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FINAL RECORD OF DECISION SITE 22 GROUNDWATER BURN PAD NWS YORKTOWN VA
09/01/2012
CH2M HILL

Final

Record of Decision

Site 22 Groundwater – Burn Pad

Naval Weapons Station Yorktown

Yorktown, Virginia

EPA ID: VA8170024170

NAVFAC

Naval Facilities Engineering Command

September 2012

1 Declaration

1.1 Site Name and Location

This Record of Decision (ROD) presents the selected remedy for groundwater at Environmental Restoration Program (ERP) Site 22, Burn Pad, at Naval Weapons Station (WPNSTA) Yorktown, Yorktown, Virginia. WPNSTA Yorktown was placed on the United States Environmental Protection Agency (USEPA) National Priorities List effective October 15, 1992 (USEPA Identification [ID]: VA8170024170).

1.2 Statement of Basis and Purpose

This remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended. This decision is based on information contained in the Administrative Record (AR) file for the site. Information not specifically summarized in this ROD or its references[1], but contained in the AR, has been considered and is relevant to the selection of the remedy at Site 22. Thus, the ROD is based upon and relies upon the entire AR file for the site remedy selection decision.

The United States Department of the Navy (Navy) is the lead agency and provides funding for ERP activities at Site 22. The Navy and USEPA Region 3, the lead regulatory agency, issue this ROD jointly. The Commonwealth of Virginia, Virginia Department of Environmental Quality (VDEQ), the support regulatory agency, concurs with the selected remedy.

1.3 Assessment of the Site

Groundwater is the only remaining environmental medium to be addressed at Site 22. A no further action ROD was signed for soil at Site 22 in 2003, and a no further action ROD for sediment and surface water at Site 22 was signed in 2011. Therefore, this ROD serves as the final ROD for Site 22.

Previous investigations concerning groundwater at Site 22 did not identify any potential ecological risks, but did identify the presence of chemicals of concern (COCs) at concentrations that pose a potential threat to human health. Trichloroethene (TCE) in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario. Vinyl chloride (VC) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario.

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

[1] Reference phrases, presented as ***Bold Italicized Text***, are followed by a corresponding number from the References Section.

1.4 Description of Selected Remedy

The selected remedy for Site 22 groundwater is comprised of the following components:

- Implementing Enhanced In Situ Bioremediation of RDX using emulsified vegetable oil bio-barriers perpendicular to groundwater flow in the target treatment area (with RDX above 100 micrograms per liter [µg/L]) to reduce the total time for achieving cleanup levels
- Using monitored natural attenuation (MNA) to address the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment
- Groundwater monitoring to collect data about COC concentrations and natural attenuation parameters
- Land Use Controls in the form of groundwater use restrictions to prevent contact with and use of groundwater until cleanup levels are met

The selected remedy will address COCs in groundwater at Site 22. Before completing the engineering design of the remedy, an investigation will collect additional data about natural attenuation and the extent of the RDX, TCE, and VC plumes. This investigation will help to design or, if necessary, enhance or change the remedy. The effectiveness of the selected remedy will be evaluated following a second in situ treatment event to determine if remedy enhancement (such as additional injections) or a different remedy is warranted.

The primary source of contamination was the release of chemicals that occurred during waste handling and the burning of materials on the ground surface. The contaminants that were released to the ground surface leached into the soil as a result of infiltration of rain water, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved phase groundwater plume. The contaminated soil at Site 22 was excavated and disposed of offsite in 2002 resulting in conditions that allow unlimited use and unrestricted exposure to soil at Site 22. Groundwater at Site 22 is not a principal threat waste.

1.5 Statutory Determinations

The selected groundwater remedy is protective of human health and the environment, complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action, is cost effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable. This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment). Because the remedy will result in hazardous substances, pollutants or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action, and every five years until cleanup is met, to ensure that the groundwater remedy is, or will be, protective of human health and the environment.

1.6 ROD Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information related to Site 22 can be found in the AR.

COCs and their respective concentrations (Section 2.5, **Table 2**)

Current and reasonably anticipated future land use assumptions and current and potential future uses of groundwater (Section 2.6)

Baseline risk represented by the COCs (Section 2.7, **Table 4**)

Cleanup levels established for COCs and the basis for these levels (Section 2.8, **Table 5**)

Estimated capital, annual operation and maintenance (O&M), and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (Section 2.9, **Table 6**)

How source materials constituting principal threats will be addressed (Section 2.10)

Key factor(s) that led to selecting the remedy (such as a description of how the selected remedy provides the best balance of tradeoffs with respect to the balancing and modifying criteria, highlighting criteria key to the decision) (Section 2.11.1)

Potential land and groundwater use that will be available at the site as a result of the selected remedy (Section 2.11.4, **Table 9**)

1.7 Authorizing Signatures

Navy Authorizing Signature for the Record of Decision for Groundwater at Site 22, the Burn Pad, WPNSTA Yorktown, Yorktown, Virginia

5 Sept 12

Captain Lowell D. Crow
Commanding Officer
Naval Weapons Station Yorktown

Date

Site 22, the Burn Pad, WPNSTA Yorktown, Yorktown, Virginia

September 17, 2012

Ronald J. Borsellino
Director
Hazardous Site Cleanup Division
USEPA (Region 3)

Date

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2 Decision Summary

2.1 Site Name, Location, and Description

Site 22 (Burn Pad)
Naval Weapons Station Yorktown
Yorktown, Virginia
USEPA ID: VA8170024170

WPNSTA Yorktown is a 10,624-acre installation located on the Virginia Peninsula between the York River and the James River in Virginia (**Figure 1**). WPNSTA Yorktown is bounded on the northwest by WPNSTA Yorktown Cheatham Annex and the King's Creek Commerce Center; on the northeast by the York River and the Colonial National Historic Parkway; on the southwest by Route 143 and Interstate 64; and on the southeast by Route 238 and the town of Lackey.

Site 22, the Burn Pad, encompasses a 9-acre area, located in the northeastern portion of WPNSTA Yorktown (**Figure 1**). An access road runs north-south and provides vehicle access to the site from the north (**Figure 2**). Site 22 consists of a grassy field surrounded by woods, situated on a flat, elevated area, with its ground surface sloping steeply to the east, south, and southwest toward the Eastern Branch of Felgates Creek and its unnamed tributary.

FIGURE 1
Regional Location Map

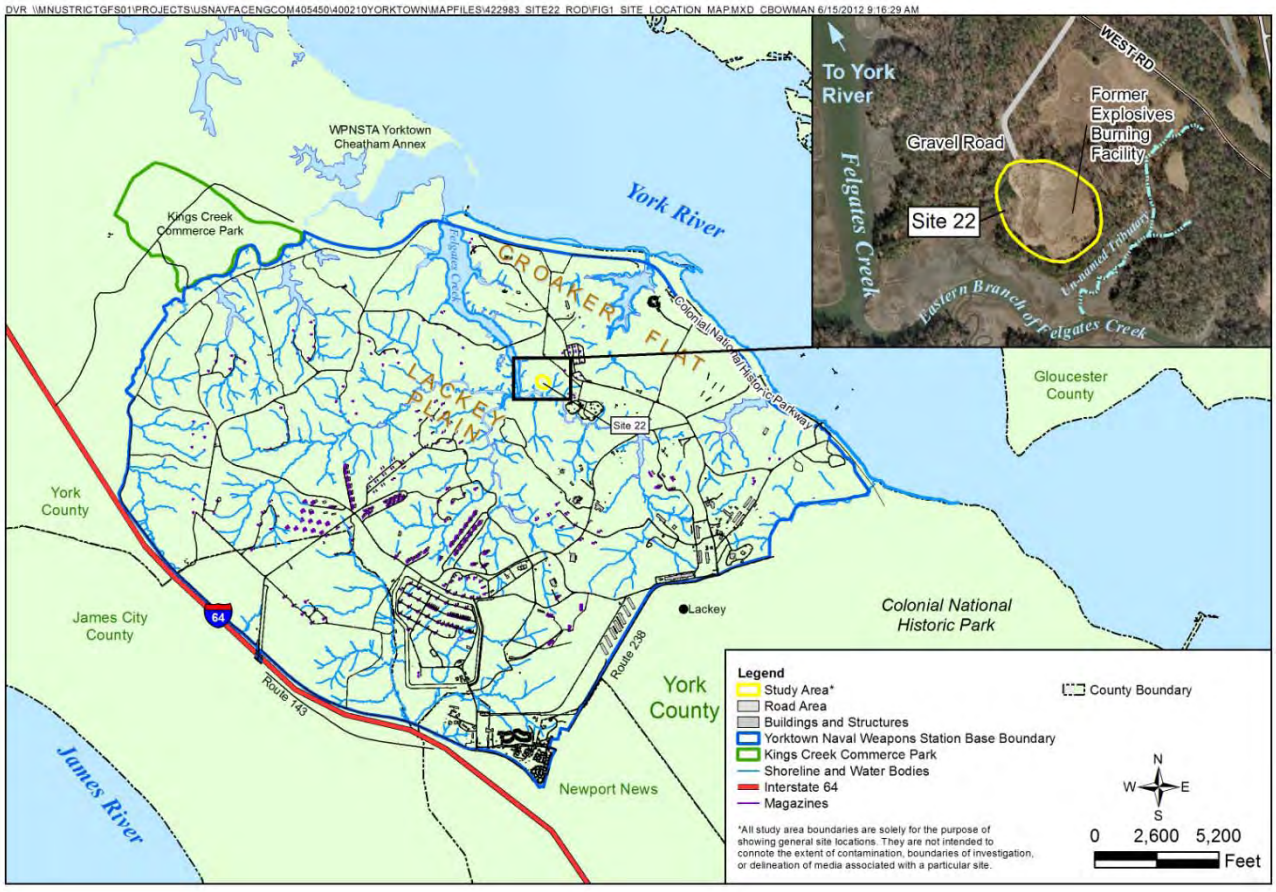
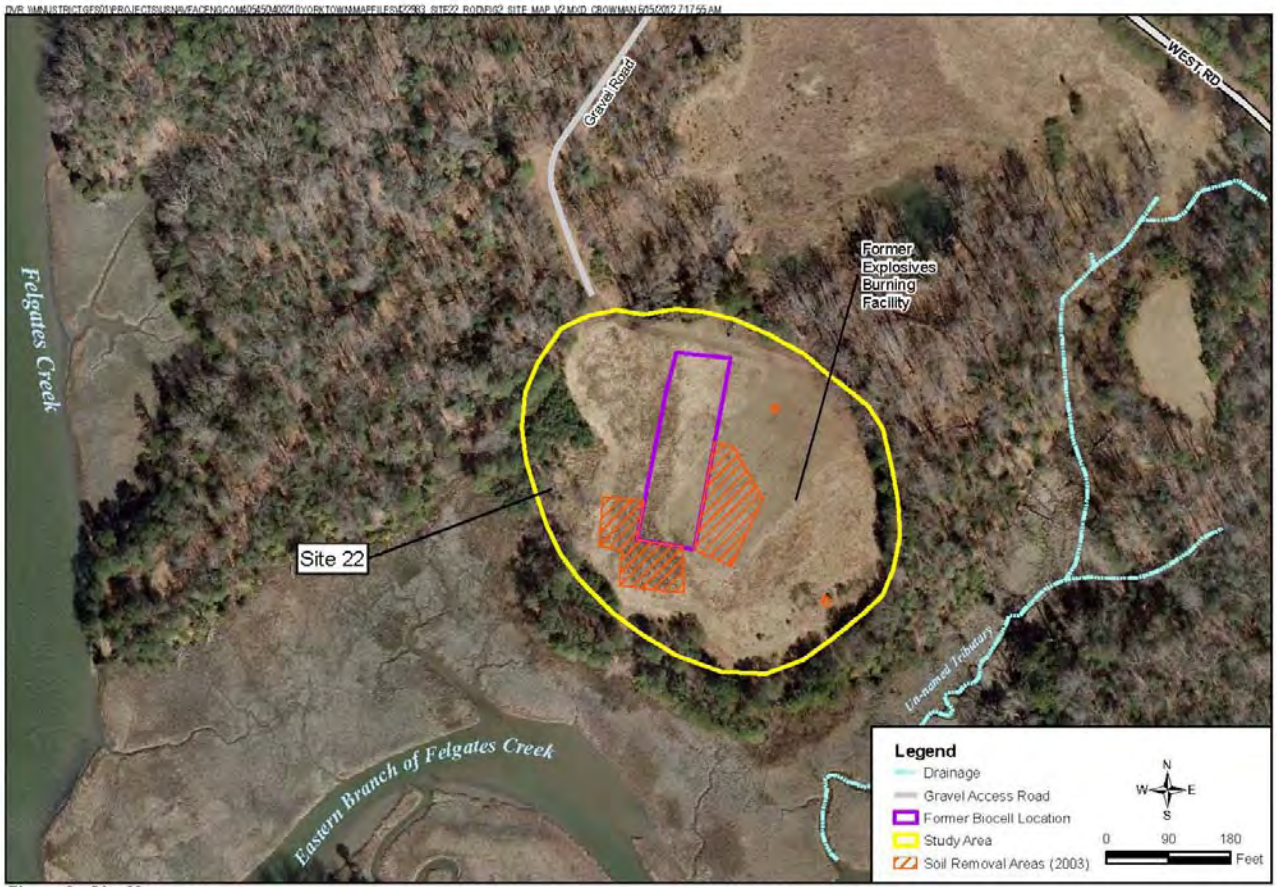


FIGURE 2
Site Map



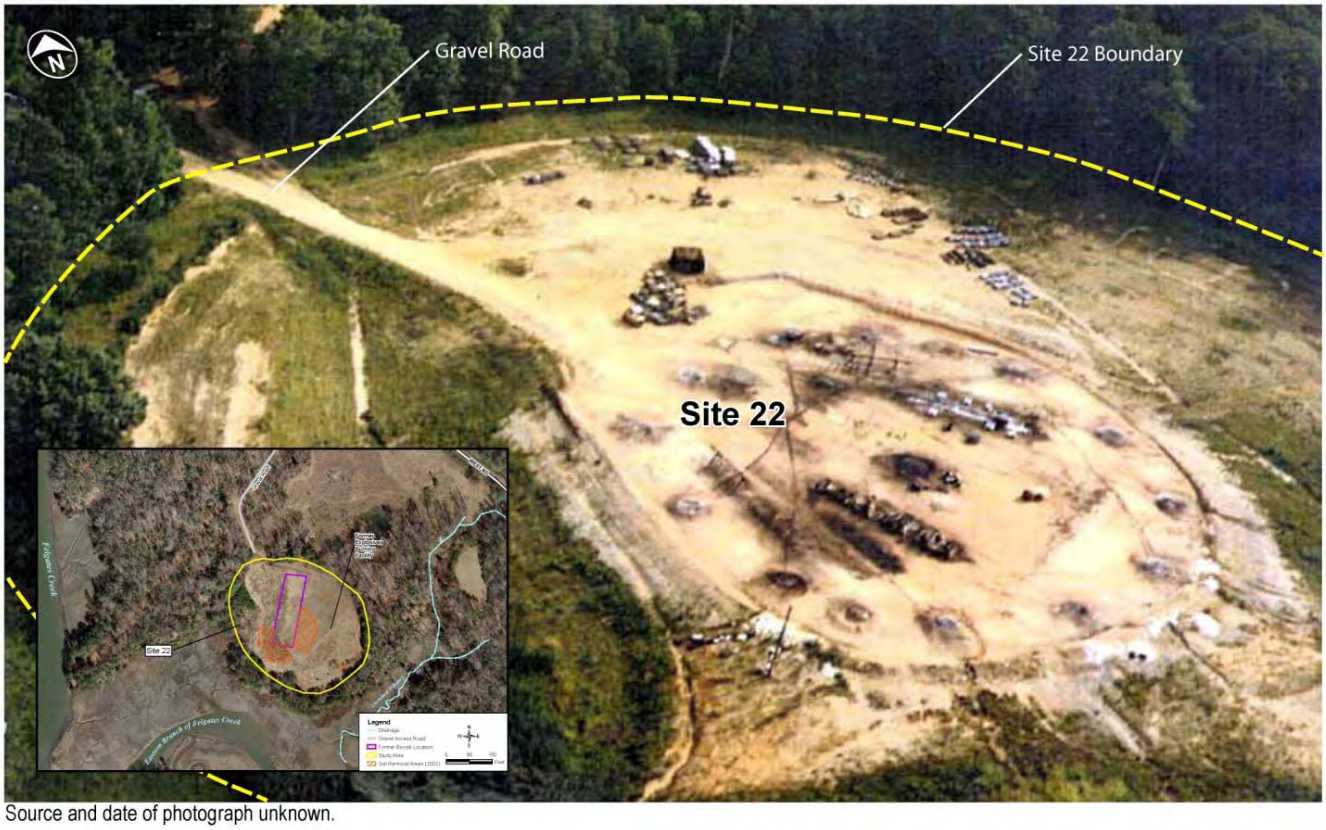
2.2 Site History and Enforcement Activities

Originally named the United States Mine Depot, WPNSTA Yorktown was established in 1918 to support the laying of mines in the North Sea during World War I. For 20 years after World War I, the depot continued to receive, reclaim, store, and issue mines, depth charges, and related materials. During World War II, the facility was expanded to include three trinitrotoluene loading plants and new torpedo overhaul facilities. A research and development laboratory for experimentation with high explosives was established in 1944. In 1947, a quality evaluation laboratory was developed to monitor special tasks assigned to the facility, which included the design and development of depth charges and advanced underwater weapons. On August 7, 1959, the depot was renamed the United States Naval Weapons Station. Today, the primary mission of WPNSTA Yorktown is to provide ordnance, technical support, and related services to sustain the war-fighting capability of the armed forces in support of national military strategy.

Site 22 was used for burning waste explosives and spent solvents generated from loading operations from the early 1940s until 1995. The ash from the burned solvents and explosives was transported to the Burning Pad Residue Landfill.

Site 22 once contained a 150-foot-diameter, circular array of 11 steel burning pans that were used for burning waste plastic explosives and spent solvents. A historical photograph taken in 1983 is included as **Figure 3**, and shows the numerous burn pads in a circular formation in the central and southern portion of Site 22.

FIGURE 3
Site 22 Historical Aerial Photograph



Source and date of photograph unknown.

In 1996, a 153-foot by 86-foot biocell was constructed at Site 22 and used for the treatment of nitramine-contaminated soils and trinitrotoluene-contaminated soils from WPNSTA Yorktown Sites 7 and 19 (**Figure 2**). Use of the biocell ended in 1999, and it was subsequently removed.

In 2002, a removal action was completed to remove contaminated soils from Site 22 (**Figure 2**). The COCs included the following: carcinogenic polynuclear aromatic hydrocarbons, octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine, cadmium, copper, and lead. Contaminated soil was excavated to a depth of 2 feet, and confirmation samples were collected. Approximately 3,450 cubic yards of soil were removed. A ***ROD*** (Ref. 1) was signed in 2003 documenting that no further action for unlimited use and unrestricted exposure was necessary for soil at Site 22. In addition, a ***ROD*** (Ref. 2) documenting that no further action was necessary for sediment and surface water at Site 22 was signed in 2011.

Groundwater at Site 22 has been characterized during several investigations. **Table 1** provides a chronological list and brief summary of previous groundwater investigations conducted at Site 22. The respective investigation documents are a part of the AR and can be referenced for further details for specific sampling strategies, media investigations, and when and where the sampling was performed. The documents listed are available in the AR and provide detailed information used to support remedy selection at Site 22.

TABLE 1
Summary of Previous Groundwater Studies and Investigations at Site 22

Previous Study / Investigation* (Document and Document Date)	Sites	Investigation Activities
Round Two Remedial Investigation Report, Sites 4, 21, and 22 Baker, 2001	Sites 4, 21, and 22	From August to November 1996, groundwater, surface water, and surface/subsurface sediment samples were collected to evaluate potential risks to human health and the environment (**Figure 4**). Samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds, TCL pesticides/polychlorinated biphenyls, explosives and Target Analyte List metals and cyanide. The ***analytical results*** (Ref. 3) of six groundwater samples at Site 22 were used to complete a Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA). The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors under a beneficial use scenario for groundwater. The ERA, which was based on a screening of groundwater concentrations at Site 22 against marine surface water screening levels, indicated aquatic receptors would potentially be at risk from exposure to 1,1-dichloroethene, TCE, di-n-butylphthalate, aldrin, and several explosives and metals if groundwater contaminants from Site 22 were to discharge to a surface water body without dilution or natural attenuation. The ***analytical results*** (Ref. 4) of six co-located surface water and sediment samples at Site 22 were used to complete an HHRA and an ERA. The HHRA indicated no unacceptable non-cancer hazards or cancer risks to current or future receptors from exposure to surface water and sediment. The ERA indicated potential risk to ecological receptors from exposure to several pesticides, explosives, and metals in sediment.
Remedial Investigation Report for Groundwater at Sites 4, 21, and 22 CH2M HILL, 2009	Sites 4, 21, and 22	From March 2007 to April 2008, groundwater, groundwater seep, surface water, and surface and subsurface sediment samples were collected to evaluate potential risks to human health and the environment. Upstream surface water and sediment samples were also collected to assess site-specific background conditions (Figure 4). Samples were analyzed for TCL VOCs, TCL semivolatile organic compounds, TCL pesticides and polychlorinated biphenyls, explosives, and Target Analyte List metals and cyanide. The analytical results (Ref. 5) of 12 groundwater samples at Site 22 were used to complete an HHRA and ERA. The HHRA indicated potential cancer risks to future residents due to exposure to VC, RDX, and arsenic, as well as non-cancer hazards to future residents from exposure to RDX, arsenic, and heptachlor epoxide, and to construction workers due to exposure to TCE. TCE, heptachlor epoxide, VC, RDX, and arsenic were identified as human health COCs within the Yorktown-Eastover aquifer at Site 22 under a future exposure scenario. However, based on the final results of the remedial investigation (RI), the COCs in groundwater at Site 22 identified for action were TCE, VC, and RDX (refer to Section 2.5.1 of this ROD). The RI concluded that development of a Feasibility Study (FS) for Site 22 groundwater was warranted. The ERA indicated no COCs were identified for seep exposures at Site 22. Similarly, no COCs were identified for food web exposures. Thus, risks to ecological receptors were considered acceptable. Groundwater is generally considered only as a transport medium since there are no ecological exposures to groundwater until it discharges to a water body or surfaces as a seep. The analytical results (Ref 6) of 11 co-located surface water and sediment samples, two independently located sediment samples, and six co-located background surface water and sediment samples were used to complete a HHRA and ERA. The ERA was completed to reevaluate conditions in surface water and sediment following the soil removal action. The HHRA and ERA identified no unacceptable risk to human health or the environment. Based on the results of the HHRA and ERA, the RI concluded that no unacceptable risk to human health or the environment from exposure to surface water or sediment is present at Site 22; therefore, no additional action was recommended to address surface water and sediment adjacent to the site.
Feasibility Study Report for Groundwater at Site 22 CH2M HILL, 2011	Site 22	An FS was generated to evaluate alternatives (Ref. 7) for remediation of TCE, VC, and RDX present at unacceptable levels in the groundwater. The preferred alternative as presented in the FS was Alternative 2 - Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, VC and RDX; and Land Use Controls.

FIGURE 4
Historical Sample Layout

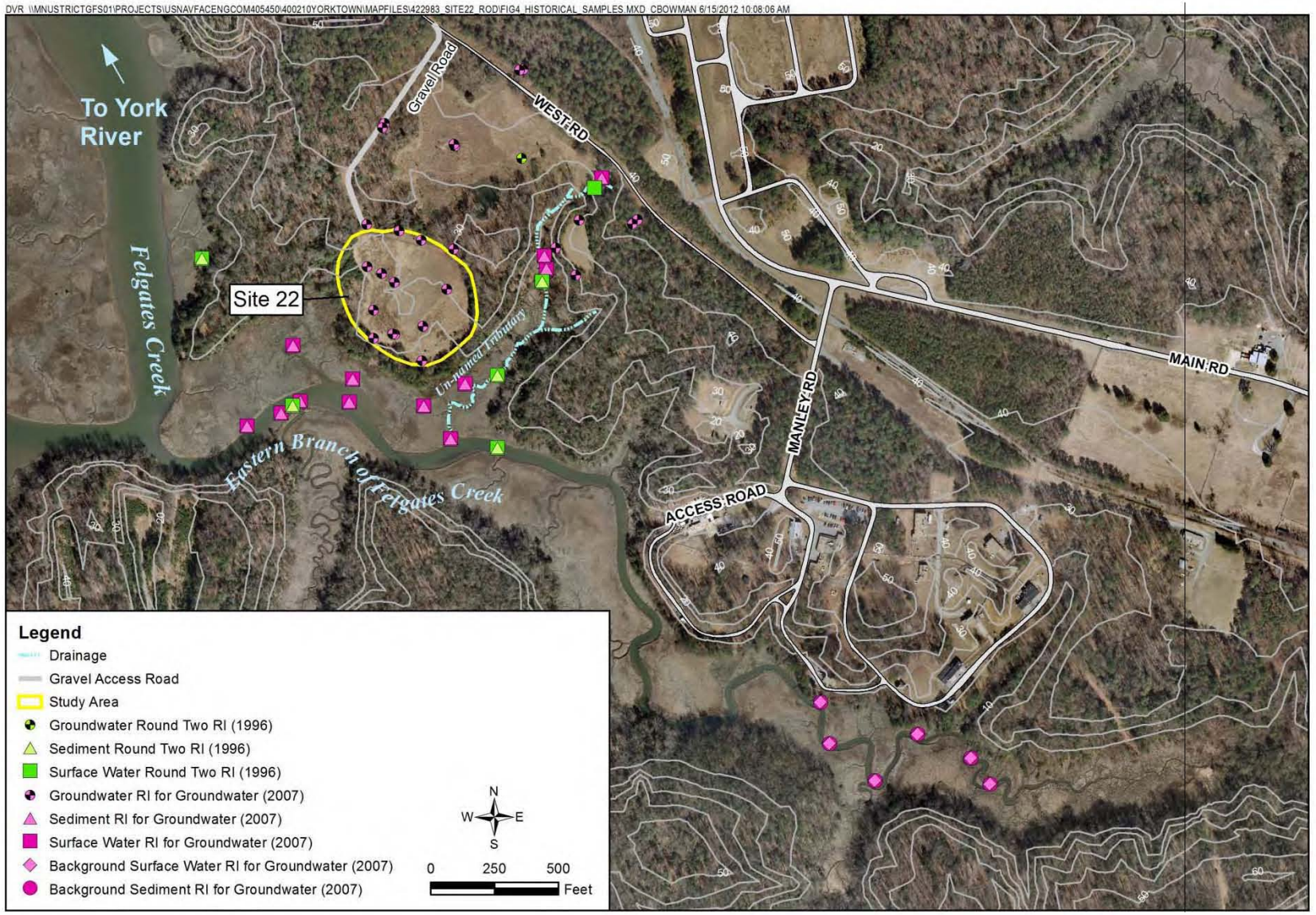


*__Figure 4__ illustrates the most recent activities conducted at each sampling location at Site 22 (sample locations associated with adjacent Sites 4 and 21 are included for completeness). In instances of samples collected in the same location across multiple reports, the most recent sampling event is shown.

2.3 Community Participation

Community participation at WPNSTA Yorktown includes a Restoration Advisory Board (RAB), public meetings, a public information repository, newsletters, fact sheets, public notices, and an ERP Website. The Community Involvement Plan for WPNSTA Yorktown, updated in 2009, provides detailed information on community participation for the ERP. The RAB was formed in 1994 and consists of community members and representatives from USEPA Region 3, VDEQ, and the Navy. RAB meetings are held twice a year and are open to the public to provide opportunity for public comment and input.

The investigations conducted at Site 22, the findings, and the documents in the AR form the basis for this ROD. A Proposed Plan (PP) was developed and made available for public review to request public input on the selected remedy for groundwater. In accordance with 40 Code of Federal Regulations 300.430(f)(3)(i)(A), a notice of availability of the PP was published in *The Virginia Gazette* and the *Daily Press* on May 12 and 13, 2012, respectively. The PP was available for review during the public comment period in accordance with Section 117(a) of CERCLA at the York County Public Library – Yorktown (8500 George Washington Memorial Highway, Yorktown, Virginia 23692, 757-890-3376). The public comment period ran from May 14 through June 28, 2012, and included a public meeting to present the PP, which was held on May 24, 2012 at the York County Public Library – Yorktown. No comments were received during the public comment period.

This ROD, the PP, and all other information that supports the selected remedy for groundwater at Site 22 are available in the AR. The AR is accessible through the WPNSTA Yorktown ERP public website at http://go.usa.gov/yFb or by contacting the WPNSTA Yorktown Public Affairs Officer at:

Public Affairs Office
P.O. Drawer 160
Yorktown, VA 23691-0160
Phone: (757) 887-4939

2.4 Scope and Role of Operable Unit

Comprehensive environmental restoration activities at WPNSTA Yorktown began in 1984 under the Navy Assessment and Control of Installation Pollutants program, prior to state and federal regulatory oversight of environmental activities at the installation. The Navy Assessment and Control of Installation Pollutants program was modified to become the ERP in 1986 (then known as the Installation Restoration Program) to meet the requirements of CERCLA, as amended. WPNSTA Yorktown was added to the National Priorities List on October 15, 1992 (USEPA ID: VA8170024170). A Federal Facilities Agreement (FFA) between the Navy and USEPA Region 3 was signed in 1994. This FFA identified CERCLA sites, Site Screening Areas, and areas of concern for investigation and possible cleanup, and provided the framework and a schedule to accomplish this work. Subsequent to the FFA, additional sites, Site Screening Areas, and areas of concern were added to the ERP. Site 22 was evaluated in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan under the Navy's ERP, the status of which can be found in the current version of the Site Management Plan in the AR file for WPNSTA Yorktown.

This ROD presents the selected remedy for groundwater at Site 22. The selected remedy documented in this ROD for groundwater at Site 22 does not include or affect any other media at Site 22 or any other sites at WPNSTA Yorktown. The WPNSTA Yorktown ERP consists of 31 sites including Site 22 as detailed below:

There are 28 Installation Restoration Program sites at various phased of investigation or cleanup. Although RODs are in place for select media at some sites, below is a summary based on the last media being addressed at each site:

- Fifteen (15) sites under investigation (Sites 1, 3, 6, 7, 8, 9, 19, 23, 24, 25, 26, 31, 32, 33, and 34)
- One (1) site at the remedy decision stage (Site 22)

- Two (2) sites in long-term management (Sites 12 and 16)
- Ten (10) closed sites (Sites 4, 5, 11, 17, 18, 21, 27, 28, 29, and 30)

There are 3 Munitions Response Program sites at various phases of investigation and cleanup. Below is a summary based on the last media being addressed at each site:

- Two (2) sites under investigation (UXO 2 and 3)
- One (1) closed site (UXO 1)

2.5 Site Characteristics

Site 22 consists primarily of a flat, grass-covered open area surrounded by woods; elevations for the site range from 20 to 32 feet above mean sea level. The southern and eastern edges of the site slope steeply toward the east, south, and southwest, toward the Eastern Branch of Felgates Creek and its unnamed tributary (**Figure 2**). Felgates Creek is a tidally influenced tributary to the York River. A gravel road runs north-south and provides vehicle access to Site 22 from the north. The site is currently unused except for periodic recreational hunting, and is located within a restricted area of WPNSTA Yorktown.

The hydrogeology at Site 22 consists of unsaturated soils at the ground surface, which are lithologically consistent with the Yorktown confining unit (gray silt and clay). The uppermost saturated unit in the Site 22 area is the Yorktown-Eastover aquifer, which lies below the 10- to 30-foot-thick Yorktown confining unit. The Yorktown-Eastover aquifer consists of coarse, shelly, gray sand, and is approximately 25 to 50 feet thick in the vicinity of Site 22. This aquifer overlies the Eastover-Calvert confining unit. There is no current or expected future use for groundwater at Site 22; drinking water is supplied to WPNSTA Yorktown and the surrounding area by the City of Newport News Waterworks.

Groundwater at Site 22 ranges from 5 to 20 feet bgs and flows to the south toward drainage channels and the Eastern Branch of Felgates Creek (**Figure 5**).

A ***conceptual site model*** (Ref. 8) was developed to summarize site conditions, contaminant distribution, transport pathways, potential receptors, exposure pathways, and land use for Site 22 (**Figure 6**). The sources of contamination were releases of chemicals that occurred during waste handling and burning of materials on the ground surface. No subsurface burial of materials at Site 22 is known to have occurred. Some of the contaminants that were released to the ground surface leached into the soil as a result of infiltration of stormwater, causing downward migration of contamination into subsurface soil and ultimately creating a dissolved-phase groundwater plume. Much of the contamination remained relatively close to the land surface due to adsorption to soil. The contaminated soil at Site 22 was excavated and disposed of offsite and a no further action ROD which allows unlimited use of and unrestricted exposure to soil was signed in 2003. Contaminant concentrations in the groundwater of the Yorktown-Eastover aquifer at Site 22 are likely to decrease in the future because the source is no longer present and there is no ongoing release mechanism.

FIGURE 5
Yorktown-Eastover Aquifer Potentiometric Surface Map

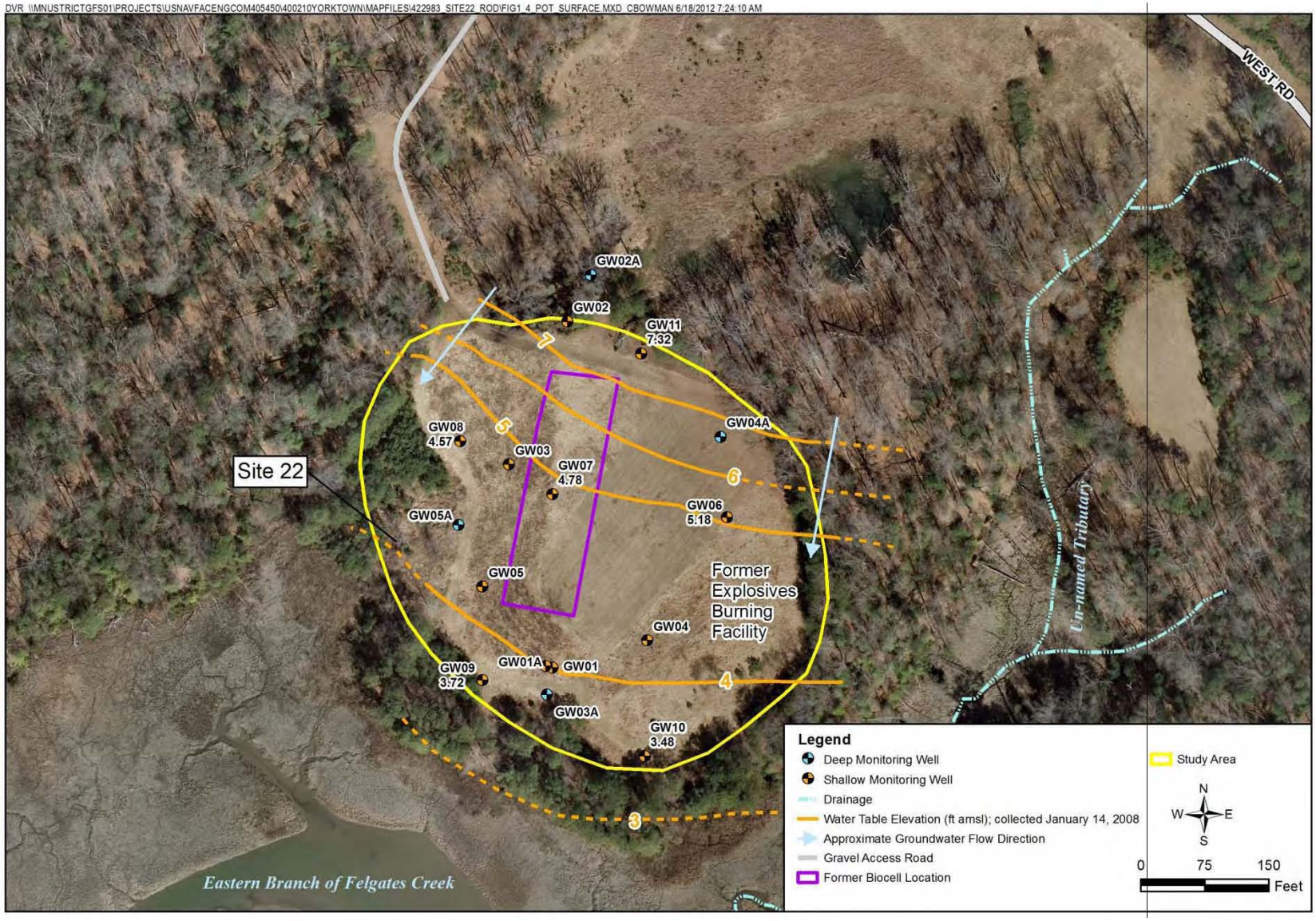
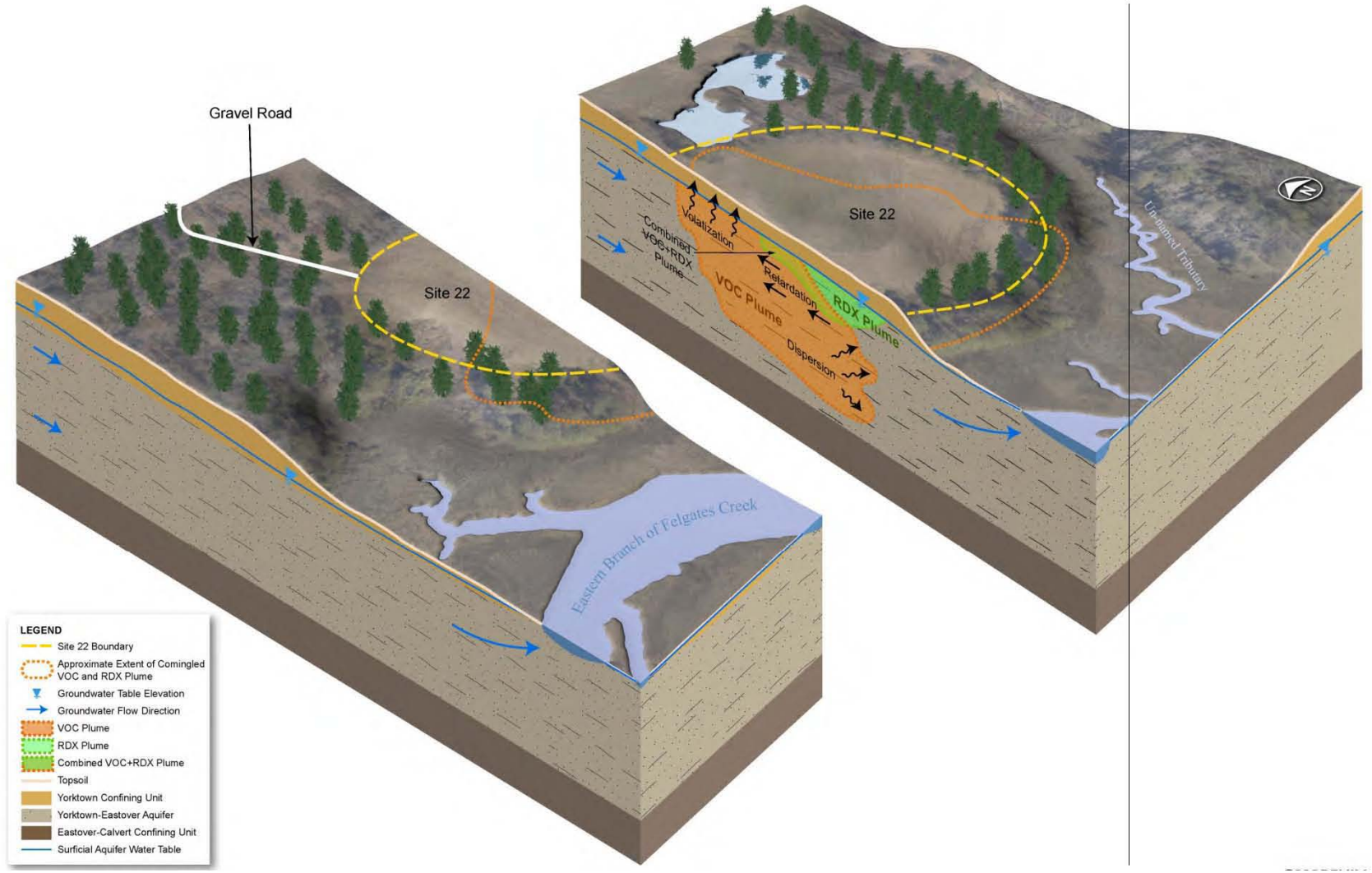


FIGURE 6
Conceptual Site Model



2.5.1 Nature and Extent of Contamination in Groundwater

Numerous investigations (Ref. 9) have been conducted to characterize potential impacts at Site 22 (**Table 1**). Based on the results of these investigations, the COCs in groundwater at Site 22 are TCE, VC, and RDX. Sampling locations from previous investigations are depicted on **Figure 4**, and the nature and extent of contamination is discussed as follows. Maximum concentrations of chemicals identified as site COCs detected from the October 2007 sampling event Site 22 groundwater are presented in **Table 2**.

TABLE 2
October 2007 Sampling: Maximum Detected Concentrations of Site 22 Chemicals of Concern in Groundwater

VOCs	Concentration (µg/L)	MCL (µg/L)
TCE	650	5
VC	17	2
Explosives	**Concentration (µg/L)**	**RSL (µg/L)**
RDX	150	0.61

The ***results*** (Ref. 10) of the investigations at Site 22 indicated that TCE, VC, and RDX concentrations exceeded their respective Maximum Contamination Level (MCL) or Regional Screening Level (RSL) in shallow groundwater. TCE was detected at concentrations exceeding the MCL (5 µg/L) in five shallow monitoring wells, VC was detected at concentrations exceeding the MCL (2 µg/L) in two shallow monitoring wells, and RDX was detected at concentrations exceeding the RSL (0.61 µg/L) in 10 shallow monitoring wells.

The TCE, VC, and RDX groundwater contamination is present in a "corridor" that runs through the middle of Site 22 from north to south (**Figure 7**). Analytical results indicated the VOCs and RDX detected in groundwater were within the upper portion of the Yorktown-Eastover aquifer. The highest concentrations of TCE, VC, and RDX were detected between 10 and 50 feet bgs along the central portion of the site in sand containing a number of silt and clay stringers that may be retarding the downward mobility of the contaminants. No COCs were identified in samples taken from the base of the Yorktown-Eastover aquifer, which lies above the Eastover Calvert confining unit. Contaminant discharge to surface water via groundwater was not found to exceed any risk screening values (adjusted RSLs or ecological screening values) at Site 22; groundwater is therefore not a significant continuing source of contaminants to the aquatic habitats adjacent to the site.

2.5.2 Fate and Transport of COCs in Groundwater

The lateral groundwater seepage velocity at Site 22 is approximately 0.128 feet per day. However, contaminants are not expected to migrate as rapidly as groundwater because of a tendency for sorption to soil particles (retardation). Contaminants may also be migrating in groundwater through dispersion, which may slowly increase the size of the contaminant plume in groundwater. Volatilization of some contaminants from the groundwater into the air is also a possible migration pathway where elevated concentrations of chlorinated solvents are present.

TCE and VC

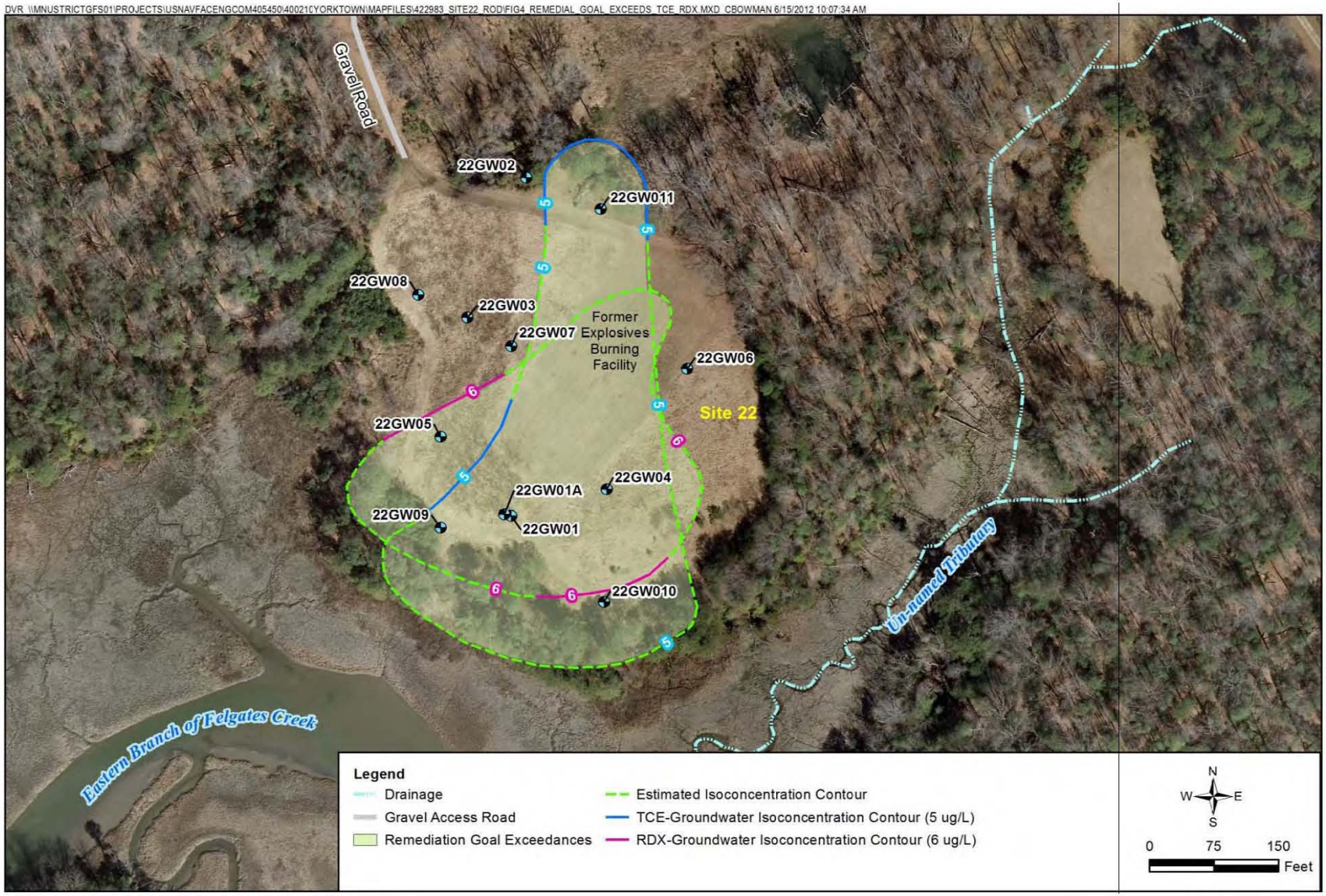
The source of TCE and its degradation product, VC, are likely releases from burn activities previously conducted at Site 22. Chlorinated VOC concentrations such as TCE and VC can change over time due to dilution and dispersion, but the primary mechanism for reductions under naturally occurring conditions is ***biodegradation*** (Ref. 11). Historical groundwater data for monitoring well YS22-GW04 demonstrates a trend of decreasing contaminant mass and/or concentration over time (**Table 3**). In addition, other sites at WPNSTA Yorktown, which share similar contaminants and aquifer characteristics, have demonstrated that the MNA process is a viable component of the selected groundwater remedy.

TABLE 3
TCE and Associated Degradation Products in Monitoring Well YS22-GW04 at Site 22

VOCs (µg/L)	11/12/1996	10/25/2007
TCE	1200	69
1,1-Dichloroethene	1700	37
cis-1,2-Dichloroethene	Not Analyzed	22
trans-1,2-Dichloroethene	Not Analyzed	10U
Total 1,2-Dichloroethene	*370*	*32*
VC	Not Detected	10U

U - The material was analyzed for, but not detected.

FIGURE 7
Remedial Goal Exceedances TCE and RDX



Note: Remedial goals are detailed in Section 2.8.

Biodegradation of chlorinated ethenes (such as TCE and VC) occurs through two primary mechanisms: co-metabolism and reductive dechlorination. Co-metabolism occurs as a fortuitous destruction of contaminants by organisms intending to metabolize other organic compounds. Reductive dechlorination occurs as part of a microbial respiratory process called halorespiration. As halorespiring organisms make energy, each chlorine ion on the chlorinated VOC molecule is sequentially replaced with hydrogen. Once all chlorine ions have been replaced, only innocuous end-products, such as chloride, ethene, and ethane remain. *Dehalococcoides sp.* is the primary organism known to be capable of completely degrading contaminants like TCE to innocuous end products. This organism thrives under oxygen depleted (reducing) conditions. The reductive dechlorination type of biodegradation is currently occurring at Site 22. This is evidenced by the presence of the *Dehalococcoides sp.* and partially degraded TCE. TCE contains three chlorine ions. Cis-1,2-DCE contains two chlorine ions and VC contains only one. The presence of these less-chlorinated compounds indicates that halorespiring organisms are removing the chlorines through their respiratory process.

Geochemical and microbial samples were collected from two wells (YS22-GW01 and YS22-GW04) at Site 22. Results from these two locations suggest the site is characterized by low concentrations of native and/or anthropogenic carbon (0.5U and 1.0 milligram per liter, respectively). In addition to the geochemical data, the presence of the *Dehalococcoides sp.* bacterial species (0.134J and 0.493 cells per milliliter, in monitoring wells YS220GW01 and YS22-GW04,respectively), which is the only microbe identified to be capable of degrading chlorinated ethenes completely to ethane, was identified at Site 22.

RDX

The likely source of RDX is releases from burn activities previously conducted at Site 22. RDX can be biodegraded under both oxygen rich and oxygen poor conditions by a variety of microorganisms. Three mechanisms for the biodegradation of RDX have been identified: two-electron reduction, single-electron reduction/denitration, and direct enzymatic cleavage. The denitration pathway is considered the major pathway for biodegradation in the natural environment, resulting in the formation of products such as nitrite, ammonia, formaldehyde, and formic acid. Under ideal (laboratory) conditions, the biodegradation rate for RDX is exponential, and could decay as much as 1 to 5 times in a day (that is, a half-life of 0.2 to 1 day). RDX is not volatile and not very mobile; therefore, biodegradation is believed to be the primary attenuation mechanism for this chemical.

2.6 Current and Potential Future Land and Resource Uses

Site 22 is currently unused except for periodic recreational hunting, and is predominantly characterized by vegetated fields within a locked wire gate. Site 22 is located inside an area encumbered by the Explosive Safety Quantity Distance, which limits the activities that can be performed to explosives-related functions; therefore, the site cannot be developed for real estate purposes. It is anticipated that WPNSTA Yorktown will remain a military installation for the foreseeable future, and use of Site 22 will remain the same.

Groundwater from the Yorktown-Eastover aquifer in the vicinity of Site 22 is not a current or anticipated future source of drinking water at WPNSTA Yorktown due to generally low natural water quality and yield and a more readily available potable water source. Potable water at WPNSTA Yorktown is currently supplied by the City of Newport News Waterworks. However, the Commonwealth of Virginia considers all aquifer groundwater of potential beneficial use as potable water.

2.7 Summary of Site Risks

The baseline risk assessment estimates what risks the site poses if no action was taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this site.

Potential human health and ecological risks at Site 22 were evaluated for groundwater and documented in the 2009 RI report (**Appendix A**). The following subsections and **Table 4** briefly summarize the findings of the risk assessments.

2.7.1 Summary of Human Health Risk Assessment

As part of the 2009 RI report for Site 22, an HHRA was completed. Based on the human health conceptual site model (**Appendix B**), risks were quantitatively evaluated for future adult construction workers and future adult/child residents exposed to shallow groundwater using reasonable maximum exposure (RME) and central tendency exposure (CTE) scenarios. Exposure pathways that were quantified included inhalation/ingestion of and dermal contact with groundwater for hypothetical future lifetime adult and child residents and ingestion and dermal contact with groundwater for hypothetical future construction workers. Based on current site use and conditions, there are no ***complete exposure pathways*** (Ref. 12) for groundwater at Site 22. The vapor intrusion pathway was not evaluated as part of this RI (the pathway is incomplete; there are no buildings); potential future risk for the vapor intrusion pathway will be addressed in the LUC RD.

The RME calculation determines risk based on the highest level of human exposure that could reasonably be expected to occur, whereas the CTE level reflects human exposure to average concentrations across the site. The potential non-cancer hazards, expressed as the hazard index (HI), and cancer risk estimates were calculated using RME concentrations. For non-cancer effects, an HI represents the ratio between the reference dose and the dose for a person in contact with site chemicals of potential concern. An HI exceeding 1.0 indicates that potential health effects may occur. For known or suspected carcinogens, acceptable exposure levels generally are concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (a 1 in 10,000 chance of developing cancer) and 10^{-6} (a 1 in 1,000,000 chance of developing cancer) using information on the relationship between dose and response.

Potential unacceptable human health risks (Ref. 13) were identified under a future resident and/or construction worker exposure scenario due to exposure to TCE, heptachlor epoxide, VC, RDX, and arsenic within the Yorktown-Eastover aquifer (**Table 4**).

Although arsenic and heptachlor epoxide contributed to the total RME cancer risk for the future lifetime resident (adult/child) scenario, the Navy, in partnership with USEPA and VDEQ, agree that no additional action is required for these chemicals for the following reasons:

- Although arsenic was considered a human health COC under the RME scenario, concentrations of arsenic did not pose risk under the CTE scenario
- Dissolved arsenic concentrations did not exceed the MCL (10 µg/L)
- Arsenic concentrations are consistent with natural background concentrations rather than a site-related CERCLA source
- Heptachlor epoxide (YS22-GW03 at 0.21 µg/L) only slightly exceeded the MCL (0.2 µg/L) in 1 out of 13 samples
- The low concentrations of heptachlor epoxide suggest its presence is attributable to routine pesticide treatment activities by the base
- The HHRA concluded TCE and VC in groundwater exceed MCLs and contribute to potential risk under hypothetical future exposure scenarios in the upper portion of the Yorktown-Eastover aquifer. No MCL exists for RDX, but concentrations were found to pose potential risk under hypothetical future exposure scenarios. COCs were not detected above MCLs or RSLs in the deep portion of the Yorktown-Eastover aquifer. The Navy, in partnership with USEPA and VDEQ, agree that remedial action for groundwater is necessary to address TCE, VC, and RDX in the upper portion of the Yorktown-Eastover aquifer.

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TABLE 4

Summary of Potential Human Health Risks for Site 22 COCs

Receptor	Exposure Pathway	COC	Exposure Point Concentration	RME Cancer Risk	RME Non-Cancer Risk (HI)	CTE Cancer Risk	CTE Non-Cancer Risk (HI)	Cancer Toxicity Factor (Cancer Slope Factor) milligrams per kilogram per day^{-1}	Non-Cancer Toxicity Factor (Reference Dose) milligrams per kilograms per day
Future Resident Adult	Ingestion	VC	17	N/A	0.16	Not Applicable (N/A)	0.016	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.3	N/A	0.089	9.1	0.000013
		RDX	94.17	N/A	0.86	N/A	0.076	0.11	0.003
		Arsenic	6.96	N/A	0.64	N/A	0.21	1.5	0.0003
		Total*	--	--	**2.9[1]**	--	0.62	--	--
	Dermal Contact	VC	17	N/A	0.0083	N/A	0.00077	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.62	N/A	0.17	9.1	0.000013
		RDX	94.17	N/A	0.0077	N/A	0.00064	0.11	0.003
		Arsenic	6.96	N/A	0.0033	N/A	0.00068	1.5	0.0003
		Total*	--	--	0.8	--	0.21	--	--
	Inhalation/Shower	TCE	315	1.6 x 10-5	0.039	4.0 x 10^{-6}	0.026	0.007	0.17
		VC	17	2.7 x 10-6	0.018	6.8 x 10^{-7}	0.012	0.015	0.029
		Total*	--	3.3 x 10-5	0.1	8.2 x 10^{-6}	0.9	--	--
	Total Across All Exposure Routes	--	--	3.3 x 10-5	**3.8[1]**	8.2 x 10^{-6}	0.07	--	--
Future Resident Child	Ingestion	VC	17	N/A	0.36	N/A	0.053	0.72	0.003
		Heptachlor epoxide	0.142	N/A	0.70	N/A	0.30	9.1	0.000013
		RDX	94.17	N/A	**2.0**	N/A	0.25	0.11	0.003
		Arsenic	6.96	N/A	**1.5**	N/A	0.70	1.5	0.0003
		Total*	--	--	**6.8**	--	**2.1**	--	--
	Dermal Contact	VC	17	N/A	0.020	N/A	0.0015	0.72	0.003
		Heptachlor epoxide	0.142	N/A	**1.4**	N/A	0.34	9.1	0.000013
		RDX	94.17	N/A	0.017	N/A	0.0013	0.11	0.003
		Arsenic	6.96	N/A	0.0098	N/A	0.0015	1.5	0.0003
		Total*	--	--	**1.8**	--	0.41	--	--
	Total Across All Exposure Routes	--	--	N/A	**8.7**	N/A	**2.5**	--	--
Future Lifetime Resident (Adult/Child)	Ingestion	TCE	315	6.1 x 10-5	N/A	5.3 x 10^{-6}	N/A	0.013	N/A
		VC	17	**1.8 x 10-4**	N/A	1.4 x 10^{-5}	N/A	0.72	0.003
		Heptachlor epoxide	0.142	1.0 x 10-5	N/A	4.4 x 10^{-6}	N/A	9.1	0.000013
		RDX	94.17	**1.5 x 10-4**	N/A	1.0 x 10^{-5}	N/A	0.11	0.003
		Arsenic	6.96	**1.6 x 10-4**	N/A	3.9 x 10^{-5}	N/A	1.5	0.0003
		Total*	--	**6.4 x 10-4**	N/A	8.7 x 10^{-5}	N/A	--	--
	Dermal Contact	TCE	315	1.0 x 10-5	N/A	6.0 x 10^{-7}	N/A	0.013	N/A
		VC	17	9.8 x 10-6	N/A	4.9 x 10^{-7}	N/A	0.72	0.003
		Heptachlor epoxide	0.142	4.0 x 10-5	N/A	6.1 x 10^{-6}	N/A	9.1	0.000013
		RDX	94.17	1.4 x 10-6	N/A	6.2 x 10^{-8}	N/A	0.11	0.003
		Arsenic	6.96	8.9 x 10-7	N/A	9.8 x 10^{-8}	N/A	1.5	0.0003
		Total*	--	8.4 x 10-5	N/A	1.1 x 10^{-5}	N/A	--	--
	Inhalation/Shower	TCE	315	1.6 x 10-5	N/A	4.0 x 10^{-6}	N/A	0.007	0.17
		VC	17	2.7 x 10-6	N/A	6.8 x 10^{-7}	N/A	0.015	0.029
		Total*	--	3.3 x 10-5	N/A	8.2 x 10^{-6}	N/A	--	--
	Total Across All Exposure Routes	--	--	**7.6 x 10-4**	N/A	**1.1 x 10-4**	N/A	--	--
Future Construction Worker - Adult	Dermal Contact	TCE	315	1.7 x 10-7	N/A	2.3 x 10^{-8}	N/A	0.013	N/A
		VC	17	2.3 x 10-7	0.0074	2.6 x 10^{-8}	0.00085	0.72	0.003
		Heptachlor epoxide	0.142	4.4 x 10-7	0.26	2.0 x 10^{-7}	0.12	9.1	0.000013
		RDX	94.17	1.7 x 10-8	0.0036	2.1 x 10^{-9}	0.00044	0.11	0.003
		Arsenic	6.96	4.4 x 10-8	0.0068	1.7 x 10^{-8}	0.0026	1.5	0.0003
		Total*	--	1.2 x 10-6	0.47	4.0 x 10^{-7}	0.17	--	--
	Inhalation	TCE	315	2.2 x 10-5	**1.3**	1.3 x 10^{-6}	0.077	0.007	0.17
		VC	17	3.9 x 10-6	0.61	2.0 x 10^{-7}	0.032	0.015	0.029
		Total*	--	4.8 x 10-5	**3.3**	3.7 x 10^{-6}	0.28	--	--
	Total Across All Exposure Routes	--	--	4.9 x 10-5	**3.7**	4.1 x 10^{-6}	0.45	--	--

*Exposure pathway totals are additive and include all chemicals that contribute to potential risk

1 = No COCs identified with an HI >1

Bold/Yellow Shaded text indicates potential unacceptable human health risk

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2.7.2 Summary of Ecological Risk Assessment

As part of the 2009 RI report for Site 22, an ERA was completed. Complete pathways for ecological receptors were limited to exposure to surface water, surface sediment, and surface soil. Surface soil was not evaluated in the ERA because risks associated with this medium were addressed during the previous remedial action. Groundwater was considered only as a transport medium since there were no ecological exposures to groundwater until it discharged to a water body or surfaced as a seep. Based on the results of the ERA, the Navy, USEPA Region 3, and VDEQ agree that groundwater at Site 22 does not pose unacceptable ecological risks to current receptors based on the following:

- No ecological COCs were identified for surface water, sediment, or seep exposures (no further action - ROD signed in 2011)
- Source areas were removed during previous site activities
- Groundwater is not a significant continuing source of contaminants to the aquatic habitats adjacent to the site

The ERA concluded there is ***no potentially unacceptable risk*** (Ref. 14) due to exposure to groundwater seeps, surface water, or sediment at Site 22. The Navy, in partnership with the USEPA and VDEQ agree that no further action for groundwater is necessary to prevent exposure to ecological receptors.

2.7.3 Basis for Response Action

The selected groundwater remedy in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

While there are no potential ecological risks from exposure to site groundwater, there are potential future human health risks from TCE, VC, and RDX. TCE in shallow groundwater (Yorktown-Eastover aquifer) was identified as posing a potential risk under the future construction worker exposure scenario, and VC and RDX in shallow groundwater (Yorktown-Eastover aquifer) were identified as posing a potential risk under the future residential use exposure scenario (**Table 4**).

2.8 Remedial Action Objectives

The site-specific remedial action objectives (RAOs) for Site 22 groundwater are as follows:

- Reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.
- Prevent human (residential and construction worker) exposure to groundwater until cleanup levels are met.

Cleanup levels for groundwater were developed for site-related COCs (TCE, VC, and RDX) with cancer risks exceeding 1 in 10,000 or with concentrations exceeding the established MCLs (**Table 5**). MCLs were used to establish the groundwater cleanup levels for TCE and VC (5 µg/L and 2 µg/L, respectively). Attainment of MCLs is considered to be protective and suitable for unlimited use and unrestricted exposure. Because no MCL has been established for RDX, a risk-based cleanup level of 6 µg/L was calculated. Cleanup level exceedances for TCE and RDX are spatially shown on **Figure 7**; VC exceeded the MCL in two wells located within the TCE plume (22GW09 and 22GW11) and fall within the footprint of the TCE plume, and therefore is not shown. The cleanup level for RDX was determined based on Remedial Goal Option calculations, which incorporate pathways for the ingestion, dermal absorption, and inhalation of volatiles and particulates for future residents using the same exposure assumptions as the HHRA.

TABLE 5
Remediation Goals (Cleanup Levels) for COCs at Site 22

COC	Remediation Goal (µg/L)
TCE	5 µg/L
VC	2 µg/L
RDX	6 µg/L

2.9 Description of Remedial Alternatives

The objective of this section is to provide a brief explanation of the remedial alternatives developed for Site 22 groundwater.

2.9.1 Description of Remedy Components

Remedial alternatives were ***developed and evaluated*** (Ref. 15) to address COCs in groundwater at Site 22, as detailed in the 2011 FS Report. Following the initial screening of groundwater remediation technologies, the following remedial alternatives were selected for detailed evaluation and comparative analysis:

- **Alternative 1** – No Action
- **Alternative 2** – Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and Land Use Controls
- **Alternative 3** – Hot Spot Treatment of RDX, TCE, and VC using In situ Chemical Oxidation (ISCO) and Associated Performance Monitoring; MNA of TCE, VC and RDX; and Land Use Controls
- **Alternative 4** – Hot Spot Treatment of TCE, VC, and RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, RDX, and VC; and Land Use Controls

Based on the results of the alternatives evaluation, Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and Land Use Controls (Alternative 2) was selected as the Preferred Alternative. With the exception of the No Action alternative (Alternative 1), each of the alternatives includes monitoring and implementation of Land Use Controls to prevent exposure and control changes in site use. A No Action alternative is required by the National Oil and Hazardous Substances Pollution Contingency Plan and serves as the baseline against which the other alternatives are compared. For Alternatives 2, 3, and 4, monitoring and Land Use Controls would be maintained until the RAOs are met, with 5-year statutory reviews to ensure protection of human health and the environment. A description of each remedial alternative is provided in **Table 6**.

TABLE 6
Description of Remedial Alternatives for Site 22

Alternative	Components	Details	Cost
1-No Action	None	Allow the COCs to breakdown naturally over time.	Capital Cost: $0 O&M Present Value: $0 Total Present Value: $0 Cost Estimate Timeframe: 0 years
2-Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring, MNA of TCE, VC, and RDX; and Land Use Controls	• Implementing Enhanced In Situ Bioremediation using emulsified vegetable oil bio-barriers in areas where RDX concentrations exceed 100 µg/L • MNA for dissolved TCE and VC plumes and the remaining RDX plume (less than100 µg/L) following active treatment • Groundwater monitoring to collect data about COC concentrations and natural attenuation parameters • Land Use Controls	Injecting a suitable insoluble substrate to the subsurface providing a carbon source for microorganisms to enhance the biodegradation of RDX. Regular, long-term monitoring performed to demonstrate that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action Land Use Controls to prevent contact with and use of groundwater until cleanup levels are met. 5-year reviews	Capital Cost: $708,026 O&M Present Value:$1,028,565 Total Present Value:$1,907,000 Cost Estimate Timeframe: 34 years
3-Hot Spot Treatment of RDX, TCE and VC using ISCO and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and Land Use Controls	• ISCO using permanganate (MN04) in active target treatment areas where TCE, VC, and RDX concentrations exceed100 µg/L • MNA for dissolved TCE, VC, and RDX plumes where concentrations are less than100 µg/L • Groundwater monitoring to collect data about COC concentrations and natural attenuation parameters • Land Use Controls	Injection of oxidizing agent to promote abiotic, in situ oxidation of COCs through reaction of oxidants with COCs to produce innocuous substances such as carbon dioxide, water, and chloride. Electron donor source is provided to enhance naturally occurring reductive dechlorination process. Regular, long-term monitoring performed to demonstrate that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action Land Use Controls to prevent contact with and use of groundwater until cleanup levels are met 5-year reviews	Capital Cost:$1,228,931 O&M Present Value:$833,902 Total Present Value:$2,482,000 Cost Estimate Timeframe: 25 years
4-Hot Spot Treatment of TCE, VC, and RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, RDX, and VC; and Land Use Controls	• Enhanced In Situ Bioremediation of RDX, TCE, and VC using emulsified vegetable oil bio-barriers in areas with TCE, VC, and RDX concentrations greater than 100 µg/L • MNA for dissolved RDX, TCE, and VC plumes where concentrations are less than100 µg/L • Groundwater monitoring to collect data about COC concentrations and natural attenuation parameters • Land Use Controls	Injection of substrates into groundwater to facilitate reductive chlorination, thereby producing an electron donor source for biodegradation. Regular, long-term monitoring performed to demonstrate that: • COC concentrations continue to decrease • Potentially toxic transformation products are not created at levels that are a threat to human health • Impacted area is not expanding • There are no changes in hydrogeologic, geochemical, or microbiological parameters that might reduce the effectiveness of the Remedial Action Land Use Controls to prevent contact with and use of groundwater until cleanup levels are met 5-year reviews	Capital Costs: $1,024,061 O&M Present Value: $994,759 Total Present Value: $2,718,000 Cost Estimate Timeframe: 29 years

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2.9.2 Summary of Comparative Analysis of Alternatives

This section summarizes a comparison and analysis of the four alternatives with respect to the National Contingency Plan's nine evaluation criteria. The nine criteria are summarized in **Table 7**. It is Navy policy to evaluate and optimize remedy efficiencies; therefore, each alternative includes an optimization effort for development of a plan for remedy enhancement (such as additional plume treatment) or development of a different remedy if the Navy, USEPA, and VDEQ determine through monitoring that the alternative is not performing as anticipated. **Table 8** depicts a comparison of the alternatives to the criteria. Alternative 1 (No Action) does not achieve RAOs designed to protect human health and the environment; therefore, it fails the first threshold criterion and is not considered further in this ROD.

TABLE 7
Evaluation Criteria for Remedial Alternative Analysis

CERCLA Criteria	Definition
Threshold Criteria	
Protection Of Human Health And The Environment	Addresses whether an alternative provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls.
Compliance with Applicable Or Relevant And Appropriate Requirements (ARARs)	Addresses whether an alternative will meet all of the ARARs or justifies a waiver of the requirements.
Primary Balancing Criteria	
Long-Term Effectiveness And Permanence	Addresses the expected residual risk and the ability of an alternative to maintain reliable protection of human health and the environment over time, once clean-up goals have been met.
Reduction In Toxicity, Mobility, Or Volume Through Treatment	Discusses the anticipated performance of the treatment technologies an alternative may employ.
Short-Term Effectiveness	Considers the period of time needed to achieve protection and any adverse impacts on human health and the environment that may be posed during the construction and implementation period, until cleanup goals are achieved.
Implementability	Evaluates the technical and administrative feasibility of an alternative, including the availability of materials and services needed to implement an option.
Present-Worth Cost	Compares the estimated initial, O&M, and present-worth costs.
Modifying Criteria	
State Acceptance	Considers the state agency response to the remedial alternative described in the Proposed Plan.
Community Acceptance	Provides the public's general response to the remedial alternatives described in the Proposed Plan. The specific responses to the public comments are addressed in the "responsiveness summary" section of the ROD.

TABLE 8
Relative-Ranking of Remedial Alternatives

CERCLA Criteria	No Action (ALT 1)	Enhanced In Situ Bioremediation and Performance Monitoring of RDX with MNA of TCE, VC, and RDX and Land Use Controls (ALT 2)	ISCO, Performance Monitoring and MNA of TCE, VC, and RDX and Land Use Controls (ALT 3)	Enhanced In Situ Bioremediation, Performance Monitoring, and MNA of TCE, VC, and RDX and Land Use Controls (ALT 4)
Threshold Criteria				
Protection of human health and the environment	❍	●	●	●
Compliance with ARARs	N/A	●	●	●
Primary Balancing Criteria				
Long-term effectiveness and permanence	❍	●	●	●
Reduction in toxicity, mobility, or volume through treatment	❍	●	●	●
Short-term effectiveness	❍	◘	◘	◘
Implementability	●	◘	◘	◘
Cost	N/A	● $1,907,000	◘ $2,482,000	◘ $2,718,000
Modifying Criteria				
State Acceptance	NC	C	NC	NC
Community Acceptance	NC	C	NC	NC

Ranking: ● High ◘ Moderate ❍ Low N/A=Not Applicable

Rankings are provided as qualitative descriptions of the relative compliance of each alternative with the criteria.

NC = No significant comments were received from State or Community Members on the Proposed Plan.

C = Concurrence received from the State and Community Members on the with the preferred alternative

Threshold Criteria

Overall Protection of Human Health and the Environment

With the exception of Alternative 1 (No Action), each alternative protects human health and the environment by reducing or controlling risks posed by the site through treatment and/or Land Use Controls. Alternative 2 employs treatment to reduce RDX concentrations in a faster timeframe than would occur naturally. Alternatives 3 and 4 employ treatment to reduce concentrations in the RDX, TCE, and VC target areas to reduce the remedial timeframe. Monitoring will be conducted to confirm that the remedies are functioning and protective, and that Land Use Controls have been implemented and maintained to provide adequate protection of human health and the environment by controlling exposure to contaminated groundwater and potential vapor intrusion until cleanup levels are met.

Compliance with Applicable or Relevant and Appropriate Requirements

The ARARs for the selected remedy at Site 22 are listed in **Appendix C**. Alternatives 2, 3, and 4 are expected to comply with the federal and state ARARs. All of these alternatives would also require additional measures to ensure compliance with ARARs related to the injections of reagents into the subsurface.

Primary Balancing Criteria

Long-Term Effectiveness and Permanence

Each alternative with the exception of Alternative 1 is expected to achieve long-term effectiveness and permanence at the conclusion of remedial activities in reducing concentrations of TCE, VC, and RDX. Once RAOs are achieved, all alternatives, except Alternative 1, are expected to be effective in the long-term, as active treatment is intended to treat the contamination (treatment for RDX using Enhanced In Situ Bioremediation for Alternative 2, treatment for RDX, TCE, and VC using ISCO for Alternative 3, and treatment for RDX, TCE, and VC using Enhanced In Situ Bioremediation for Alternative 4) and allow natural attenuation to reduce groundwater contaminant concentration to below cleanup levels.

Reduction in Toxicity, Mobility, or Volume through Treatment

Alternatives 2 (treatment of RDX), 3 (treatment of RDX, TCE, and VC), and 4 (treatment of RDX, TCE, and VC) are each expected to reduce toxicity, mobility, and volume by treating the groundwater, which is a statutory preference. For Alternative 2, some active treatment of TCE and VC is assumed to occur where the VOC plumes overlap with the RDX treatment area. Also, while MNA is not considered a treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected to occur over time for Alternatives 2, 3, and 4.

Short-Term Effectiveness

The short-term effectiveness associated with Alternatives 2, 3, and 4 are similar with regard to how they affect the community and the local environment. Alternatives 2, 3, and 4 all rely on direct injection technology for implementation. The community would be impacted due to the transportation of injection materials and the generated investigation-derived waste.

While the relative-rankings of the remedial alternatives provided in **Table 8** show similar short term effectiveness between Alternatives 2, 3, and 4, minor distinctions for comparative analysis are discussed below.

Alternative 2 would least impact the environment due to a lower amount of construction or intrusive activities and environmental impacts (fewer injection points and Enhanced In Situ Bioremediation injections and a limited extent of treatment area). RAOs are estimated to be achieved in 34 years.

Alternative 3 has the highest impact on workers and the community due to the high use of heavy machinery, handling of chemical oxidants, and transportation of chemical oxidant on public roads and highways. This alternative has the highest greenhouse gas emissions and energy consumption primarily due to oxidant and polyvinyl chloride manufacturing. RAOs are estimated to be achieved in 25 years.

Alternative 4 will have a moderate impact on workers and the community due to the highest amount of intrusive activities (greater number of injection points and Enhanced In Situ Bioremediation injections) and the high volume of heavy machinery traffic and frequency of site visits. This alternative has the highest sulfur oxide emissions, nitrogen oxide, particulate matter less than 10 micrometers in aerodynamic diameter, and emissions due to fuel consumption. RAOs are estimated to be achieved in 29 years.

Alternative 2 provides the greatest short-term effectiveness due to its minimization of intrusive activities compared to Alternatives 3 and 4.

Implementability

Alternatives 2, 3, and 4 can each be implemented using standard and widely available technologies. All materials and services needed for implementation are readily and commercially available. These three alternatives (2, 3, and 4) require engineering and construction services, and each alternative requires thorough monitoring to ensure they continue to operate on a path toward achieving RAOs. Each of the three alternatives (2, 3 and 4) is reliable provided they are designed and implemented correctly.

Cost

An order of magnitude cost for each alternative has been estimated based on a variety of key assumptions, including an assumed 35-year project life. The estimated timeframe required to achieve the cleanup levels varies by alternative (**Table 6**). The estimated capital cost for implementation of Alternative 2 ($700,000) is less than that of Alternative 3 ($1.2 million) or Alternative 4 ($1.0 million). The estimated present value cost for Alternative 2 is $1.9 million, less than for Alternative 3 ($2.5 million) and Alternative 4 ($2.7 million). Alternative 2 has a lower capital cost due to the type and quantity of injection materials.

Table 6 provides details of the cost summaries, and **Table 8** provides a relative ranking of the four alternatives.

Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA and remedy selection process. VDEQ, as the designated state support agency in Virginia, has reviewed this ROD and has given concurrence on the selected remedy for groundwater at Site 22. The selected remedy, Alternative 2 (Hot Spot treatment of the RDX target area [concentrations above 100 µg/L] using Enhanced In Situ Bioremediation and associated performance monitoring; MNA of TCE, VC, and RDX; and Land Use Controls), is consistent with the VDEQ's preference for active treatment of high-concentration target areas.

Community Acceptance

The public meeting was held on May 24, 2012, to present the Proposed Plan and answer community questions regarding the proposed remedial action at Site 22. The questions and concerns raised at the meeting were general inquiries for informational purposes only; but no comments were received requiring amendment to the Proposed Plan, and no additional written comments, concerns, or questions were received from community members during the public comment period.

2.10 Principal Threat Wastes

Principal threat wastes are source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should an exposure occur. Although no "threshold level" of risk has been established to identify principal threat waste, a general guideline is to consider a principal threat to be those source materials with toxicity and mobility characteristics that combine to pose a potential risk several orders of magnitude greater than the risk level that is acceptable for the current or reasonably anticipated future land use, given realistic exposure scenarios. Contaminated groundwater is generally not considered to be a source material, and VOC concentrations are below 1 percent of the aqueous solubility of each COC, indicating that groundwater contamination likely consists of a dissolved phase plume with no dense non-aqueous phase liquid present. Therefore, the groundwater at Site 22 is not considered to be a principal threat waste. However, the selected remedy includes a treatment technology that will be used to permanently reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels.

2.11 Selected Remedy

Based on the ***comparative analysis*** (Ref. 16), the selected remedy to address risk associated with groundwater at Site 22 is Alternative 2, consisting of three components: (1) Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; (2) MNA of RDX, TCE, and VC; and (3) Land Use Controls.

2.11.1 Summary of the Rationale for the Selected Remedy

Based on the evaluation of the data and information currently available, the Navy, in partnership with USEPA, has determined that the selected remedy meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. The Navy expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA §121(b): 1) be protective of human health and the environment; 2) comply with ARARs; 3) be cost-effective; 4) utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable; and 5) satisfy the preference for treatment as a principal element.

Alternative 2 is the selected remedy for remediation of groundwater contamination at Site 22. Alternative 2 was chosen over Alternatives 3 and 4 (not including the No Action alternative) because the nine criteria analysis indicated that although Alternative 2 takes longer to reach RAOs, it is protective, more cost-effective and results in less short term risk during implementation. Targeting areas using Enhanced In Situ Bioremediation where RDX concentrations exceed 100 µg/L decreases the environmental impacts of construction or intrusive activities by reducing the extent of the treatment area. Although no active treatment process would be employed specifically for VOCs, some active treatment of TCE and VC would occur where the VOC plumes overlap with the RDX target treatment area. Outside the influence of the RDX treatment area, natural biodegradation and other attenuation processes would be occurring.

2.11.2 Description of the Selected Remedy

The selected remedy (Alternative 2) for groundwater at Site 22 consists of the following elements:

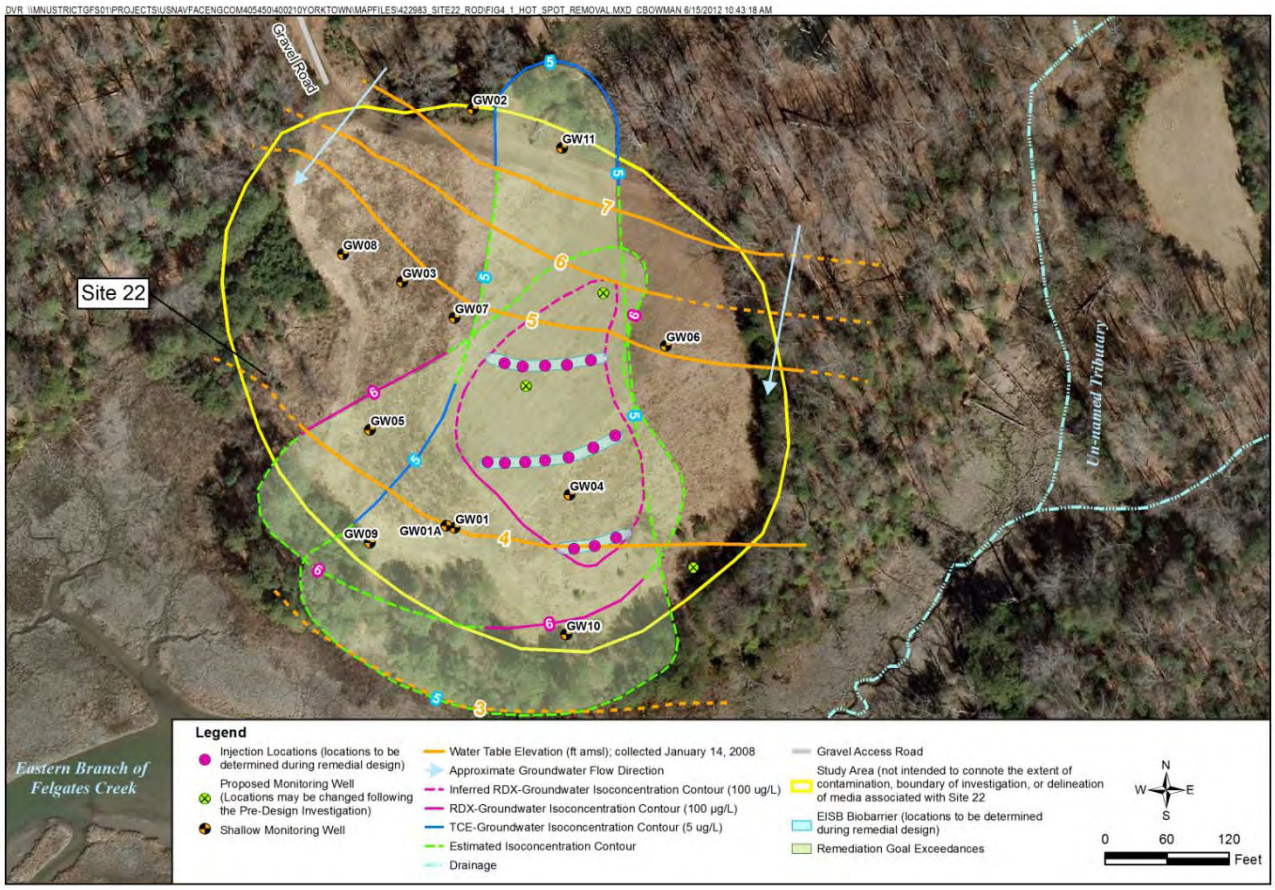
- Implementing Enhanced In Situ Bioremediation of RDX using emulsified vegetable oil bio-barriers perpendicular to groundwater flow in the target treatment area (with RDX above 100 µg/L) to reduce the total time for achieving cleanup levels
- Monitored natural attenuation to address the dissolved TCE and VC plumes and the remaining dissolved RDX plume (less than 100 µg/L) following active treatment
- Groundwater monitoring to collect data about COC concentrations and natural attenuation parameters
- Land Use Controls in the form of land and groundwater use restrictions to prevent contact with and use of groundwater until cleanup levels are met

Figure 8 presents a conceptual illustration of the potential implementation of the selected remedy (Alternative 2).

The Navy will implement the selected remedy in phases to optimize treatment in groundwater at Site 22. Prior to completing the Remedial Design (RD) of Alternative 2, a pre-design investigation will be performed to refine the CSM. The remedy implementation approach will be finalized during RD.

FIGURE 8

Alternative 2 - Hot Spot Treatment of RDX using Enhanced In Situ Bioremediation and Associated Performance Monitoring; MNA of TCE, VC, and RDX; and Land Use Controls



Pre-Design Investigation

Prior to the final design of the selected remedy (Alternative 2), a pre-design investigation will be implemented for greater resolution of the lateral and vertical extent of TCE, VC, and RDX to collect additional data about natural attenuation of VOCs at the site, and to identify the precise areas, depths, and lithologic units requiring RDX treatment. Based on historical data, the only monitoring well with RDX concentrations above 100 µg/L in groundwater is YS22-GW04 (at 150 µg/L in 2007). This investigation is expected to include installation of at least three new monitoring wells, one round of groundwater samples from new and select existing monitoring wells for TCE, VC, RDX, and MNA parameters (**Figure 8**), and groundwater samples from 30 direct-push technology (DPT) points to pinpoint the RDX treatment area. Additional lines (or transects) of DPT points will be added if RDX concentrations at the edge of each transect exceeds 100 µg/L. The details of this pre-design investigation, including a schedule and criteria for evaluating natural attenuation of VOCs, will be presented in a pre-design workplan for review and approval by USEPA and VDEQ. Following the pre-design investigation, if it is determined that a different remedy for the VOCs should be considered, the Navy, USEPA, and VDEQ will evaluate remedy enhancements or other remedial alternatives on a schedule set forth in the Site Management Plan for WPNSTA Yorktown.

Enhanced In Situ Bioremediation of RDX Using Emulsified Vegetable Oil Bio-barriers

Enhanced In Situ Bioremediation of RDX using bio-barriers will be implemented in the target treatment area, defined as where RDX concentrations exceed 100 µg/L, through direct injection of a suitable insoluble substrate (such as, but not limited to, emulsified oil substrate or 3D microemulsion) to the shallow groundwater. The

introduced substrate will create conditions favorable for degradation for both RDX and the chlorinated ethene compounds at the site. Additionally, a pH buffer (either as a pre-buffered substrate, such as sodium bicarbonate, or as an additional injection) may be required to raise the existing groundwater pH. Based on the observed effectiveness of Enhanced In Situ Bioremediation during field investigations for other Navy projects with similar subsurface conditions, it is assumed that no laboratory treatability studies or field pilot studies are warranted prior to full-scale implementation of Alternative 2.

Before this alternative is implemented, baseline groundwater samples will be collected to confirm assumptions made in the conceptual design and to modify as necessary the application locations, substrate, and the corresponding monitoring locations. Based on current site conditions, conceptual design elements for implementation of Enhanced In Situ Bioremediation are presented in **Figure 8**.

Upon completion of the pre-design investigation, an injection method will be determined (pneumatic fracturing, direct-push, or permanent injection wells). One bio-barrier is anticipated to be placed directly upgradient of the area with the highest RDX concentrations as determined during the pre-design investigation. Two additional bio-barriers are assumed, one to the north and one to the south of this primary line. The southernmost bio-barrier will help prevent further migration of the RDX plume. Within each bio-barrier, or transect line, the injection wells will be spaced approximately 20 feet apart. The radius of influence of each injection point is assumed to be 10 feet. As shown on **Figure 8**, approximately 15 permanent injection locations are estimated for the target treatment area. The vertical target interval will be determined during the design. For cost-estimating purposes, it was assumed that each location will have two co-located permanent injection wells, each with 10-foot screens to more effectively distribute emulsified vegetable oil to units with lower permeability across a 20-foot-depth interval. It was also assumed that two injections would be completed within a 2-year interval. If necessary, as treatment progresses and the concentrations of COCs and their daughter products change, the type and quantity of substrate, frequency of injection, and the location of injection may be revised.

Monitored Natural Attenuation of VOCs and RDX

MNA refers to the reliance on natural processes to achieve cleanup levels. Natural attenuation processes include a variety of physical, chemical, or biological processes that under favorable conditions act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in groundwater. These processes include biodegradation; dispersion; dilution; sorption; volatilization; and chemical or biological stabilization, transformation, or destruction of contaminants. Biodegradation pathways for chlorinated VOCs were discussed in Section 2.5.

MNA will be implemented in the area outside the target treatment area and will rely on natural attenuation processes to achieve the cleanup levels for TCE (5 µg/L), VC (2 µg/L), and RDX (6 µg/L). Reducing conditions predominantly present at the site are favorable for biological degradation of the chlorinated VOCs and RDX. In addition, the RDX target treatment area may overlap with a portion of the TCE and VC plumes, resulting in enhanced biodegradation of these chemicals within this area. Natural attenuation will continue under this alternative until the COC concentrations decline to below cleanup levels.

Groundwater Monitoring

Following substrate injection, groundwater monitoring will begin with a brief (estimated 2-year) period of performance monitoring, during which the Navy will collect data about (1) the effect of the injections on COC concentrations and (2) natural attenuation parameters. Effectiveness of the remedial technology (emulsified vegetable oil bio-barriers and MNA) will be evaluated through one year of quarterly groundwater monitoring following each of the two rounds of substrate injections. Following performance monitoring and optimization review of remedy efficiency, remedy enhancements (such as additional injections) may be implemented, or if it is determined that a different remedy should be considered, the Navy, USEPA, and VDEQ will evaluate other

remedial alternatives. Any implementation of remedy enhancements or evaluation of other remedial alternatives shall be done on a schedule, which shall be set forth in the Site Management Plan for WPNSTA Yorktown.

The Navy shall submit to USEPA and VDEQ for review and approval performance monitoring and long-term monitoring plans, which shall identify criteria for remedy performance, and the estimated schedule of remedy implementation. Based on current site conditions, it was assumed for cost-estimating purposes that any new monitoring wells plus the 12 existing shallow monitoring wells and one existing deep monitoring well will be included in the performance and long-term monitoring plans.

Land Use Controls

Throughout implementation of the remedy, the Navy will implement Land Use Controls in the area shown on Figure 7 to prevent unacceptable risks to humans from exposure to COCs in groundwater. Under Alternative 2, the site will be designated as a "restricted use" area in the base geographic information system. This designation will place controls on groundwater at Site 22.

The associated Land Use Controls will meet the following objectives:

- Prohibit activities that would result in contact with groundwater except for environmental monitoring
- Prohibit the withdrawal of groundwater except for environmental monitoring
- Prohibit construction and occupation of any future buildings in the area shown on Figure 7 unless (1) an investigation, concurred upon by the Navy, EPA and VDEQ, shows that risks to human health from vapor intrusion are within acceptable limits or (2) the Navy, EPA and VDEQ concur on the design of a vapor mitigation system for the building, and the vapor mitigation system is installed and operating properly and successfully
- Maintain the integrity of any current or future remedial or monitoring system

The Land Use Controls shall be maintained until concentrations of RDX, TCE and its breakdown-products (including VC) in groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure. The Navy will develop and submit to USEPA and VDEQ, for review, a LUC RD within 90 days following the signature of this ROD. The LUC RD will provide for implementation and maintenance actions, including periodic inspections and reporting. The Navy will implement, maintain, monitor, report on, and enforce the Land Use Controls according to the approved LUC RD and this ROD.

Although the Navy may transfer these responsibilities to another party by contract, property transfer agreement, or through other means, the Navy will remain ultimately responsible for remedy integrity and will: 1) perform CERCLA Section 121(c) 5-year reviews; 2) notify the appropriate regulators and/or local government representatives of any known land use control deficiencies or violations; 3) provide access to the property to conduct any necessary response; 4) retain the ability to change, modify, or terminate Land Use Controls; and 5) ensure that the LUC objectives are met to maintain remedy protectiveness.

2.11.3 Summary of the Estimated Remedy Costs

Table 6 presents a cost estimate summary for implementation of the selected remedy. ***Detailed cost estimates*** (Ref. 17) are provided in the 2011 FS report. The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the remedial alternative. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

2.11.4 Expected Outcomes of the Selected Remedy

Site 22 is currently only being used for periodic hunting activities. This use is expected to continue, and there are no other planned land uses in the foreseeable future. Cleanup levels for the selected remedy are based on established risk-based cleanup levels suitable for unlimited use and unrestricted exposure. Exposure will be controlled through Land Use Controls until COCs in groundwater (TCE, VC, and RDX) are reduced to the cleanup levels. Remedial activities at Site 22 will consist of Hot Spot treatment of RDX using Enhanced In Situ Bioremediation and associated performance monitoring; MNA of RDX, TCE, and VC; and Land Use Controls. **Table 9** identifies the potential unacceptable human health risks (there are no potential unacceptable ecological risks), the RAOs established to address these unacceptable risks, the remedy component(s) that will be implemented to achieve each RAO, what metrics will be used to confirm the RAOs are met, and the expected outcome from implementation of the remedy components.

2.11.5 Statutory Determinations

In accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan, the selected remedy meets the following statutory requirements:

Protection of Human Health and the Environment— The selected remedy will protect human health (there are no potential ecological risks) from known site risks to future receptors through groundwater treatment and monitoring to reduce COC concentrations, and through Land Use Controls to restrict the use of and exposure to shallow groundwater and shallow groundwater emissions until concentrations are reduced to established risk-based cleanup levels that allow for unrestricted use and unlimited exposure.

Compliance with ARARs—The selected remedy will meet all identified ARARs. Federal and state ARARs for Site 22, summarized by classification, are presented in **Appendix C**. The classification of ARARs identified includes chemical-specific, location-specific, and action-specific requirements.

Cost-Effectiveness—The selected remedy provides the most reasonable value relative to the cost through the use of active treatment in the high-concentration target area, while allowing for MNA in the low-concentration target areas.

Utilization of Permanent Solutions and Alternative Treatment Technologies or Resource Recovery Technologies to the Maximum Extent Practicable—The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Site 22. The selected remedy provides treatment through substrate injection that enhances biologically mediated degradation of the chlorinated COCs and RDX through natural microbial degradation processes to reduce contaminant mass. Because the long-term effectiveness and permanence, as well as reduction of toxicity and volume, are achieved through the selected remedy, the Navy, USEPA, and VDEQ concur that the selected remedy provides the best balance of tradeoffs in terms of the balancing criteria, while also considering the statutory preference for treatment as a principal element and considering state and community acceptance.

Preference for Treatment as a Principal Element—The selected remedy uses treatment of the high-concentration target area as a principal element, and therefore satisfies the statutory preference for treatment.

Five-Year Review Requirements—Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of remedial action, and every five years until cleanup is met to ensure that the remedy is, or will be, protective of human health and the environment.

TABLE 9
Expected Outcomes

Risk		RAO	Remedy Component	Metric	Expected Outcomes	
Human Health	Ecological					
Groundwater						
Ingestion of, dermal contact with, and inhalation of TCE, VC, and RDX in groundwater for hypothetical future lifetime adult and child residents; ingestion of and dermal contact with groundwater for hypothetical future construction workers	No exposure pathway	To reduce TCE, VC, and RDX concentrations in groundwater to established risk-based cleanup levels	Hot Spot treatment of RDX using Enhanced In Situ Bioremediation bio-barriers in areas where concentrations exceed 100 µg/L and associated performance monitoring	Monitor shallow groundwater concentrations to confirm reduction of RDX concentrations to cleanup levels	Reduction of RDX concentrations to cleanup levels	No further treatment or monitoring after achieving cleanup goals that allow for unlimited use and unrestricted exposure or groundwater
			MNA for TCE, VC; and MNA for RDX when <100 µg/L	Monitor groundwater COC concentrations and their degradation products, geochemical parameters, and sensitive metals to confirm the natural degradation process is occurring until concentrations are at or below cleanup levels	Reduction of RDX, TCE, and VC concentrations to cleanup levels	
				Monitor shallow groundwater COC concentrations and their degradation products for potential toxic transformation products to confirm concentrations are not created at levels that threaten human health		
		To maintain Land Use Controls to prevent human (residential and construction worker) exposure to groundwater until cleanup levels are met.	Land Use Controls	Annual LUC inspections until cleanup levels are met for groundwater COCs	Elimination of groundwater exposure pathway	Removal of groundwater Land Use Controls

2.12 Documentation of Significant Changes

The Proposed Plan for Site 22 was released for public comment on May 14, 2012. The public comment period ran from May 14 to June 28, 2012 with the public meeting to discuss the plan on May 24, 2012. General inquiries were received during the public meeting on May 24, 2012, but no comments were received requiring amendment to the Proposed Plan, and no additional written comments, concerns, or questions were received from community members 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.

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3 Responsiveness Summary

The participants in the public meeting held on May 24, 2012, included representatives of the Navy and VDEQ. Two community members attended the meeting. Questions received during the public meeting were general inquiries and are included in the ***meeting transcript*** (Ref. 18 and **Appendix D**). There were no comments received at the public meeting requiring amendment to the PP, and no additional written comments, concerns, or questions were received from community members during the public comment period.

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References

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the AR
1	*ROD*	Section 2.2	Baker Environmental, Inc. (Baker). 2003. Record of Decision Site 22 Burn Pad, Naval Weapons Station, Yorktown, Virginia. September. AR No. 01375.
2	*ROD*	Section 2.2	CH2M HILL. 2011. Record of Decision, Site 4 – Burning Pad Residue Landfill, Site 21 – Battery and Drum Disposal Area & Site 22 – Burn Pad, Naval Weapons Station, Yorktown, Virginia. August. AR No. 000262.
3	*analytical results*	Table 1	Baker. 2001. Round Two Remedial Investigation Report, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. January. Tables 4-36 through 4-38. AR No. 01296, 01297, and 01298.
4	*analytical results*	Table 1	Baker. 2001. Round Two Remedial Investigation Report, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. January. Tables 4-15 through 4-20 and Tables 4-39 through 4-41. AR No. 01296, 01297, and 01298.
5	*analytical results*	Table 1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Table 6-3. AR No. 000024.
6	*analytical results*	Table 1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Tables 7-1 and 7-7. AR No. 000024.
7	*evaluate alternatives*	Table 1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 6. AR No. 000181.
8	*CSM*	Section 2.5	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 2.2.3. AR No. 000181.
9	*Numerous investigations*	Section 2.5.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Sections 2.1 and 2.2. AR No. 000181.
10	*results*	Section 2.5.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Sections 2.2.1. AR No. 000181.
11	*biodegradation*	Section 2.5.2	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 10.5.3. AR No. 000024.

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the AR
12	***complete exposure pathways***	Section 2.7.1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 8.4.2. AR No. 000024.
13	***Potential unacceptable human health risks***	Section 2.7.1	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Tables 8-14 and 8-15. AR No. 000024.
14	***no potentially unacceptable risk***	Section 2.7.2	CH2M HILL. 2009. Remedial Investigation Report for Groundwater, Sites 4, 21, and 22, Naval Weapons Station, Yorktown, Virginia. November. Section 9.5.4. AR No. 000024.
15	***developed and evaluated***	Section 2.9.1	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 4.2. AR No. 000181.
16	***comparative analysis***	Section 2.11	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Section 6. AR No. 000181.
17	***Detailed cost estimates***	Section 2.11.3	CH2M HILL. 2011. Feasibility Study Report for Groundwater at Site 22, Naval Weapons Station, Yorktown, Virginia. November. Appendix C. AR No. 000181.
18	***meeting transcript***	Section 3	CH2M HILL. 2009. Proposed Plan, Site 1: Landfill Near Incinerator, Naval Weapons Station Yorktown, Cheatham Annex. January. AR No. Pending.

Detailed site information reference in this ROD in bold blue text is contained in the AR.

For access to information contained in the AR for WPNSTA Yorktown please contact:

Public Affairs Office
P.O. Drawer 160
Yorktown, VA 23691-0160
Phone: (757) 887-4939

Appendix A

APPENDIX A-1
Potentially Complete Human Health Exposure Pathways - Site 22
Record of Decision Report for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Land Use	Media	Potentially Exposed Populations	Exposure Route (Human Health)	Pathway Selected for Evaluation	Rationale
Future					
Residential	Yorktown Aquifer - Tap Water	Residents - Adults and Children	Ingestion and dermal contact	Yes	Groundwater is not currently used on-site as a water supply and the site is not expected to be developed for residential use; however, a future residential scenario is included for a conservative evaluation of unrestricted land use.
	Yorktown Aquifer - Water Vapors at Showerhead	Residents - Adults	Inhalation	Yes	Although unlikely, groundwater will be evaluated for use as a future potable water supply. Children assumed to bathe and not shower, therefore, inhalation exposure not as great for a child as that for adult.
	Yorktown Aquifer - Vapor Intrusion from Groundwater to Indoor Air	Residents - Adults and Children	Inhalation	No*	Although unlikely, if future residence constructed at the site, vapors from groundwater could migrate to indoor building air.
Residential or Industrial	Yorktown Aquifer - Excavation Pit	Construction Worker	Dermal contact and inhalation	Yes	Workers may inhale vapors and have exposed skin surfaces come into contact with shallow groundwater during excavation activities.
Industrial	Yorktown Aquifer - Vapor Intrusion from Groundwater to Indoor Air	Industrial Worker	Inhalation	No*	Although unlikely, if future industrial building constructed at the site, vapors from groundwater could migrate to indoor building air.

* Evaluated qualitatively in risk assessment

APPENDIX A-2
Summary of RME Cancer Risks and Hazard Indices - Site 22
Record of Decision Report for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks $>10^{-4}$	Chemicals with Cancer Risks $>10^{-5}$ and $<10^{-4}$	Chemicals with Cancer Risks $>10^{-6}$ and $<10^{-5}$	Hazard Index	Chemicals with HI>1
Future Resident Adult	Yorktown Aquifer Groundwater	Ingestion	N/A				2.9E+00	
		Dermal Contact	N/A				8.0E-01	
		Inhalation/Shower	N/A				1.0E-01	
		Total	N/A				3.8E+00	
Future Resident Child	Yorktown Aquifer Groundwater	Ingestion	N/A				6.8E+00	RDX, Arsenic
		Dermal Contact	N/A				1.8E+00	Heptachlor epoxide
		Inhalation/Shower	N/A				N/A	
		Total	N/A				8.7E+00	
Future Resident Adult/Child	Yorktown Aquifer Groundwater	Ingestion	6.4E-04	Vinyl chloride, RDX, Arsenic	1,2-Dichloroethane, Tetrachloroethene, Trichloroethene, Heptachlor epoxide	Benzene, Carbon tetrachloride, Chloroform	N/A	
		Dermal Contact	8.4E-05		Tetrachloroethene, Trichloroethene, Heptachlor epoxide	1,2-Dichloroethane, Carbon tetrachloride, Chloroform, Vinyl chloride	N/A	
		Inhalation/Shower*	3.3E-05		Trichloroethene	1,2-Dichloroethane, Benzene, Carbon tetrachloride, Vinyl chloride, RDX	N/A	
		Total	7.6E-04				N/A	
Future Construction Worker - Adult	Yorktown Aquifer Groundwater	Ingestion	N/A				N/A	
		Dermal Contact	1.2E-06				4.7E-01	
		Inhalation	4.8E-05		1,2-Dichloroethane, Trichloroethene	Benzene, Carbon tetrachloride, Chloroform, Vinyl chloride	3.3E+00	Trichloroethene
		Total	4.9E-05				3.7E+00	

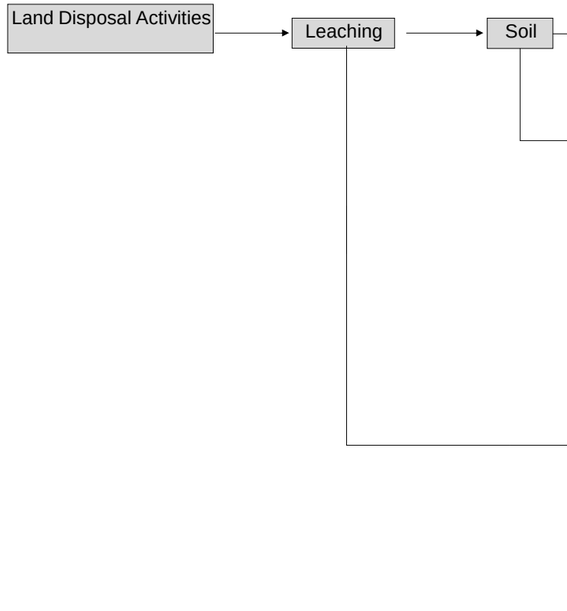
N/A - Not applicable, pathway incomplete.
*Calculated for adult only.

APPENDIX A-3
Summary of CTE Cancer Risks and Hazard Indices - Site 22
Record of Decision Report for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks >10^{-4}	Chemicals with Cancer Risks >10^{-5} and <10^{-4}	Chemicals with Cancer Risks >10^{-6} and <10^{-5}	Hazard Index	Chemicals with HI>1
Future Resident Adult	Columbia Aquifer Groundwater	Ingestion	N/A				6.2E-01	
		Dermal Contact	N/A				2.1E-01	
		Inhalation/Shower	N/A				7.0E-02	
		Total	N/A				9.0E-01	
Future Resident Child	Columbia Aquifer Groundwater	Ingestion	N/A				2.1E+00	
		Dermal Contact	N/A				4.1E-01	
		Inhalation/Shower	N/A				N/A	
		Total	N/A				2.5E+00	
Future Resident Adult/Child	Columbia Aquifer Groundwater	Ingestion	8.7E-05		Vinyl chloride, RDX, Arsenic	1,2-Dichloroethane, Carbon tetrachloride, Tetrachloroethene, Trichloroethene, Heptachlor epoxide	N/A	
		Dermal Contact	1.1E-05			Tetrachloroethene, Heptachlor epoxide	N/A	
		Inhalation/Shower*	8.2E-06			1,2-Dichloroethane, Trichloroethene	N/A	
		Total	1.1E-04				NA	
Future Construction Worker - Adult	Yorktown Aquifer Groundwater	Ingestion	N/A				N/A	
		Dermal Contact	4.0E-07				1.7E-01	
		Inhalation	3.7E-06			1,2-Dichloroethane, Trichloroethene	2.8E-01	
		Total	4.1E-06				4.5E-01	

NA - Not applicable, pathway incomplete.
*Calculated for adult only.

Appendix B



Primary Source	Primary Release Mechanism	Secondary Source	Secondary Release Mechanism	Exposure Media	Exposure Route	Potential Human Receptors: Industrial Worker	Trespasser/ Visitor Adult	Trespasser/ Visitor Youth	Trespasser/ Visitor Child	Residential Adult	Residential Child	Construction Worker
Land Disposal Activities	Leaching	Soil		Soil[1]	Ingestion	NA	NA	NA	NA	NA	NA	NA
					Dermal Contact	NA	NA	NA	NA	NA	NA	NA
					Inhalation	NA	NA	NA	NA	NA	NA	NA
			Leaching	Groundwater	Ingestion	NA	NA	NA	NA	X	X	NA
					Dermal Contact	NA	NA	NA	NA	X	X	X
					Inhalation[2]	NA	NA	NA	NA	X	X	X
				Indoor Air[3]	Inhalation	X	NA	NA	NA	X	X	NA
				Seeps[1]	Ingestion	NA	X	X	X	NA	NA	X
					Dermal Contact	NA	X	X	X	NA	NA	X
					Inhalation	NA	NA	NA	NA	NA	NA	NA
			Surface Runoff / Overland flow	Surface Water[1]	Ingestion	NA	X	X	X	NA	NA	X
					Dermal Contact	NA	X	X	X	NA	NA	X
					Inhalation	NA	NA	NA	NA	NA	NA	NA
				Sediment[1]	Ingestion	NA	X	X	X	NA	NA	X
					Dermal Contact	NA	X	X	X	NA	NA	X
					Inhalation	NA	NA	NA	NA	NA	NA	NA

APPENDIX B

Site 22 Human Health Conceptual Site Model

Record of Decision Report for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

[1]Record of Decision (ROD) documents for soil, waste, surface water (including seeps), and sediment at Site 22 have been completed for no further action (NFA).

[2]Foster and Chrostowski Shower Model used for groundwater inhalation during showering.
Concentration in Excavation Trench methodology from the Virginia Voluntary Remediation Program used to calculate concentration in air resulting from volatilization from shallow groundwater in an open excavation for constructin workers.

[3]Vapor intrusion from groundwater into indoor air qualitatively evaluated qualitatively.

NA - Not Applicable or pathway is incomplete

X - Potentially complete exposure pathways

Appendix C

APPENDIX C

Applicable or Relevant and Appropriate Requirements
Record of Decision for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Classification	Media/ Location/ Action	Requirement	Prerequisite	Citation	ARAR/TBC Determination	Comment
Federal-Chemical Specific	***Remedial Goals***					
	Groundwater	SDWA standards serve to protect public water systems. Primary drinking water standards consist of federally enforceable MCLs. MCLs are the highest level of a contaminant that is allowed in drinking water.	Groundwater contamination exceeds MCLs. Cleanup to MCLs for the contaminants presenting Human Health Risk is being considered in order to meet the state's expectations for beneficial use.	40 CFR 141.61 (a) (1) and (5)	Relevant and Appropriate	Relevant and appropriate because the aquifer is neither currently, nor reasonably anticipated in the future to be used as a potable water supply. The RGs set using MCLs are: VC: 2 µg/L TCE: 5 µg/L
	Groundwater	Chemical concentrations corresponding to fixed levels of human health risk (i.e., a hazard quotient of 1, or lifetime cancer risk of 10^{-6}, whichever occurs at a lower concentration).	Assessment of potential human health risks.	USEPA Region III RSL Tables only as they apply to RDX CAS #121-82-4	To Be Considered	The following RGs at Site 22 were developed using RSLs: RDX: 6 µg/L
Federal-Location Specific	***Migratory Flyway***					
	Migratory bird area	Protects almost all species of native birds in the United States from unregulated taking.	Presence of migratory birds.	16 USC 703	Applicable	Site 22 is located in the Atlantic Migratory Flyway. If migratory birds, or their nests or eggs, are identified at Site 22, operations will not destroy the birds, nests or eggs.
	Coastal zone					
	Coastal zone or area that will affect the coastal zone	Federal activities must be consistent with, to the maximum extent practicable, State coastal zone management programs. Federal agencies must comply with the consistency requirements of 15 CFR § 930.	Actions that may affect identified coastal zone resources or uses	15 CFR 930.33(a)(1), (a)(2), (b);.36(a)	Applicable	Activities at Site 22 that will affect Virginia's coastal zone will be consistent to the maximum extent practicable with Virginia's enforceable policies. Activities performed on-site and in compliance with CERCLA are not subject to administrative review; however the substantive requirements of making a consistency determination will be met.

APPENDIX C

Applicable or Relevant and Appropriate Requirements
Record of Decision for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Classification	Media/ Location/ Action	Requirement	Prerequisite	Citation	ARAR/TBC Determination	Comment
Federal-Action Specific	***Storage of Petroleum and Non-petroleum Oils***					
	Storage of fuels and oils (petroleum and non-petroleum) onsite	If storage capacity limits are exceeded a Spill, Prevention, Control, and Countermeasures Plan must be prepared and implemented with procedures, methods, equipment, and other requirements to prevent the discharge of into or upon the navigable waters of the United States.	Total onsite storage capacity exceeding 1,320 gallons in containers that are 55 gallons or larger in size.	40 CFR 112.3(a)(1); 112.5 through 7; and 112.8(b),(c), and (d)(2) through (5)	Applicable	It is anticipated that fuels or other treatment chemicals will be stored onsite. If the storage capacity in containers that are 55 gallons or greater is equal to or exceeds 1,320 gallons a Spill Prevention, Control, and Countermeasure (SPCC) Plan must be prepared and implemented. Containers include oil and fuel reservoirs in equipment.
	Subsurface Injection					
	Underground injection	Regulates the subsurface emplacement of liquids through the Underground Injection Control program, which governs the design and operation of five classes of injection wells in order to prevent contamination of underground sources of drinking water. The Underground Injection Control program regulates well construction, well operation, and monitoring.	Any dug hole or well that is deeper than its largest surface dimension, where the principal function of the hole is in subsurface placement of fluids.	40 CFR 144.12(a), 144.82(a)(1) and (b), 146.8(a) through (e), and 146.10(c)	Applicable	These alternatives will include substrate injections. Permits and administrative reviews are not required for on-site CERCLA injection wells; however, the remedial action will comply with the substantive requirements of the regulation.
Virginia Chemical-Specific	**State Water Control Law**					
	Groundwater	Establishes antidegradation policy to support groundwater quality standards to protect the public health or welfare and enhance the quality of water.	Groundwater is addressed in the remedy	Groundwater Quality Standards, 9 VAC 25-280-30	Applicable	This remedial action is being implemented with the goal of achieving MCLs. A baseline HHRA has been performed to calculate site specific risks and was used in the development of PRGs in the event that MCLs were not available for a chemical of concern. The aquifer is not currently, or reasonably anticipated to be, used as a potable water supply.

APPENDIX C

Applicable or Relevant and Appropriate Requirements
Record of Decision for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Classification	Media/ Location/ Action	Requirement	Prerequisite	Citation	ARAR/TBC Determination	Comment
Virginia-Action Specific	***Waste Management***					
	Accumulation of hazardous waste in containers onsite for less than 90 days	Hazardous waste may be accumulated on site in containers for up to 90 days so long as the containers are in good condition, compatible with the waste being stored, and labeled with the words "Hazardous Waste" and the date that accumulation began. The containers must also be kept closed unless adding or removing waste and inspected weekly.	Accumulation of hazardous waste in containers onsite.	9 VAC 20-60-262 only as it incorporates 40 CFR 262.34 (a) (1)(i), (2), (3), and 40 CFR 265.171 through 174	Applicable	It is possible that hazardous wastes may be generated during remedial activities. Containers will be managed in accordance with these requirements.
	Management of non-hazardous waste in containers	Establishes standards and procedures pertaining to the management of non-hazardous solid wastes in containers. Nonputrescible wastes must be stored in appropriate containers and not staged for more than 90 days.	Generation of non-hazardous solid waste that is managed onsite in containers.	9 VAC 20-81-95(D)(10)(b)	Applicable	It is anticipated that some wastes (such as decontamination fluids) may be generated and managed onsite in containers. Based on the analytical results from previous investigations, it is expected that these wastes will be non-hazardous solid waste. Wastes will be characterized prior to offsite disposal.
	Monitoring Well Construction and Abandonment					
	Monitoring Well Installation and Abandonment	Establishes requirements for the installation and abandonment of observation and monitoring wells, governed jointly by the State Board of Health and Department of Environmental Quality.	Observation and monitoring wells must be properly installed and abandoned in accordance with Virginia regulations to prevent contamination from reaching groundwater resources via the well.	12 VAC 5-630-420(B) and (C); and 450(C)(1),(2),(4),(5), (7), (8), and (9)	Applicable	Monitoring wells will be installed and abandoned in accordance with the Virginia regulations.
	Spill Prevention					
	Activities that could result in the discharge of pollutants into surface waters, or otherwise altering the physical, chemical or biological properties of surface waters	Discharge of pollutants to state waters is prohibited.	Activities such as dredging, filling, or discharging any pollutant into or adjacent to surface waters, or otherwise altering the physical, chemical or biological properties of surface waters, excavating in wetlands, or conducting the following activities in a wetland: 1. New activities to cause draining that significantly alters or degrades existing wetland acreage or functions. 2. Filling or dumping. 3. Permanent flooding or impounding. 4. New activities that cause significant alteration or degradation of existing wetland acreage or functions.	9 VAC 25-210-50(A)	Applicable	It is possible that chemicals staged onsite during remedial actions could affect waters of the state if spilled or if "daylighting" should occur. Stormwater inlets and other pathways to surface water will be protected to prevent accidental discharges of treatment chemicals to surface water. Permits and administrative reviews are not required for on-site CERCLA actions; however, the remedial action will comply with the substantive requirements of the regulation.

Notes:
Selected Remedy: Enhanced In situ Bioremediation (EISB), MNA, and LUCs

APPENDIX C

Applicable or Relevant and Appropriate Requirements
Record of Decision for Groundwater at Site 22
Naval Weapons Station Yorktown
Yorktown, Virginia

Classification	Media/ Location/ Action	Requirement	Prerequisite	Citation	ARAR/TBC Determination	Comment
Acronyms and Abbreviations						
ARAR	Applicable or relevant and appropriate requirement			RCRA		
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act			SDWA		
CFR	Code of Federal Regulations			USC		
HHRA	Human Health Risk Assessment			VA		
MCL	Maximum Contaminant Level			VAC		
PRG	Preliminary Remediation Goal					

References

Commonwealth of Virginia, 2004. Preliminary Identification, Applicable or Relevant and Appropriate Requirements.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Interim Final* Office of Emergency and Remedial Response. EPA/540/G-89/006.

USEPA, 1998. *CERCLA Compliance with Other Laws Manual: Part II. Clean Air Act and Other Environmental Statutes*Office of Emergency and Remedial Response.

USEPA, 1998. RCRA, Superfund & EPCRA Hotline Training Manual. Introduction to Applicable or Relevant and Appropriate Requirements. EPA540-R-98-020.

Appendix D

IN RE:

THE PUBLIC MEETING FOR THE YORKTOWN WEAPONS STATION SITE 22

(The Burning Pad)

TRANSCRIPT OF PROCEEDINGS

Yorktown, Virginia

May 24, 2012

PRESENT FOR CH2M HILL:

JAMES GRAVETTE

WILLIAM FRIEDMANN

WADE SMITH

ADAM FORSHEY

ALSO PRESENT:

MR. MURDOCK

MEGAN GRAVETTE

(The hearing commenced as follows:)

MR. GRAVETTE: All right. This is the public meeting for the Yorktown Weapons Station Site 22 Burn Pad Area, and we're here to discuss the draft final proposed plan. And as Mr. Murdock pointed out, it's the draft final plan. The reason it's draft final is because this is the part in the process that we solicit community involvement. We want to know what the community thinks about the plan, if they approve it, and as a result of their reaction to the plan, hopefully positive, the State also then would concur or not concur. So this is the final part of putting together these plans that have been developed by both the Navy and in conjunction with EPA and the State. Next slide, Bill, please.

We're going to walk through a few things here, the site history, the proposed groundwater remedy, and then we're going to solicit some comments. So with this site itself, Site 22, this is a groundwater proposed plan. And we -- we have a plan that identifies the recommended alternative, the recommended cleanup alternative. The plan itself was noticed in the paper -- what was the date?

MR. FRIEDMANN: The weekend of the 12th and 13th.

MR. GRAVETTE: May 12th and 13th, so we are officially in the public comment period for the plan. And as a requirement during the public comment period we are required to hold the public meeting to discuss it. As a result of comments received during the public comment period and/or within this public meeting, the Navy, with help from EPA and the State, will address all of those comments inside the final plan. Next slide.

So here's our site, Site 22. It's located adjacent to two other sites that we've formerly cleaned up, Site 4 and Site 21. Next slide, Bill.

The background of this site is it's a burn area. We discussed it previously during the restoration advisory board meeting, but it's a former burn area. Today it's basically a grassy field that's surrounded by some woods. There are -- three sides of this site slopes down to surface water, little creeks. We have since -- with this site we've since cleaned up the rest of the media. There was a soil cleanup done in 2002, so the soil is done, and we have no further action documents for soils in 2003 and sediments and surface water in 2011. So the only thing that's left at this site is groundwater. Next slide.

Here's a historic shot of what the site looks like. This is kind of interesting, gives you a perspective on where the contamination came from. So they had a bunch of different areas where they had burn pans set up, and as a result of those operations there was releases to the soils and ultimately to the groundwater beneath it.

MR. MURDOCK: So these little round circles there are the actual burn pans?

MR. GRAVETTE: Yeah. These were the areas that they did their burning operations. And it was off-spec explosives, so this was a disposal type of an area. They were actually burning these things on purpose to dispose of off-spec explosives and this is how they did it in that day. Next slide.

So the picture on this slide, Slide 6, shows you kind of a conceptual model of what we see at the site and a cutaway of the site. So we have the impacts to soil, we have those impacts migrating down to the soil profile and the groundwater and eventually moving off the site. We have low levels or relatively low levels of explosives and volatile organic compounds in the groundwater that we're going to be cleaning up here. The levels present a potential risk to both human health and eco, and

that's what we're addressing with this plan. Next slide.

In the feasibility study, the phase that preceded this, we look at a number of criteria, seven criteria, as we identify alternatives to address groundwater. We look at things like human health, federal and state requirements, effectiveness of the solution that we're choosing, whether we're going to reduce concentrations, et cetera, mobility or volume through treatment. So we looked at treatment, we looked at short-term effectiveness of whatever option we choose, implementability, how easy it is to actually install this remedy, cost, et cetera. All these things are weighed next to each other relative to different cleanup alternatives. And then the EPA, the State and the Navy together decide the one that makes the most sense for this site. So that was the phase that preceded where we are right now in the proposed plan. Based on all of that, we selected a preferred alternative. Next slide.

So during that feasibility study where we were weighing all the different alternatives, we looked at four specific ones. We whittled them down to four specific ones. One, no action. That's a baseline. That's -- in all of this circle of

cleanups you have to weigh it against what if you do nothing. The other ones had to do with treatment of groundwater. The first one had to do with treating just the explosives and then monitoring groundwater and controlling the land use. The third one had to do with treating explosives and VOCs, and the fourth one had to do with treating explosives and VOCs. The difference in three and four are the types of treatments that you would use. Next slide.

So based on the evaluation of the alternatives, what's presented in the proposed plan is alternative two, which is we're going after the explosives in the groundwater, which is RDX. And that's a long acronym. I'm not even sure how to say that. But RDX is the contaminant of interest in the groundwater from an explosives perspective. We're going to treat that using enhanced in-situ bioremediation. So we're going to inject a chemical into the ground that will stimulate the microbes to go after the groundwater problem, the RDX.

And as I mentioned in the previous meeting, there's also volatile organics that are in the groundwater. That treatment would also impact or degrade the volatiles that are there, too, but we're not necessarily directing our cleanup at the

volatiles. It's going to be an indirect result of treating the explosives. So we're going to treat the explosives and then we're going to do some performance monitoring on that treatment. Then we're going to start into groundwater monitoring and land use controls. That's the alternative as a whole. Next slide.

So as Bill pointed out, this plan that is presented before you for this treatment for groundwater at Site 22 was noticed in the paper on May 12th and 13th. Public comment period began on May 14th and will run through the end of June. And we're going to address all comments received either during this plan, during this public meeting, and/or during the public comment period.

Once we've received all the comments, there's no issues, the State and EPA are okay with it, we're going to move into what's called a record of decision. That's our next step. And that's a legally defensible document. That will be signed by EPA and the State and being concurred by -- the State will concur on that document, and that basically sets the stage for what we're going to do. So that's the next document, the record of decision. Our goal with the record of decision is the end of September.

So I guess it's Megan and Mr. Murdock. Any questions?

MR. MURDOCK: Yeah. What you want to do is treat the -- so as I understand it, you've got something in the ground that's a problem, RDX, in whatever shape, you've got groundwater and so here it's clean and it must move along and here it gets contaminated and then it goes somewhere?

MR. GRAVETTE: Yes, sir.

MR. MURDOCK: And your proposal is send in -- stimulate microbes to mitigate, reduce the -- the RDX compounds in the dirt that's contaminating the groundwater?

MR. GRAVETTE: Exactly.

MR. MURDOCK: Okay. I'm not -- how long does it take for something clean to become -- moving off site as something contaminated?

MR. GRAVETTE: Every site would be different. There's a groundwater flow velocity. There's a calculated amount of time that it would take for something to travel in groundwater from one spot to another spot, and that's going to be based on the type of material it's moving through and the type of chemicals that are in that water. So as you pointed out earlier, if it's clay type of materials,

some of those things tend to absorb chemicals. Maybe that won't move as fast through groundwater. Other stuff flows through. If it's gravelly material, the groundwater will move more quickly through it and as a result the contaminants will move more quickly through that aquifer.

MR. MURDOCK: Why does not the contamination get diluted over time as the water flows through?

MR. GRAVETTE: It does. That's part of it. There is a component of dilution with any groundwater contaminant plume. There's different components. There's components that are going to allow it to move forward. There are going to be components that retard the movement of the groundwater plume like the type material it's moving through would retard that forward movement or disburse it.

MR. MURDOCK: Well, apparently the plume doesn't keep growing ad infinitum. Apparently this groundwater goes through and it gets contaminated, but then gets less and less and less so you don't have to deal with it at some point.

MR. GRAVETTE: Right. With this site, the source has been removed. So the activities have stopped, the soil source, the contamination of soils

as a result of those burning activities has been dug up and removed, so there's nothing left as a continuing source to groundwater. So what we're cleaning up is residual contamination from previous operations.

MR. MURDOCK: In the liquid or in the soil?

MR. GRAVETTE: In the liquid. The soils are done. What is left is what has moved through the soils into the groundwater. And the intent is -- if the plume is here, we intend to treat -- and the plume is moving this way, we intend to put up a treatment wall in front of it, inject, and as this moves through this injection wall, there will be chemicals to stimulate microbes to eat at that plume as it moves through.

But you're right, it's already naturally degrading. Types of chemicals lend themselves to naturally degrading. We're speeding that process up through this injection.

MR. MURDOCK: Okay.

MR. GRAVETTE: And then we're going to monitor the effectiveness. Our intent is to inject one, maybe two times. But based on what we've seen in the data, the EPA, the State and the Navy may decide we need to inject more, so it -- all bets are

off. We're going to monitor the performance of the injections. We hope not to inject a whole lot, but the data is the data. We will have to evaluate what comes out of it.

MR. MURDOCK: What does RDX do to people? You know, apparently it's unhealthy. It's -- what symptoms might a person that gets tainted by RDX manifest?

MR. GRAVETTE: In terms of the -- the organ, it would affect -- not sure. It's a carcinogenic compound, so it's cancer causing. At levels high enough it would be a cancer-causing agent if you were exposed to it, if you somehow absorbed it through your skin or drink the water, et cetera. So for us at this site we're going to treat it, but there's also groundwater use controls in place. There's no one near this site. There's going to be controls in place for the groundwater so there's no receptors for that type of an impact. But RDX as a whole is something that if it got into your drinking water system is a big problem. That's not the case here. But it would be a carcinogenic compound. And the same would hold true for the volatile organic compounds, so that would be a cancer-causing agent.

MR. MURDOCK: So this is at a different

level than the subsurface in the strata below the surface than the aquifers. Wherever the water comes from, could be the Mattaponi Reservoirs or whatever, they're not tainted by this groundwater?

MR. GRAVETTE: No. This is a very shallow problem, and this water is moving maybe 50 feet down. It's actually discharging into a creek, so it's not diving deep into the aquifer. We have data to support that. It's moving laterally and discharging to a creek. We have samples in the creek that indicate there's no risk. So the plume basically is dying as it moves to the creek. What we're doing is we're going to treat it to speed up the process. And the RDX plume sits closer to the top of the water table. The VOC plume sits a little bit lower. So they have different densities, they have different ways they move, but both plumes eventually discharge into the creek and so we're going to treat both of those.

MR. MURDOCK: And this would take how long?

MR. GRAVETTE: To get -- well, to get down to our cleanup level. So the way it works is that before we do this cleanup and as identified in this plan, for each of the chemicals that are chemicals of interest at the site, we develop cleanup goals. So

we'll inject to clean the stuff up, we'll start monitoring and then we'll continue to look at this as long as it stays above that cleanup goal. So there are cleanup goals. RDX I believe is six, so RDX has a cleanup goal of six parts per billion, so that's like one drop in a swimming pool, an equivalent to that. Is it TCE or PCE?

MR. FRIEDMANN: PCE.

MR. GRAVETTE: Tetrachloroethylene --

MR. FRIEDMANN: It's TCE.

MR. GRAVETTE: Trichloroethylene has a cleanup goal of five parts per billion. Again, it's the equivalent of like a drop in a swimming pool, so these are very low levels, but that's --

MR. MURDOCK: No standards are -- they're developed by the various regulatory and scientific things?

MR. GRAVETTE: Right. But for us it is a well-defined plume. It's restricted to a small area. It's not impacting any drinking water or aquifers. It's discharging to a creek that we know is clean. So we're going after it to treat it to expedite its cleanup is certainly what we're doing.

MR. MURDOCK: Is there any coordination with the William & Mary facility across the river

which deals with wildlife, you know, fish and crabs and marine, you know, creatures? I'm thinking of the environmental impacts of -- of this particular one, but also of others. It goes into Felgates Creek and then presumably into the York and on down to the bay.

MR. GRAVETTE: Sure.

MR. MURDOCK: What -- it doesn't -- it ceases to be a human health problem. What does it do for organisms in the bay?

MR. GRAVETTE: The cleanup team at Yorktown includes the Navy in partnership with EPA and the State. The State has their support that helps us with ecological issues and the EPA has their support that includes U.S. Fish and Wildlife Service and NOAH as well, so it's a big cleanup team.

And, Wade, I don't know if you can add to that, but all of our decisions are with based on feedback from the three main agencies after we've reached out to our sister organizations that are helping us with these reviews. So EPA would reach out to U.S. Fish and Wildlife service, those kind of things, and to NOAH. The State has their own in-house experts for those types of issues. And we have organizations within the Navy where we have experts that provide support to help me do this work.

So it's not done in a vacuum with just a small group of people. We actually reach out to these others agencies, and, frankly, to other partners that are along the fence line like the National Park Service. They have their own people that review these types of things in-house.

MR. MURDOCK: Yeah. Okay.

MR. SMITH: I mean, like he stated, there's no direct conversation with VIMS, if that's who you were referring to, but the ecological and human health hazards are addressed by other organizations throughout this, so we're not contacting VIMS, but the problems are addressed otherwise.

MR. GRAVETTE: Okay. Thank you. Megan?

MEGAN GRAVETTE: Why wouldn't you do the first alternative?

MR. GRAVETTE: Excuse me?

MEGAN GRAVETTE: Why wouldn't you just do the first alternative?

MR. GRAVETTE: The first alternative?

MEGAN GRAVETTE: Yes, doing nothing.

MR. GRAVETTE: Well, there's a time component, too, so it has to meet all the criteria. And one of the components is timely, it has to be done timely. We can't let something sit here and

even though it's degrading let it sit there because there is a component of contamination that continues without us doing anything. So it wouldn't be reasonable to not address with it some sort of proactive measure like treatment.

MR. FRIEDMANN: I'm Bill Friedmann. One of the other things is if we do nothing, we don't know if it's getting better or worse because we're not monitoring the groundwater either. So we do -- we literally do nothing and, you know, not doing anything means that we don't have any data or new groundwater information that says, Hey, this is getting better or this is getting worse on its own.

MR. MURDOCK: So then a very real part of the fix here is the groundwater monitoring and the land use controls?

MR. FRIEDMANN: Yes. And one of the things as we do the monitoring, the monitoring of the data is looked at, evaluated by all parties. If for some reason there's something we missed, we find that the action that we took is not adequate, say we're not going to be able to meet the cleanup goals in a reasonable amount of time, we will all proactively -- the EPA, the Virginia Department of Environmental Quality and the Navy will have a discussion to talk

about if we need to modify the remedy to improve upon it in any way, shape or form, whether it's more injection, whether it's changing an alternative altogether. This occurs continuously because we're doing monitoring. We will be doing monitoring on a routine basis yet to be determined, but as you saw during the RAB meeting, we also do what's known as a five-year review. So at an absolute minimum, every five years we look back at all the data that's been generated since that time and we are able to determine whether the remedy is working.

MR. FORSHEY: Ultimately the Navy is looking for the best of the seven criteria, so there's a lot of -- there's a scoring process that's involved with -- you know, doing nothing is going to be cheap, but you don't know if it's going to solve your problem. And doing just monitored natural attenuation and monitoring and watching the plume get diluted like you had mentioned, Mr. Murdock, is cheaper, but it's going to take a longer time. So they do a scoring process and try and find the peak performance and select that as a preferred alternative.

MR. GRAVETTE: And the benefit for the Navy, even though there's a cost associated with

doing something more than just monitoring it, is that we clean this thing up and now we can use the property. There would be no need for restrictions. We'd help the environment and there would be more operational room, so a lot of things to consider.

MR. FRIEDMANN: Does that help you, Ms. Gravette?

MEGAN GRAVETTE: Thank you.

MR. GRAVETTE: Any other questions? All right. Well, thank you very much. And, again, we're in the public comment period, so if there's something that you think of that you would like answered, Mr. Murdock or Megan Gravette, please feel free to submit your questions on the back of the proposed plan. I think it offers a place where your comments can go.

MR. MURDOCK: Thank you.

MR. FORSHEY: And there's copies of the pack back there if you haven't gotten them. It's also available in the library.

MR. FRIEDMAN: You can take extra copies with you.

MR. FORSHEY: Yes, take extra copies if you need them. And you can read it and it tells you how the submit questions or comments if you have anything.

MR. GRAVETTE: Thank you.

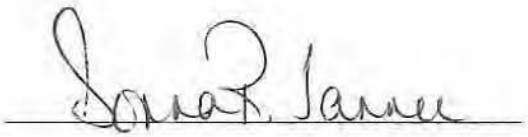
(Whereupon, the hearing was concluded at 3:26 p.m.)

CERTIFICATE OF COURT REPORTER

I, Donna R. Tanner, Shorthand Reporter, certify that I recorded verbatim by Stenotype the public hearing in the captioned cause at the Yorktown Public Library on May 24, 2012.

I further certify that to the best of my knowledge and belief the foregoing transcript constitutes a full, accurate and complete transcript of said proceedings.

Given under my hand this 4 day of June, 2012, at Virginia Beach, Virginia.



Donna R. Tanner

VDEQ Concurrence

COMMONWEALTH of VIRGINIA

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Director

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September 5, 2012

Mr. Ronald J. Borsellino, Director
Hazardous Site Cleanup Division (3HS00)
U.S. Environmental Protection Agency, Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

RE: Final Record of Decision
Site 22 – Burn Pad (Groundwater)
Naval Weapons Station Yorktown
Yorktown, Virginia

Dear Mr. Borsellino:

The Virginia Department of Environmental Quality (DEQ) staff has reviewed the Final Record of Decision (Final ROD) for Site 22 – Burn Pad (Groundwater) located at Naval Weapons Station Yorktown (NWSY), Yorktown, Virginia. The DEQ concurs with the selected remedy for groundwater, as described in the September 2012 Final ROD, which was signed by Lowell D. Crow (Captain, U.S. Navy, Commanding Officer) on September 5, 2012.

Please contact Wade Smith at (804) 698-4125 or wade.smith@deq.virginia.gov with any questions.

Sincerely,

Durwood H. Willis
Director, Office of Remediation Programs

cc: Jim Gravette, NWSY
Milt Johnston, DEQ, TRO
Wade Smith, DEQ, CO
Moshood Oduwole, EPA

CH2MHILL

For access to the Administrative Record or additional information on the IR Program, contact:

Public Affairs Office
Naval Weapons Station Yorktown
P.O. Drawer 160
Yorktown, VA 23691-0160
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