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ST JULIENS CREEK
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Interim Proposed Plan

Site 21: Industrial Area

St. Juliens Creek Annex
Chesapeake, Virginia

JULY 2009

1 Introduction

This **Interim Proposed Plan** identifies the Preferred Alternative for mitigating the **chlorinated volatile organic compound** (CVOC) **plume** in shallow groundwater at **Site** 21 located at St. Juliens Creek Annex (SJCA), Chesapeake, Virginia. The Preferred Alternative is groundwater treatment through a two-phase approach: (1) **in situ chemical reduction** (ISCR) and (2) **enhanced reductive dechlorination** (ERD). Performance monitoring will be included in both phases of treatment to ensure effective and optimal conditions are established for mitigation of the CVOCs and to ensure the process is performing effectively. **Land-use controls** (LUCs) will be maintained until site conditions allow for unlimited use and unrestricted exposure.

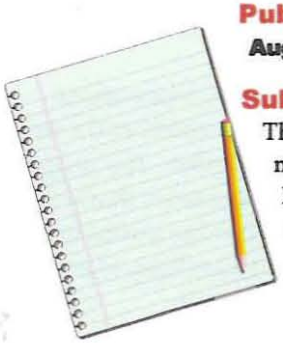
This plan summarizes the remedial alternatives evaluated and provides the rationale for selection of ISCR and ERD as the Preferred Alternative for Site 21 shallow groundwater. This plan is "interim" because it does not address all potential site concerns. Currently under additional investigation is the potential risk to indoor workers from vapor intrusion through the inhalation of indoor air. If risk is identified, a subsequent proposed plan will be prepared to address that pathway.

This Interim Proposed Plan is issued jointly by the U.S. Navy (the lead agency for site activities) and the **U.S. Environmental Protection Agency** (EPA) Region III (the lead regulatory agency) in consultation with the **Virginia Department of Environmental Quality** (VDEQ), the support agency. This Interim Proposed Plan fulfills the public participation responsibilities required under Section 117(a) of the **Comprehensive Environmental Response, Compensation, and Liability Act of 1980** (CERCLA) and Section 300.430(f)(2) of the **National Oil and Hazardous Substances Pollution Contingency Plan** (NCP).

Information documenting the environmental investigation at Site 21 can be found in the **Site Investigation** (SI) Report (June 2004), the **Remedial Investigation** (RI) Report for Site 21 (June 2008), the **Feasibility Study** (FS) Report for Site 21 (February 2009), and other documents in the **Administrative Record** file and **Information Repository** for SJCA. Key information from the FS report, including all remedial options considered and detailed information for the Preferred Alternative, is summarized in this plan. A glossary of key terms, which are identified in bold print the first time they appear, can be found at the end of this document.

The Navy and EPA, in consultation with the VDEQ, will make the final decision on the remedial approach for Site 21 after reviewing and considering all information

Mark Your Calendar for the Public Comment Period



Public Comment Period
August 1 – September 14, 2009

Submit Written Comments
The Navy will accept written comments on the Interim Proposed Plan during the public comment period. To submit comments or obtain further information, please refer to the back page.

Attend the Public Meeting
August 11, 2009

Time – 5:00 pm
Place – Major Hillard Library

The Navy will hold a public meeting to explain the Interim Proposed Plan. Verbal and written comments will be accepted at this meeting.

Location of Information Repository

Major Hillard Library
824 Old George Washington Highway N
Chesapeake, Virginia 23323
Phone: (757) 382-3600

Survey

submitted during the 45-day **public comment** period. The Preferred Alternative may be modified or another **remedial action** may be selected based on new information or public comments received. Therefore, public comment on the alternatives and the rationale for selection of the preferred alternative is encouraged.

2 Site Background

2.1 Site Description

SJCA covers approximately 490 acres and is situated at the confluence of St. Juliens Creek and the Southern Branch of the Elizabeth River in the city of Chesapeake, Virginia (Figure 1). Most of the surrounding area is developed and includes residences, schools, recreational areas, and shipping facilities for several large industries. Potable water and water for industrial use by SJCA and the surrounding neighborhoods are provided by the cities of Chesapeake and Portsmouth.

SJCA began operations as a naval ammunitions facility in 1849. The facility was one of the largest ammunition depots in the United States and was involved in the wartime transfer of ammunitions to other naval facilities. After ordnance operations ceased at SJCA in 1977, decontamination was performed in, around, and under ordnance-handling facilities by flushing the areas with chemical solutions and water. SJCA has also been involved in non-ordnance services, including degreasing; operating various shops, such as paint, machine, vehicle and locomotive maintenance, pest control, battery, printing, and electrical; operating boiler plants, wash racks, and potable-water and saltwater fire-protection systems; providing firefighter training; and storing oil and chemicals.

Figure 1 - Site Location

Site 21 is in an industrial area in the south-central portion of SJCA (Figure 1). Site 21 was initially identified as Building 187, which was a locomotive maintenance facility where **trichloroethene** (TCE) was used; however, data from investigations indicated the need to expand the initial boundary to encompass a CVOC groundwater plume underlying a number of nearby industrial buildings (Figure 2), which historically had been used as machine, vehicle, and locomotive maintenance shops, electrical shops, and munitions-loading facilities. The outdoor areas were used for storing equipment and chemicals. A fuel service station, including two underground storage tanks, had existed just south of Building 187, but has been removed (Figure 2). Waste oils and degreasers (including TCE) were reportedly disposed of on the ground surface and around the railroad tracks in this industrial area. Many of the older buildings at the site have been demolished. Remaining buildings within the Site 21 area are used for storage and maintenance activities.

2.2 Summary of Previous Investigations

Several investigations were conducted at SJCA and Site 21. Detailed information from previous investigations is available in the Administrative Record for SJCA. A complete list of the documents included in the Administrative Record files for SJCA can be obtained from the SJCA Installation Restoration Web site (http://public.lantops-ir.org/sites/public/sjca), from the Information Repository (see Page 1), or by contacting the **Naval Facilities Engineering Command** (NAVFAC) Public Affairs Office.

Basewide investigations and studies conducted at SJCA are summarized below:

Initial Assessment Study (Naval Engineering and Environmental Support Activity, 1981)

In 1981, the Navy conducted the Initial Assessment Study (IAS) as part of the Naval Assessment and Control of Installation Pollutants (NACIP) Program. The purpose was to qualitatively identify and assess sites that posed a potential threat to human health and the environment because of contamination from past handling of and operations involving hazardous materials.

The IAS indicated that degreasers used for base operations were commonly disposed of by being dumped onto railroad tracks next to buildings. The IAS also included

reports of waste hydraulic oil being disposed of along fence lines to control weeds and waste oils and solvents being applied to roads to control dust. The area around Building 187 is detailed in the report as being saturated with oil. Details regarding pesticides, degreasers, oils, paints, solvents, etc., and the buildings associated with the use of these substances are provided in the IAS.

Resource Conservation and Recovery Act Facility Assessment (A.T. Kearney, 1989)

The Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) was conducted to identify areas at SJCA that could be identified as solid waste management units (SWMUs) or areas of concern (AOCs). This included a preliminary review of all available relevant documents and a visual site inspection. Seven of the SWMUs and one of the AOCs identified and recommended for further action in the RFA are located within the current Site 21 extended boundary.

Relative Risk Ranking System Data Collection Report (CH2M HILL, 1996)

A relative risk ranking (RRR) was conducted to determine and prioritize sites requiring possible further investigation. It based the ranking on the results of the RFA and focused on the areas of greatest concern (e.g., visible contamination) to serve as a conservative screen to determine whether or not additional investigation was necessary. The RRR included collection of groundwater and surface soil samples within the SWMUs and AOCs located within the current Site 21 extended boundary. The results indicated the presence of **volatile organic compounds** (VOCs), **semi-volatile organic compounds** (SVOCs), and metals in groundwater and VOCs, SVOCs, pesticides, **polychlorinated biphenyls** (PCBs), and metals in soil.

The site-specific investigations and studies conducted at Site 21 are summarized below:

Site Screening Assessment (CH2M HILL, 2002)

Based on the results of the RFA and RRR, a Site Screening Assessment (SSA) was conducted. The partnering team visited the site to help determine the appropriate path forward for the sites identified in the RFA, including identifying the necessity to collect additional samples for inclusion in the SSA report. Based on a review of the information gathered during the site visit, no additional samples were recommended within the Site 21 area. During the SSA, the analytical data from the RRR were evaluated, and human health and ecological risk screenings were conducted to evaluate whether areas required additional investigation, removal action, or no further

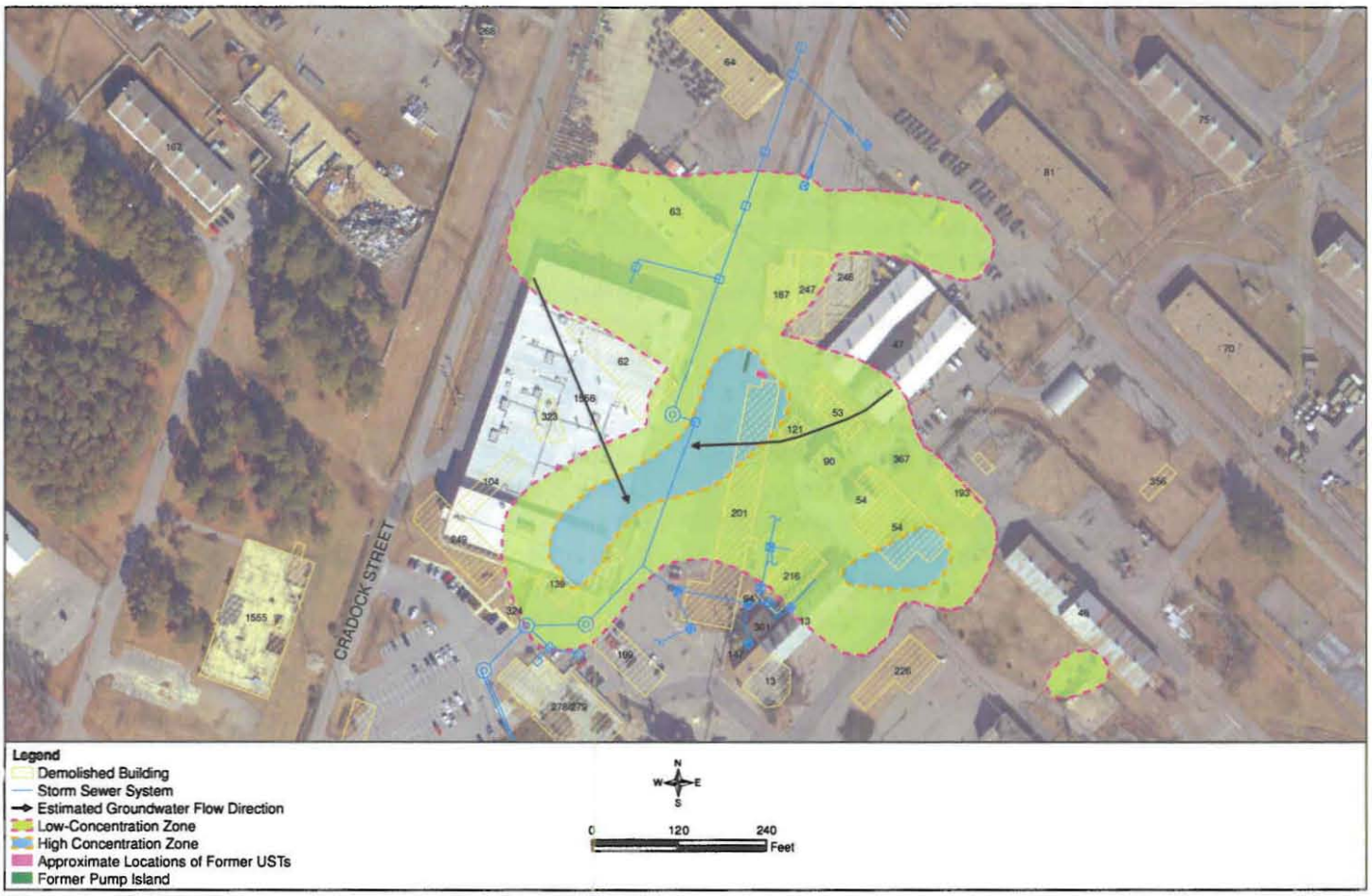


Figure 2 - CVOC Plume

action. The SSA determined that no further action was recommended for soil at all of the SWMUs and AOCs within the Site 21 area and that VOCs in shallow groundwater would be addressed following further investigation of groundwater at Site 21. The SSA report provided in the Administrative Record summarizes the findings for sites located within the current, expanded Site 21 boundary.

Site Investigation (CH2M HILL, 2004)

Based on the results of the SSA, an SI was conducted to further characterize potential contamination in groundwater. The investigation aimed to identify the extent and determine the magnitude of CVOCs present in the Columbia aquifer (shallow groundwater) and determine if site activities had affected the Yorktown aquifer (deep groundwater).

The data collected during field activities confirmed the presence of a CVOC plume in shallow groundwater with TCE concentrations up to 2,500 µg/L; however, the plume was not fully delineated. SVOCs, one pesticide, explosives, and metals were also detected in shallow groundwater. One VOC, one SVOC, one explosive, and several metals were detected in deep groundwater; however, it was not clear if the detections were related to site activities.

A **human health risk screening (HHRS)** identified potential human health risks from CVOCs and an explosive (cyclotrimethylenetrinitramine, or RDX) in shallow groundwater and from chloroform, arsenic, and vanadium in deep groundwater. An ecological risk screening was also conducted. Although Site 21 provides little habitat for potential ecological receptors, potential for chemicals in groundwater to be transported and discharged to St. Juliens Creek or its tributaries was identified. Therefore, chemical concentrations in groundwater were screened to determine if they are present in groundwater at concentrations that could represent a potential risk to aquatic life. Only TCE was detected at concentrations exceeding its ecological screening value, indicating a potential risk. However, based on the transport distance before its discharge to surface water, and the potential for mixing and dilution; it was concluded that there is minimal potential for adverse effects to aquatic life and TCE concentrations are unlikely to pose risk to ecological receptors. Therefore, no further ecological evaluation was recommended.

The SI report recommended further evaluation of shallow and deep groundwater, including further delineation of the CVOC plume in shallow groundwater and resampling select existing groundwater-monitoring wells to confirm or rule out elevated concentrations of metals (arsenic and vanadium) in deep groundwater and RDX in shallow groundwater. No further investigation of the chloroform detected in deep groundwater was recommended because the concentration was well below the MCL.

Remedial Investigation (CH2M HILL, 2008)

The RI was conducted to determine the nature and extent of contamination present and evaluate contaminant fate and transport mechanisms to develop a conceptual site model (CSM), and further evaluate whether the site posed unacceptable human health and ecological risks. Specific objectives were to define the boundary of the shallow groundwater CVOC plume, determine whether or not RDX is present in shallow groundwater, and further evaluate the metals detected in the deep aquifer during the SI. Storm sewer sampling was also performed to evaluate contaminant migration.

An approximately 8-acre CVOC plume [primarily of TCE, cis-1,2-dichloroethene (DCE), and vinyl chloride (VC)] was delineated. In addition, benzene and arsenic were detected at isolated locations in shallow groundwater. RDX was not detected in shallow groundwater during the investigation. Several metals were detected in deep groundwater, including arsenic and vanadium; however, concentrations were much lower than those detected during the SI. CVOCs were detected in samples collected from the storm sewer system, indicating that groundwater discharges into the storm sewer system.

The human health risk assessment (HHRA) quantitatively evaluated potential human health risks to current and future receptors from ingestion, dermal contact, and inhalation through showering from shallow and deep groundwater. TCE, cis-1,2-DCE, VC and 1,1-DCE were retained as the chemicals of concern (COCs) for potable use of the shallow groundwater. Arsenic and benzene in shallow groundwater and arsenic and vanadium in deep groundwater were identified as posing potential risk; however, a qualitative evaluation of the data resulted in their elimination as COCs. The HHRA also evaluated the potential human health risks associated with current and future hypothetical industrial workers inhaling indoor air; however, an additional investigation is being performed to further assess this exposure pathway due to the uncertainties identified in the HHRA, and the results of this additional investigation will be presented in a future addendum to the RI report. The stormwater data was not evaluated in the HHRA because it was collected to evaluate the groundwater migration pathway; the presence of CVOCs indicates groundwater in the storm sewer system and was evaluated through the shallow groundwater HHRA. Soil was not evaluated in the HHRA based on the HHRSs conducted during the SSA and SI and the recommendation for no further action for soil.

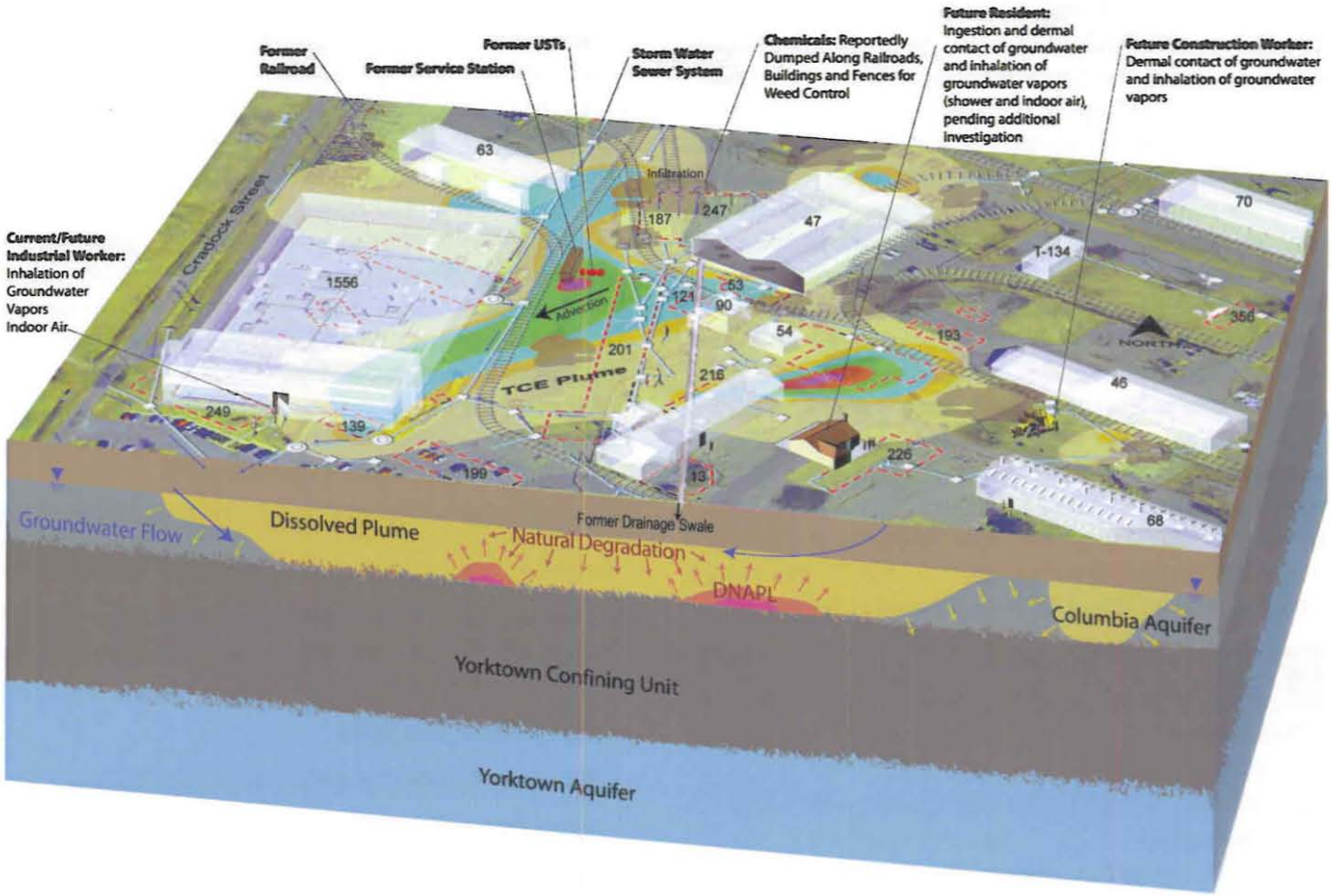


Figure 3 - Conceptual Site Model

The RI report recommended that an FS be completed to evaluate potential remedial alternatives to mitigate unacceptable human health risks from the COCs for potable use of the shallow groundwater at Site 21. No unacceptable human health or ecological risks were identified from exposure to deep groundwater, surface and subsurface soil, or stormwater. The CSM is depicted in Figure 3.

Feasibility Study (CH2M HILL, 2008)

An FS was completed to develop and evaluate remedial action alternatives to prevent unacceptable risk exposure through potable use of shallow groundwater at Site 21. Four remedial alternatives were selected for detailed comparative analysis: (1) no action, (2) monitored natural attenuation (MNA), (3) ISCR and ERD, and (4) in situ chemical oxidation (ISCO) and ERD.

3 Site Characteristics

Most of Site 21's ground surface, with the exception of a few small, unconnected grassy areas, is covered with asphalt. Although many of the older buildings at the site have been demolished, several still remain, including Buildings 47 and 1556. The general topography of the area is flat, with elevations ranging from 7 to 9 feet above mean sea level. A storm sewer system runs through Site 21 and drains to a downstream inlet to St. Juliens Creek (Site 2). Shallow groundwater at Site 21 is encountered from 2 to 7 feet below ground surface and flows southwest in the eastern portions of the site and southeast in the western portion of the site, toward the storm sewer system east of Building 1556 (Figure 2).

The subsurface geology at Site 21 consists of the fine to coarse silty and clayey sands of the Columbia aquifer underlain by the high-plasticity clay of the Yorktown confining unit. The Columbia aquifer extends to a depth of between 13.5 and 20 feet below ground surface. Shallow groundwater flow has been calculated to be approximately 72 feet per year. The Columbia aquifer is not currently used, and is not expected to be used, as a potable or industrial water supply. Water for drinking and industrial use is supplied to SJCA by the City of Chesapeake. The Yorktown confining unit, consisting of relatively impermeable silt and clay layers, is approximately 17 feet thick and contiguous at Site 21 and lies above the fine to coarse shelly sands of the Yorktown aquifer.

3.1 Nature and Extent of Contamination

The source of CVOCs in shallow groundwater is likely associated with the disposal of waste fluids (oils and degreasers, including TCE) on the ground surface and other undocumented releases within the site boundaries. TCE and its degradation products (cis-1,2-DCE and VC) were the most frequently detected contaminants in the shallow aquifer. Contaminant concentrations appear to follow groundwater flow, with the dissolved plume (low-concentration zones) moving from apparent source release points (high-concentration zones) to the southeast and southwest toward the storm sewer system. Depth-specific data indicate that contaminant concentrations are highest at the bottom of the Columbia aquifer and that contaminants may be sorbed into the top of the Yorktown confining unit. The Site 21 CVOC plume underlies a number of the nearby industrial buildings and extends over approximately 8 acres (Figure 2). Maximum detected concentrations of the COCs are provided in Table 1.

Chemical of Concern	Maximum Concentration (µg/L)
Trichloroethene	16,000
cis-1,2-Dichloroethene	2,600
Vinyl chloride	390
1,1-Dichloroethane	11

Table 1 - Maximum Concentration for Chemicals of Concern

3.2 Fate and Transport of Contamination

The current primary migration pathways of CVOCs at Site 21 include dissolved contaminant migration down-gradient with groundwater flow (advection), groundwater discharge to the leaking storm sewer system and to the south toward St. Juliens Creek, and presumed **dense non-aqueous phase liquids** (DNAPLs) desorbing from the top of the Yorktown confining unit into shallow groundwater. Vapor intrusion from groundwater into indoor air (volatilization) is currently being evaluated as a potential migration pathway and is, therefore, not considered within this Interim Proposed Plan. The mechanisms responsible for the fate of the contaminants include sorption of contaminants to soil surfaces (which affects the rate contaminants are carried by groundwater and how far they are spread), natural degradation through different pathways (which plays a significant role in the length of time the contaminants will exist in the subsurface), and volatilization of contaminants from groundwater into the gas phase (which results in a decrease of contaminant mass from the saturated zone).

3.3 Principal Threats

"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 they be exposed. Contaminated groundwater generally is not considered to be a source material; however, non-aqueous phase liquids (NAPLs) in groundwater may be. Therefore, DNAPL could represent a principal threat waste if present in small, localized pockets at the top of the Yorktown confining unit. Investigations have not confirmed that DNAPL exists at the site, though the CVOC concentrations indicate it is likely present in select areas of the site based on the rule-of-thumb that concentrations in excess of 1 percent of a compound's solubility suggest that DNAPL may be present. Therefore, although the groundwater at Site 21 is not considered to be principal threat waste, as a conservative measure, the potential DNAPL will be considered as a principal threat waste.

4 Scope And Role of Response Action

SJCA was placed on EPA's **National Priorities List (NPL)** on July 27, 2000. Currently, three sites have Final Records of Decision (RODs):

- Site 3: No-action ROD
- Site 4: Action ROD for soil cover and LUCs
- Site 6: No-action ROD

In addition to Site 21, two sites (Sites 2 and 5) are currently in the RI/FS phase of the CERCLA process. One site, Site UXO 0001, is currently active in the Munitions Response Program (MRP), undergoing a Preliminary Assessment. Further details are included in the Site Management Plan for SJCA, which is available in the Administrative Record and Information Repository. The Preferred Alternative presented in this Interim Proposed Plan is intended to address potential risks to human health and the environment posed by CVOCs in groundwater at Site 21 through potable use, and is intended to be the final remedy for the potable-use pathway. The Preferred Alternative does not include or affect any other site at SJCA. Potential risk to indoor workers due to inhalation of indoor air from vapor intrusion is currently under additional investigation (see Remedial Investigation discussion in Section 2.2). If risk is identified, a separate Proposed Plan will be prepared to address that pathway.

5 Summary Of Site Risks

It is the current judgment of the Navy and EPA, in consultation with VDEQ, that the Preferred Alternative, or one of the other active alternatives, identified in this Interim Proposed Plan is necessary to protect human health and the environment from actual or threatened exposure to hazardous substances (CVOCs) in shallow groundwater at Site 21. Detailed results of the HHRA conducted at Site 21 are presented in the HHRA section

of the RI Report, which is available in the Administrative Record.

5.1 Human Health Risk Summary

An HHRA was conducted to evaluate the potential human health risks (see sidebar, "What is Human Health Risk and How is it Calculated?") associated with current receptors (industrial workers) and hypothetical future receptors (construction workers, adult residents, child residents, lifetime residents) and exposure scenarios (ingestion; dermal, or skin, contact; and inhalation, through showering or breathing indoor air) if no remedial action were implemented for the shallow and deep groundwater. This information was used to determine if any further actions needed to be taken at Site 21 to sufficiently protect human health. Health risks are based on a conservative estimate of the potential **cancer risk** or the potential to cause other health effects not related to cancer (**non-cancer hazard**, or **hazard index** (HI)). EPA identifies an acceptable cancer risk range of 1 in 10,000 (10^{-4}) to 1 in 1 million (10^{-6}) and a non-cancer hazard as an HI of less than 1.

Soil

Because the nature and extent of contamination in soil was defined and evaluated during previous investigations in the Site 21 vicinity, and no human health or ecological risks were identified, no further investigation or action for soil was necessary. Therefore, soil was not considered as a potential exposure point in the HHRA.

Groundwater

Deep Groundwater

The HHRA identified potential human health risks from exposure to arsenic and vanadium in deep groundwater (Yorktown aquifer). However, the risk assessment was performed using the results of all rounds of data collected from the deep aquifer, and the concentrations were not consistent. The arsenic and vanadium concentrations in deep groundwater collected in the first round of sampling indicated potential risk; however, arsenic and vanadium were either not detected or detected below their **maximum contaminant levels** (MCLs) in the two subsequent rounds of sampling. Arsenic and vanadium were not detected in the shallow aquifer (Columbia aquifer) in the same area of the site, and a laterally extensive hydraulic aquitard (Yorktown confining unit) prevents the downward migration of contaminants. Therefore, it is likely that the arsenic and vanadium concentrations detected in the first round of sampling are indicative of natural conditions and not a site release. Data collected and presented in the RI report supports the fact that deep groundwater does not appear to have been impacted by Site 21 activities, and thus no further investigation or action for deep groundwater is necessary.

Shallow Groundwater

Based on the reasonable maximum exposure in the HHRA, there are no non-cancer hazards or cancer risks that exceed EPA acceptable levels for a construction worker exposed to shallow groundwater during excavation activities. However, based on reasonable maximum exposure, the following exposure pathways

What is Human Health Risk and How is it Calculated?

A human health risk assessment estimates the "baseline risk." This is an estimate of the likelihood of health problems occurring if no cleanup action were taken at a site. To estimate the baseline risk at a site, the Navy performs the following four-step process:

Step 1: Analyze Contamination

Step 2: Estimate Exposure

Step 3: Assess Potential Health Dangers

Step 4: Characterize Site Risk

In **Step 1**, the Navy looks at the concentrations of contaminants found at a site as well as past scientific studies on the effects these contaminants have had on people (or animals, when human studies are unavailable). Comparisons between site-specific concentrations and concentrations reported in past studies help the Navy to determine which contaminants are most likely to pose the greatest threat to human health.

In **Step 2**, the Navy considers the different ways that people might be exposed to the contaminants identified in Step 1, the concentrations that people might be exposed to, and the potential frequency (how often) and length of exposure. Using this information, the Navy calculates a "**reasonable maximum exposure**" (RME) scenario that portrays the highest level of human exposure that could reasonably be expected to occur.

In **Step 3**, the Navy uses the information from Step 2 combined with information on the toxicity of each chemical to assess potential health risks. The Navy considers two types of risk: cancer and (2) non-cancer. The likelihood of any kind of cancer resulting from a contaminated site is generally expressed as an upper-bound probability, for example, a "1 in 10,000 chance." In other words, for every 10,000 people that could be exposed, one extra cancer case may occur as a result of exposure to site contaminants. An extra cancer case means that one more person could get cancer than normally would be expected to from all other causes. For non-cancer health effects, the Navy calculates a "**hazard index**." The hazard index represents the ratio between the "reference dose," the dosage at which no adverse health effects are expected to occur, and the RME (see Step 2), the estimated maximum exposure level for a given category of individuals coming into contact with contaminants at the site. The key concept here is that a "threshold level" (measured usually as a hazard index of less than 1) exists below which noncancer health effects are no longer predicted to occur.

In **Step 4**, the Navy determines whether site risks are great enough to cause health problems for people at or near the site. The results of the three previous steps are combined, evaluated, and summarized. The Navy adds up the potential risks from the individual contaminants and exposure pathways and calculates a total site risk.

Receptor	Media	Pathway	Chemical of Concern	Exposure Point Concentration (µg/L)	Cancer Risk	Non-Cancer Hazard Index
Future Child Resident	Shallow Groundwater	Ingestion	TCE	3,100	NA	33
			VC	170	NA	3.6
			cis-1,2-DCE	1,500	NA	9.7
		Dermal	TCE	3,100	NA	5.5
Future Adult Resident	Shallow Groundwater	Ingestion	TCE	3,100	NA	14
			VC	170	NA	1.6
			cis-1,2-DCE	1,500	NA	4.2
		Dermal	TCE	3,100	NA	2.4
		Inhalation (while showering)	TCE	3,100	1.6×10^{-4}	0.38
Future Lifetime Resident	Shallow Groundwater	Ingestion	TCE	3,100	6.0×10^{-4}	Not calculated, risks were calculated for future child and adult residents
			VC	170	3.6×10^{-3}	

Potential unacceptable risks are shaded yellow.

Table 2 - Summary of Unacceptable Human Health Risks

may pose an unacceptable risk or hazard for future child, adult, and/or lifetime hypothetical residents: ingestion of TCE, cis-1,2-DCE, VC, benzene, and arsenic through potable use; inhalation of TCE while showering; and/or dermal contact with TCE. Although potential risks were identified from exposure to benzene and arsenic, these compounds were identified only in the vicinity of a closed underground storage tank, which is the likely source of the benzene. Because benzene is fuel-related, it is not treated under CERCLA based on the petroleum exclusion and was not carried through as a COC. Arsenic commonly occurs as natural mineral coatings of the sand and gravel in the aquifer and becomes more mobile under reducing conditions, which are present near the former underground storage tank, and was therefore also not carried through as a COC. However, the remedy evaluation did take into consideration the potential for the mobilization of naturally occurring arsenic. Based upon this evaluation, if mobilization of naturally occurring arsenic occurs as a result of the selected alternative, monitoring will be performed to confirm that the concentrations return to a level that does not pose unacceptable risk to potential receptors. Reasonable maximum exposure risks and hazards for the COCs are summarized in Table 2.

Indoor Air Vapor

The HHRA evaluated the potential human health risks associated with current and future hypothetical industrial workers for inhalation of indoor air, but because of the uncertainties associated with modeling methods used, additional evaluation of the vapor intrusion pathways at Site 21 was recommended and is currently underway. The results of the evaluation will be used to refine the HHRA. If potential risk is identified through this investigation, it will be addressed separately.

5.2 Ecological Risk Summary

Based on recommendations of the ecological risk screening (ERS) conducted in the SSA and SI, an ecological risk assessment is not required for Site 21. The SI ERS concluded that Site 21 provides little terrestrial habitat (e.g., it is mostly a paved industrial area) and no viable aquatic habitats (e.g., there are no surface water features) for potential ecological receptors. Therefore, further evaluation was not recommended.

6 Remedial Action Objectives

It is the current judgment of the Navy and EPA, in consultation with VDEQ, that the remedial action is necessary to protect public health, welfare, and the environment from actual or threatened releases of COCs at Site 21. Therefore, the following **Remedial Action Objectives** (RAOs) were established for Site 21:

- Reduce contaminant concentrations in shallow groundwater to the maximum extent practicable
- Prevent exposure to shallow groundwater until contaminant concentrations allow for unlimited use and unrestricted exposure

Preliminary remediation goals (PRGs) were developed for constituents with concentrations contributing to unacceptable risks and hazards from exposure to shallow groundwater within Site 21. Based on the RI report, COCs were identified as those site-related constituents with cancer risks exceeding 1 in 10,000, with an HI exceeding 1 (Table 2), or with concentrations exceeding their MCL. The COCs are TCE, cis-1,2-DCE, VC, and 1,1-DCE. To achieve RAOs for unlimited use and unrestricted exposure, PRGs were established as the MCLs after consideration of the total risks/hazards associated with their use. PRGs are identified in Table 3.

Chemical of Concern	Preliminary Remediation Goal (µg/L)*
Trichloroethene	5
cis-1,2-Dichloroethene	70
Vinyl chloride	2
1,1-Dichloroethane	7

* Based upon Maximum Contaminant Level.

Table 3 - Preliminary Remediation Goals for Chemicals of Concern

7 Summary of Remedial Alternatives

Remedial alternatives developed and evaluated to address COCs in groundwater at Site 21 are detailed in the FS. Following the screening of groundwater remediation technologies, the following four alternatives were selected for detailed evaluation and comparative analysis:

- Alternative 1: No action
- Alternative 2: MNA
- Alternative 3: ISCR and ERD
- Alternative 4: ISCO and ERD

Based upon the results of the evaluation, ISCR and ERD (Alternative 3) was selected as the Preferred Alternative for Site 21. With the exception of the no-action alternative (Alternative 1), each of the alternatives includes groundwater monitoring and implementation of LUCs to prevent unacceptable risk exposure. Alternative 1 is required by the NCP and serves as the baseline against which the other alternatives are compared. For Alternatives 2, 3, and 4, monitoring and LUCs would be maintained until the RAOs are met, with 5-year statutory reviews to ensure protection of human health and the environment. In Alternatives 3 and 4, separate treatments are considered for the high- and low-concen-

Alternative	Components	Details	Cost	
1—No Action	None	Allow the COCs to breakdown naturally over time.	Capital Cost O&M present value Total present value	$0 $0 $0
2 - Monitored Natural Attenuation	- Groundwater monitoring - Land use controls	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 hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the remedial action. LUCs prevent exposure	Capital Cost O&M present value Total present value	$50K $434K $484K
3 - ISCR & ERD	- Injection of reducing agent (ZVI) - Injection of electron source (EVO) - Groundwater monitoring - Land use controls	Injection of reducing agents promotes abiotic in-situ reduction of COCs to ethene and chloride. Electron donor source, which is generally the limiting factor, 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 hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the remedial action. LUCs prevent exposure	Capital Cost O&M present value Total present value	$3.1M $0.8M $3.9M
4 - ISCO & ERD	- Injection of oxidizing agent (permanganate) - Injection of electron source (EVO) - Groundwater monitoring - Land use controls	Injection of oxidizing agent to promote abiotic in-situ oxidation of COCs through reaction of oxidants with the COCs to produce innocuous substances such as carbon dioxide, water, and chloride. Electron donor source, which is generally the limiting factor, 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 hydrogeological, geochemical, or microbiological parameters that might reduce the effectiveness of the remedial action. LUCs prevent exposure	Capital Cost O&M present value Total present value	$4.6M $0.7M $5.3M

O&M, operations and maintenance.

Table 4 - Descriptions of Remedial Alternatives for Site 21

tration zones that could be implemented concurrently or in a phased approach, treating the high-concentration zones first, followed by the low-concentration zones.

A description of each alternative is provided in Table 4.

8 Evaluation of Alternatives

The NCP identifies the nine evaluation criteria for use in a comparative analysis of alternatives (Table 5). Each remedial alternative for Site 21 was evaluated against the nine criteria in comparison to one another (Table 6). Alternative 1 (no action) does not protect human health and the environment, is not effective in the long term, and does not reduce toxicity, mobility, or volume through treatment. Therefore Alternative 1 serves only as a baseline and is not discussed in the following sections.

8.1 Threshold Criteria

Protection of human health and the environment

Alternatives 2, 3, and 4 are all protective of human health and the environment. Alternative 2 is considered to be less protective than Alternatives 3 and 4 because it relies on natural degradation, which adds a higher degree of uncertainty for the rate of contaminant reduction and length of time to achieve RAOs. Alternatives 3 and 4 are similar in protectiveness because they each employ an active treatment to reduce chemical concentrations. Monitoring will be conducted and LUCs will provide adequate protection of human health and the environmental by controlling exposure to shallow groundwater until the RAOs are achieved.

Compliance with Applicable or Relevant and Appropriate Requirements

Alternatives 2, 3, and 4 are expected to comply with **applicable or relevant and appropriate requirements (ARARs)**. Alternative 2 will have a longer timeframe associated with meeting the ARARs because it relies on natural degradation, whereas Alternatives 3 and 4, which are similar, employ active treatment and will therefore meet the ARARs in a shorter timeframe than Alternative 2.

8.2 Primary Balancing Criteria

Long-term effectiveness and permanence

Alternatives 2, 3, and 4 are each expected to effectively reduce concentrations of VOCs in shallow groundwater to allow for unlimited use and unrestricted exposure over time. Alternatives 3 and 4 are considered equally effective and will achieve a more rapid reduction in VOC concentrations because they employ active treatment, while Alternative 2 relies on natural degradation. For each alternative, with proper planning and implementation, controls can be put in place to monitor all the alternatives effectively to verify continued compliance with RAOs.

CERCLA Criteria	Definition
Threshold Criteria	
Protection of human health and the environment	Addresses whether a remedy provides adequate protection and describes how risks posed through each pathway are eliminated, reduced, or controlled through mitigation, engineering controls, or institutional controls.
Compliance with Applicable Relevant and Appropriate Requirements (ARARs)	Addresses whether a remedy will meet all of the ARARs of other Federal and State environmental laws and/or justifies a waiver of the requirements.
Primary Balancing Criteria	
Long-term effectiveness and permanence	Addresses the expected residual risk and the ability of a remedy 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 a remedy 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 clean-up goals are achieved.
Implementability	Evaluates the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement an option.
Present-worth cost	Compares the estimated initial, operations and maintenance, and present-worth costs.
Modifying Criteria	
State acceptance	Considers the State support agency comments on the Proposed Plan.
Community acceptance	Provides the public's general response to the alternatives described in the Proposed Plan, RI report, and FS report. The specific responses to the public comments are addressed in the "Responsiveness Summary" section of the ROD.

Table 5 - Nine Evaluation Criteria for Remedial Alternative Evaluation

Reduction in toxicity, mobility, or volume through treatment

Alternatives 2, 3, and 4 are each expected to reduce toxicity, mobility, and volume. Only Alternatives 3 and 4 have treatment components, which is the statutory preference. While MNA is not considered a treatment, the natural reduction of contaminant concentrations through a variety of physical, chemical, or biological activities is expected over time.

Short-term effectiveness

The short-term effectiveness associated with Alternatives 3 and 4 are similar with regard to how they would affect the community because both treatments rely on direct injection technology for implementation. The community impact associated with Alternatives 3 and 4 is slightly higher than Alternative 2 because of the vehicle traffic through the community associated with transportation of injection materials and investigative derived waste. Alternative 2 has a lower impact on the community because it does not rely on an active treatment. Alternative 4 has a slightly higher risk to construction workers during implementation than Alternatives 2 and 3 do because it involves the handling of and potential exposure to oxidizing chemicals. Alternatives 3 and 4 have similar potential impacts to the environment because each may result in a temporary mobilization of naturally occurring metals, whereas Alternative 2 would not. Because Alternative 2 relies on natural degradation rather than active treatment, it results in the lowest rate of reduction in COCs and the longest timeframe for achieving the RAOs. Alternative 3 provides the greatest short-term effectiveness.

Implementability

Alternatives 2, 3, and 4 can each be implemented using standard and widely available technologies. The implementability associated with Alternatives 3 and 4 are lower than that of Alternative 2 due to the logistical challenges of working in an industrial area (e.g., the presence of buildings and utilities). Alternative 3 would be slightly easier to implement than Alternative 4 because Alternative 3 relies on naturally occurring reducing conditions, whereas Alternative 4 would require the reversal of the conditions to oxidizing for the initial phase of treatment (ISCO) then return to reducing for the second phase (ERD).

Cost

The estimated capital cost for implementation of Alternative 2 ($50,000) is less than that of Alternative 3 ($3.1 million) or Alternative 4 ($4.6 million). The estimated present value cost, factoring in a 30-year operation and maintenance period for each alternative, is $500,000 for Alternative 2, less than for Alternatives 3 ($3.9 million) or 4 ($5.3 million). Alternative 3 has a lower capital cost and present-value cost than Alternative 4 due to the type and quantity of injection materials.

CERCLA Criteria	No Action (1)	MNA (2)	ISCR & ERD (3)	ISCO & ERD (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	●	●	◐	○

Ranking: ● High ◐ Moderate ○ Low N/A=Not Applicable

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

Table 6 - Relative Ranking of Alternatives

8.3 Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA and remedy selection process. The State supports the Preferred Alternative, Alternative 3, and their final concurrence will be solicited following the review of all comments received during the public comment period.

Community Acceptance

This modifying criterion will be evaluated after the public comment period for the Interim Proposed Plan.

A comparative analysis of the alternatives is presented in Table 6, and is detailed in the FS.

9 Preferred Alternative

Based on the comparative analysis, the Preferred Alternative is Alternative 3, consisting of ISCR and ERD.

As a comparison, Alternative 2 does not actively treat the source area and takes significantly longer to achieve the RAOs; Alternative 4 adequately meets the RAOs but requires the reversing of oxidizing effects caused by the ISCO before the ERD is implemented. Additionally, Alternative 4 is more expensive than Alternative 3 and has a slightly higher risk to construction workers during implementation due to their handling of and potential exposure to oxidizing chemicals.

Long-term monitoring will be conducted to evaluate the effectiveness of ISCR and ERD and changes in the concentration and location of the plume; and monitor changes in environmental conditions resulting from implementation of the selected remedy. Although the effectiveness of mitigation of CVOCs in groundwater will be measured by comparison to PRGs, the remedial technology is not guaranteed to reduce CVOC concentrations to levels at or below PRGs across Site 21. However, natural attenuation processes will continue to reduce VOC concentrations over time. LUCs will be maintained to prohibit the withdrawal of groundwater except for environmental monitoring within the boundaries of Site 21 until the concentrations of hazardous substances in the groundwater have been reduced to levels that allow for unlimited use and unrestricted exposure. As required by CERCLA, 5-year reviews will be conducted to assess the effectiveness of the remedy. The need for LUCs to prevent exposure and ensure protection will be periodically reassessed as CVOC concentrations are reduced over time.

Based on information currently available, the Navy believes the Preferred Alternative (Alternative 3) meets the threshold criteria and provides the best balance of tradeoffs with respect to the balancing and modifying criteria. The Navy expects the Preferred Alternative to satisfy the statutory requirements of CERCLA Section 121 (b): (1) protection of human health and the environment, (2) compliance with ARARs, (3) cost-effectiveness, (4) use of permanent solutions and alternative treatment technologies to the maximum extent practicable, and (5) the preference for treatment as a principal element. The Preferred Alternative will be reevaluated as appropriate in response to public comment or new information.

During the comment period, interested parties

MAY SUBMIT WRITTEN COMMENTS TO:

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10 Community Participation

The Navy and EPA provide information regarding environmental cleanups at SJCA to the public through the Restoration Advisory Board (RAB), public meetings, the Administrative Record for the site, the Information Repository, and announcements published in *The Virginian-Pilot* newspaper. The public is encouraged to gain a more comprehensive understanding of Site 21 and the Installation Restoration Program (IRP - see Page 1). The public comment period for this Interim Proposed

Plan is from August 1, 2009, through September 14, 2009; a public meeting will be held on August 11, 2009, at 5:00 p.m. (see page 1 of this report for details). Minutes of the public meeting will be included in the Administrative Record file. The Navy will summarize and respond to comments in a responsiveness summary, which will become part of the official ROD and will also be included in the Administrative Record file.

Glossary

This glossary defines in non-technical language the more commonly used environmental terms appearing in this Interim Proposed Plan. The definitions do not constitute the Navy's, EPA's, or VDEQ's official use of terms and phrases for regulatory purposes, and nothing in this glossary should be construed to alter or supplant any other Federal or Commonwealth document. Official terminology may be found in the laws and related regulations as published in such sources as the Congressional Record, Federal Register, and elsewhere.

Administrative record: A compilation of site-related information for public review.

Applicable or Relevant and Appropriate Requirements (ARARs): These are Federal or State environmental rules and regulations.

Aquifer: Underground bed of soil or rock from which groundwater can be usefully extracted.

Cancer risk: Cancer risks are expressed as a number reflecting the increased chance that a person will develop cancer if exposed to chemicals or substances. For example, EPA's acceptable risk range for Superfund sites is 1×10^{-4} to 1×10^{-6}, meaning there is 1 additional chance in 10,000 (1×10^{-4}) to 1 additional chance in 1 million (1×10^{-6}) that a person will develop cancer if exposed to a site that is not remediated.

Chlorinated volatile organic compound (CVOC): Any one of a number of manufactured chemicals that evaporate easily and are typically used in manufacturing as industrial chlorinated solvents, such as degreasers. See also "volatile organic compound."

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA): A Federal law, commonly referred to as the "Superfund" Program, passed in 1980 that provides for cleanup and emergency response in connection with numerous existing inactive hazardous waste disposal sites that endanger public health and safety or the environment.

Conceptual site model: A description of a site and its environment that is based on existing knowledge and that assists in planning, interpreting data, and communicating. It describes sources of contamination (e.g., spills) and receptors (e.g., humans) and the interactions that link the two.

Cyclotrimethylenetrinitramine (RDX): A white crystalline explosive used in high explosives.

Dense Non-Aqueous Phase Liquid. See "Non-Aqueous Phase Liquid."

Enhanced reductive dechloronation (ERD): An anaerobic (i.e., without oxygen) process in which an electron donor source is injected into the subsurface to allow chlorine atoms on a parent CVOC molecule to be sequentially replaced with hydrogen and break down COCs.

Feasibility study (FS): Analysis of the practicability of a remedial proposal, supported by data and risk assessment, to allow decision makers to select the most appropriate site remedy.

Groundwater: Subsurface water that occurs in soils and in geologic formations that are fully saturated.

Hazard Index (HI): A number indicative of non-cancer health effects that is the ratio of the existing level of exposure to an acceptable level of exposure. A value equal to or less than 1 indicates that the human population is not likely to experience adverse effects.

Human health risk assessment (HHRA): An evaluation of the risk posed to human health should remedial activities not be implemented.

Human health risk screening (HHRS): A conservative evaluation of site data for risk posed to human health, conducted to determine if a comprehensive evaluation (i.e., HHRA) should be performed.

Information Repository: A file containing information, technical reports, and reference documents regarding an NPL site. This file is usually maintained at a location with easy public access, such as a public library.

In situ chemical oxidation (ISCO): Use of oxidizing chemicals to break down groundwater contaminants into carbon dioxide and water.

In situ chemical reduction (ISCR): The use of reducing agents (zero-valent iron) to break down COCs through abiotic in situ reduction.

Land use controls (LUCs): Physical, legal, or administrative methods that restrict the use of or limits access to property to reduce risks to human health and the environment.

Maximum Contaminant Levels (MCLs): Enforceable standards that apply to public water systems, developed by EPA. The highest level of a contaminant that is allowed in drinking water.

Media (singular, medium): Soil, groundwater, surface water, or sediments at the site.

National Oil and Hazardous Substances Pollution Contingency Plan (NCP): Provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

National Priorities List (NPL): A list, developed by EPA, of uncontrolled hazardous substance release sites in the United States that are considered priorities for long-term remedial evaluation and response.

Natural attenuation (NA): Reduction in mass or concentration of a constituent over time or distance from the source due to naturally occurring physical, chemical, and biological processes.

Naval Facilities Engineering Command (NAVFAC): Global organization which provides planning, design and construction of shore facilities for U.S. Navy activities around the world.

Non-aqueous phase liquid (NAPL): A liquid that does not dissolve or mix easily in water. A dense non-aqueous phase liquid (DNAPL) is a NAPL that is denser than water.

Non-cancer hazard: Noncancer hazards are expressed as a quotient that compares the existing level of exposure to the acceptable level of exposure. There is a level of exposure (the reference dose) below which it is unlikely for even a sensitive population to experience adverse health effects. EPA's threshold level for noncancer hazard at Superfund sites is 1, meaning that if the exposure exceeds the threshold, there may be a concern for potential noncancer effects.

Plume: A space in air, water, or soil containing pollutants released from a point source.

Polychlorinated Biphenyl (PCB): A type of industrial compound, such as lubricants, heat-transfer fluids, and plasticizers, that accumulates in animal tissue and results in adverse health conditions. PCBs are especially deadly to fish and invertebrates, and stay in the food chain for many years. The manufacture and use of PCBs has been restricted since the 1970s because they are very harmful to the environment,

Potable: Safe for drinking.

Proposed plan: A document that presents and requests public input regarding the proposed cleanup alternative.

Public comment period: The time allowed for the members of an affected community to express views and concerns regarding an action proposed to be taken by the Navy and EPA, such as a rulemaking, permit, or Superfund-remedy selection.

Remedial action objectives (RAOs): Objectives of remedial actions that are developed based on contaminated media, chemicals of concern, potential receptors and exposure scenarios, human health and ecological risk assessment, and attainment of regulatory cleanup levels, if any exist.

Remedial action: A cleanup method proposed or selected to address contaminants at a site.

Remedial investigation (RI): A study of a facility that supports the selection of a remedy where hazardous substances have been disposed or released. The RI identifies the nature and extent of contamination at the facility.

Reasonable Maximum Exposure (RME): The highest level of site chemical concentrations a human can reasonably be exposed to under different exposure scenarios.

Semi-Volatile Organic Compound (SVOC): Manufactured chemical that does not evaporate as easily as a VOC and is typically used in manufacturing materials such as adhesives and preservatives.

Site: The area of the facility where a hazardous substance, hazardous waste, hazardous constituent, pollutant, or contaminant from the facility has been deposited, stored, disposed of, placed; has migrated; or has otherwise come to be located.

Site investigation: An investigation conducted to make a general determination if activities at the site have impacted environmental media and determine whether the site should be included in the CERCLA remedial investigation and feasibility study process.

Trichloroethene (TCE): VOC typically used as a solvent in industrial applications.

U.S. Environmental Protection Agency (EPA): The Federal agency responsible for administration and enforcement of CERCLA (and other environmental statutes and regulations), and with final approval authority for the Selected Remedy.

Virginia Department of Environmental Quality (VDEQ): The Commonwealth agency responsible for administration and enforcement of environmental regulations.

Vinyl chloride (VC): VOC that results from the breakdown of TCE and tetrachloroethene (PCE) in groundwater.

Volatile organic compound (VOC): A compound that easily vaporizes and has low water solubility. Many VOCs are manufactured chemicals such as those associated with paint, solvents, and petroleum. VOCs are common groundwater contaminants.

Please print or type your comments here

Mark Your Calendar for the Public Comment Period

Public Comment Period
August 1 – September 14, 2009

Submit Written Comments

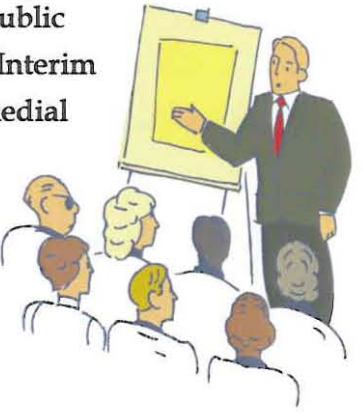
The Navy will accept written comments on the Interim Proposed Plan during the public comment period.

Attend the Public Meeting

Tuesday, August 11, 2009 at 5:00 pm

Major Hillard Library
824 Old George Washington Highway N
Chesapeake, Virginia 23323

The Navy will hold a public meeting to explain the Interim Proposed Plan and remedial actions conducted at the Site to date. Verbal and written comments will also be accepted at this meeting.



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