based upon comments that we receive. All your comments and responses will be incorporated into the record of decision. Public comment period runs through the end of the month, the public meeting is tonight. Once the plan is final, there will be a record of decision, which will be signed sometime in the fall, possibly in the winter, and the remedy put in place next year. Comments can be verbal tonight, written postmarked by the end of the month. Again, if you're going to send them by U.S. mail I would really appreciate you letting me know that they're coming. You can e-mail or you can call me at any time with any questions or comments.

1 With that, I welcome questions and comments now.
2 MR. DENNIS BROUD: I had a couple of questions.
3 One has to do with potassium permanganate. It degrades,
4 it's used up in the chemical reaction and manganese comes
5 out somewhere.
6 MR. SCOTT MACEWAN: Yes.
7 MR. DENNIS BROUD: And so what's the effect of that
8 long term? Is it of concern or not?
9 MR. SCOTT MACEWAN: In the long term it's not a
10 concern. Manganese is naturally in the groundwater and in
11 the rocks and you're going to find it there now. The
12 concentrations of manganese will probably go up a little
13 bit. The amount of potassium permanganate that's being put
14 in the ground, it's on the total magnitude of, I think the
15 feasibility study and design say about 300 pounds total, so
16 over this area it's not a whole lot. It's not expected --
17 and the response to this comment, I'll provide some
18 calculations about what to expect, but we wouldn't expect it
19 to go up above drinking water standards, risk-based
20 standards.
21 MR. DENNIS BROUD: I'm a little confused about the
22 explanation in here under the groundwater alternative 5,
23 because it says under alternative 5, as with alternative 4,
24 fractures in the rock will be expanded by injecting high-
25 pressure nitrogen gas. So 5 is really very similar to 4a
26 except that instead of potassium permanganate you're putting
27 in something to enhance the biodegradation?
28 MR. SCOTT MACEWAN: That's correct.
29 MR. DENNIS BROUD: So it's really more like 4, it

is a variation of 4a rather than something like 4, because it says you reduce the borings from 25 to 13. I can understand why you're doing that, but why you want to reduce the borings if it's just less work it would seem, but I'm kind of confused as to why 4a with half as many borings costs more than 4, and they both have the same 5-year remediation tactic. So why would you go spend a half a million dollars more to do the same thing if it's going to happen in 5 years? I mean, I'm a taxpayer too, and I figure half a million dollars could be used for something else. That's on observation I think more than a question.

MR. SCOTT MACEWAN: What's not in that proposed plan is a better explanation as to why we think that -- even though you're doing fewer borings, you're still going to have a lot better chance of getting --

MR. DENNIS BROUD: Well, I understand that, but fracturing the rock and so on, by fracturing the rock you think you'll get better penetration and you don't have to drill as many holes. But if drilling more holes is a half a million dollars cheaper, according to this estimated cost, who cares how many holes you put in the ground out there? It's not like anybody else is going to be running up and down that hill there or skiing or whatever.

MR. WALTER LEGG: The additional investment is associated with a higher probability of success.

MR. DENNIS BROUD: Well, that's not really explained in here.

MR. SCOTT MACEWAN: You're right. It's not well explained in there.

1 MR. DENNIS BROUD: Right. Because if I looked at
2 the chart, I mean, the difference between moderate to high
3 to high, I guess, is the rankings, and a half a million
4 dollars associated with the difference there. The numbers
5 have changed from one place to the other. Here to there
6 it's not quite $200,000. Basically what I was looking at is
7 the capital cost.
8 MR. JOHN TINO: Cost effectiveness is medium to
9 high.
10 MR. DENNIS BROUD: I guess the long-term, the
11 present worth cost, I'm not sure what that means. What does
12 that mean?
13 MR. SCOTT MACEWAN: Present worth cost is today's
14 value of the 30-year cost of the alternative or the total
15 cost of the alternative, so the future years are -- the
16 costs out, whatever, 10, 20 years from now in today's
17 dollars are less.
18 MR. DENNIS BROUD: Okay. But I gather what this is
19 telling me then is that the future costs are less -- are
20 likely to be less under alternative 4a than they are under
21 alternative 4 and that's why the two kind of merge in price
22 by the end. Is that what it's saying? So that the one --
23 because the numbers aren't jibing here, okay, when you look
24 at these two. One over here says $1.1 million is the cost
25 and $830,000 on the other one, and then when you go back to
26 this previous page, it says $1.2- to $1.3 million for one
27 and $830- to $890,000. I don't know what numbers you were
28 using. They didn't transpose here. It's not consistent. I
29 mean, I really don't care which one you use as long as it

gets done.

MR. SCOTT MACEWAN: You're right. It's inconsistent and I'll figure out which is the correct one and address that in the comments.

MR. DENNIS BROUD: So what I gather you're telling me is that long term it's only about a $200,000 difference and you think that 4a has a higher probability of success?

MR. SCOTT MACEWAN: That's correct.

MR. DENNIS BROUD: Okay. As long as you understand what's going on.

MR. WALTER LEGG: Any other questions or comments? Okay. I guess we'll close the meeting. Thank you all.

(Whereupon, at 7:54 p.m., the meeting was adjourned.)