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January 26, 2016

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Ms. Patti Vanture
NAVFAC Mid-Atlantic
Marine Corps IPT, Code OPQE3
9324 Virginia Avenue
Norfolk, VA 23511-3095

Subject: Draft Final Record of Decision, Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98, MCAS Cherry Point, North Carolina, Contract No: N62470-08-D-1000, CTO-0114.

Dear Ms. Vanture:

CH2M HILL is pleased to submit the Draft Final Record of Decision, Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98, Marine Corps Air Station (MCAS) Cherry Point, North Carolina, along with the redline version showing responses to MCAS Cherry Point, NAVFAC, USEPA, and NCDEQ comments. If you have any questions or comments, feel free to contact me at (704) 543-3263.

Sincerely,

CH2M HILL

Jessica M. High, PE
Project Manager

Enclosures: Draft Final Record of Decision, Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98, MCAS Cherry Point, North Carolina (1 hard copy, 1 CD)

C: Ms. Marti Morgan, NCDEQ (1 hard copy, 1 CD)
Ms. Michelle Thornton, EPA (2 hard copies, 1 CD)
Mr. Will Potter, MCAS Cherry Point (1 hard copy, 1 CD)
Mr. Doug Bitterman, CH2M HILL (1 electronic copy)
Mr. Bill Hannah, CH2M HILL (1 electronic copy)

Draft Final

Record of Decision

Operable Unit 1, Central Groundwater Plume

Sites 42, 47, 51, 52, 92, and 98

Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

January 2016

1 Declaration

1.1 Site Name and Location

This Record of Decision (ROD) presents the selected remedy for the portions of Operable Unit 1 (OU1), located at Marine Corps Air Station (MCAS) Cherry Point, North Carolina, that were identified as contributing chlorinated volatile organic compounds (cVOCs) to groundwater (Sites 42, 47, 51, 52, 92, and 98) and are collectively referred to as the OU1 Central Groundwater Plume (CGWP) sites. MCAS Cherry Point was placed on the U.S. Environmental Protection Agency (USEPA) National Priorities List (NPL) effective December 16, 1994 (Comprehensive Environmental Response, Compensation, and Liability Information System [CERCLIS] National Superfund database identification number: NC1170027261).

The remedy was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The remedy selection is based on information contained in the Administrative Record file for OU1. Information not specifically summarized in this ROD or its references, but contained in the Administrative Record, has been considered and is relevant to the remedy selection at OU1. Thus, the ROD is based upon and relies on those portions of the Administrative Record file for the sites that pertain to OU1 in making the decision.

1.2 Statement of Basis and Purpose

The U.S. Department of the Navy (Navy) is the lead agency and provides funding for site cleanups at MCAS Cherry Point. The remedy set forth in this ROD has been selected by the Navy, Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic Division, MCAS Cherry Point Environmental Affairs Department (EAD), and USEPA Region 4. North Carolina Department of Environmental Quality (NCDEQ), the support regulatory agency, actively participated throughout the investigation process, has reviewed this ROD and the materials on which it is based, and concurs with this Selected Remedy.

1.3 Scope and Role of Response Action

OU1 is one of nine OUs under investigation at MCAS Cherry Point as part of the Installation Restoration Program (IRP), and consists of 12 sites that have been grouped together because of their proximity to one another within the approximate 565-acre industrial section of MCAS Cherry Point. Two earlier RODs have documented no further action (NFA) as the selected remedy for five of these sites (Sites 14, 15, 17, 18, and 83) (CH2M HILL, 2010; Rhēa, 2012a). Site 16 is currently being investigated separately. The remaining six sites (Sites 42, 47, 51, 52, 92, and 98) were collectively identified as the OU1 CGWP sites due to their contribution of cVOCs to groundwater beneath OU1. This ROD presents the final remedial action for the OU1 CGWP sites.

1.4 Description of Selected Remedy

As a result of environmental investigations conducted at OU1, cVOCs were identified in groundwater at concentrations that pose a potential threat to human health. A remedial action is required to return the aquifer to beneficial use because the groundwater is considered a potential source of drinking water. The response action presented in this ROD is necessary to protect the public health, welfare, and the environment from actual or threatened releases of hazardous substances from the site.

No significant cVOC contamination was found at OU1 in soil, sediment, or surface water, and no further action is required for these media. The no further action determination for these media is addressed by this ROD, which is the final ROD for OU1.

The selected remedy for groundwater contamination at the OU1 CGWP sites is In-Situ Enhanced Bioremediation (ISEB), Permeable Reactive Barriers (PRBs), Vapor Intrusion Monitoring, Monitored Natural Attenuation (MNA), and Land Use Controls (LUCs) across both source and downgradient zones of OU1. ISEB includes injection of a slow-release carbon source into clustered wells in and near the source area to treat cVOCs migrating downgradient over time; adding organic carbon will enhance natural anaerobic biodegradation. The PRBs include the injection of micro-scale Zero Valent Iron (ZVI) into closely spaced soil borings at a new PRB location and monitoring the results of a previously installed ZVI PRB to treat cVOCs prior to their migration to downgradient surface water bodies; the oxidation of ZVI under anaerobic conditions acts as a reducing agent for cVOCs. Vapor intrusion (VI) monitoring includes long-term monitoring of subslab soil vapor and indoor air at select buildings of interest to evaluate the potential of vapors migrating from the cVOC plume to overlying buildings. MNA involves the collection of monitoring data to verify the effectiveness of naturally occurring processes to reduce contaminant concentrations over time. LUCs maintain groundwater and associated property-use restrictions until the contaminant concentrations in groundwater have been reduced to levels that allow for unlimited use/ unrestricted exposure (UU/UE).

1.5 Statutory Determinations

The selected remedy for the OU1 CGWP sites meets the statutory requirements and is protective of human health and the environment, complies with Federal and State regulations that are applicable or relevant and appropriate to the remedial action, is cost-effective, uses permanent solutions to the maximum extent practicable, and satisfies the preference for treatment as a principal element of the remedy. Because this remedy will result in pollutants or contaminants remaining onsite in groundwater above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within 5 years after the initiation of the remedial action to ensure that the remedy is protective of human health and the environment.

1.6 Data Certification Checklist

The following information is included in the Decision Summary section of this ROD. Additional information can be found in the Administrative Record file for OU1 at MCAS Cherry Point.

- Contaminants of concern (COCs) and their respective concentrations (Section 2.6.3 and Table 4)
- Baseline risk represented by the COCs (Section 2.6)
- Cleanup levels established for COCs and the basis for these levels (Section 2.8)
- How source materials constituting principal threats will be addressed (Section 2.7)
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and ROD (Section 2.4 and Section 2.5)
- Potential land and groundwater use that will be available at the site as a result of the selected remedy (Sections 2.8 and 2.9)
- Estimated capital, annual operations 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 2.9.1 and Tables 6 and 7)
- Key factor(s) that led to selecting the remedy (describing 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 2.9.2 and Tables 8 and 9)

1.7 Authorizing Signatures

This ROD presents the selected remedy for the OU1 CGWP sites at MCAS Cherry Point, North Carolina.

C. Pappas III
Colonel, U. S. Marine Corps
Marine Corps Air Station Cherry Point

Date

Franklin E. Hill
Director, Superfund Division
United States Environmental Protection Agency, Region 4

Date

With concurrence from:

Jim Bateson
Section Chief, Division of Waste Management, Superfund Section
North Carolina Department of Environmental Quality

Date

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2 Decision Summary

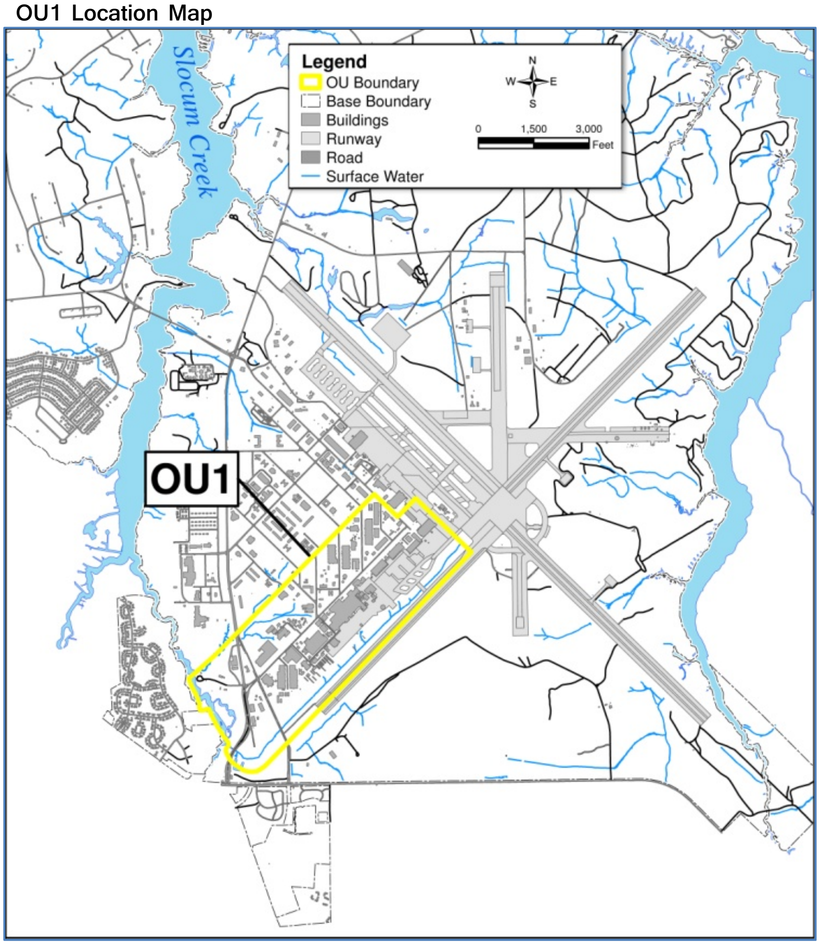
2.1 Site Description and History

MCAS Cherry Point is a 13,164-acre military reservation located adjacent to the city of Havelock in southeastern Craven County, North Carolina (**Figure 1**). MCAS Cherry Point was commissioned in 1942 and provides support facilities and services for the Second Marine Aircraft Wing, the Fleet Readiness Center-East ([FRCE], formerly the Naval Aviation Depot [NADEP]), Combat Service Support Detachment 21 of the Second Marine Logistics Group, the Naval Air Maintenance Training Group Detachment, and the Defense Reutilization and Marketing Office (DRMO). MCAS Cherry Point maintains facilities for training and for supporting the Atlantic Fleet Marine Force aviation units and is designated as a primary aviation supply point.

FIGURE 1
Base Map

OU1 is an industrial area covering approximately 565 acres, located in the southwestern portion of MCAS Cherry Point. OU1 is bounded by C Street and Sandy Branch to the northwest, portions of the MCAS Cherry Point flight line and runway to the northeast and southeast, and East Prong Slocum Creek to the southwest (**Figure 2**).

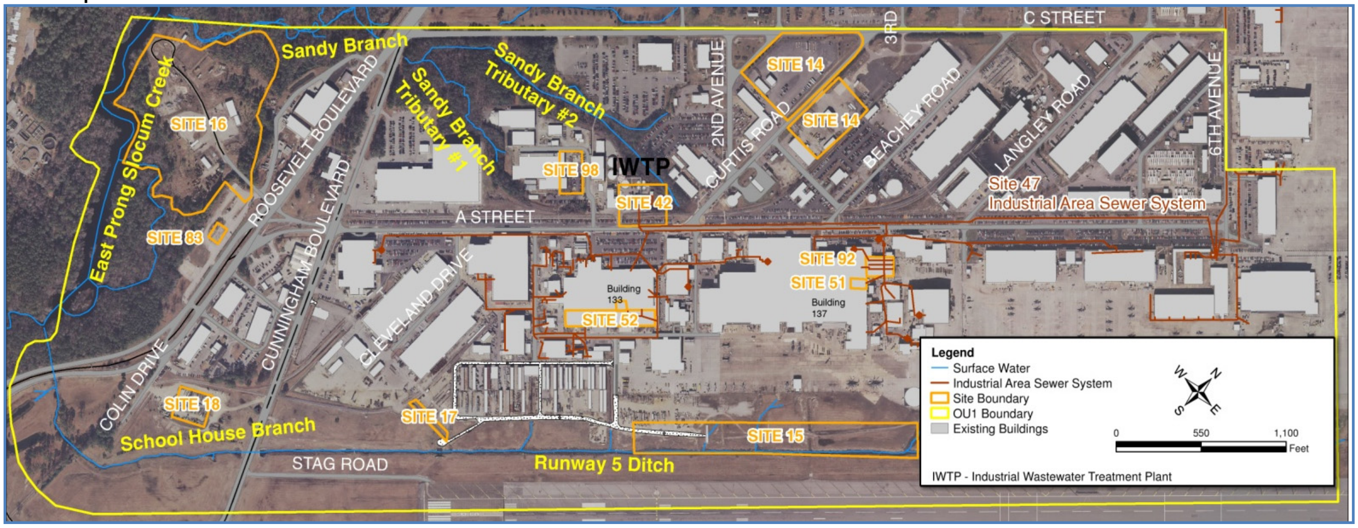
FIGURE 2
OU1 Location Map



The major features of OU1 are the FRCE, a former borrow pit/disposal area (Site 16), the Industrial Wastewater Treatment Plant (IWTP, Site 42), the DRMO, and several support facilities. The FFA identified 12 sites (shown in **Figure 3**) that were investigated as part of the OU1 Remedial Investigation (RI):

- Site 14 – Motor Transportation
- Site 15 – Ditch and Area Behind FRCE
- Site 16 – Landfill at Sandy Branch
- Site 17 – DRMO Drainage Ditch
- Site 18 – Facilities Maintenance Compound
- Site 42—IWTP
- Site 47—Industrial Area Sewer System
- Site 51—Building 137 Former Plating Shop
- Site 52—Building 133 Former Plating Shop and Ditch
- Site 83 – Building 96, Former Pesticide Mixing Area
- Site 92—VOCs in Groundwater near the Stripper Barn
- Site 98—VOCs in Groundwater near Building 4032

FIGURE 3
Site Map



2.2 Site Characteristics

Most of OU1 consists of paved or concrete surfaces with buildings in between. The ground surface is relatively flat, with elevations that range from 18 to 24 feet above mean sea level (msl). However, in the southwestern portion of OU1 along East Prong Slocum Creek, the surface elevation drops to approximately 2 to 10 feet above msl. A conceptual site model of OU1 is included in **Figure 4**.

Surface water bodies present within OU1 are East Prong Slocum Creek and its tributaries, Schoolhouse Branch and Sandy Branch. East Prong Slocum Creek flows into Slocum Creek and eventually the Neuse River. East Prong Slocum Creek, Schoolhouse Branch, and Sandy Branch have been classified by the State of North Carolina as Class C fresh water bodies, which consist of surface water intended for fish and wildlife propagation, agriculture, secondary recreation (that is, recreational activities not involving whole-body contact), and other uses except primary recreation or as a source of water supply for drinking, culinary, or food-processing purposes (CH2M HILL, 2009).

Sandy Branch and its tributaries include wide, swampy adjacent areas, and a few areas where the banks are steep. Schoolhouse Branch is heavily vegetated, with grasses near the runway and a heavily wooded area between Roosevelt Boulevard and East Prong Slocum Creek (TetraTech, 2002).

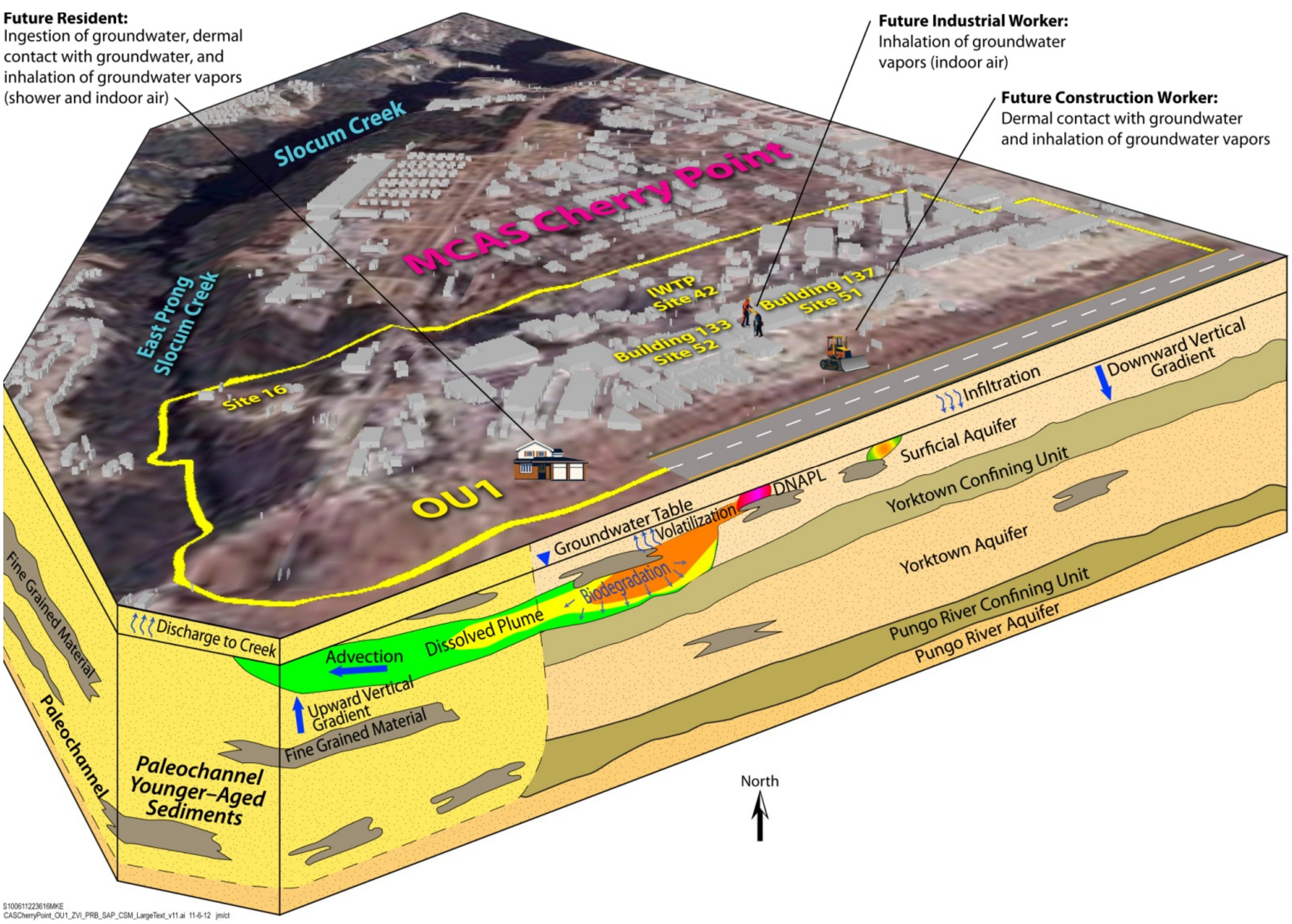
The first encountered groundwater beneath OU1 is the unconfined surficial aquifer, at depths ranging from approximately 4 to 21 feet below ground surface (bgs). The surficial aquifer has a saturated thickness of approximately 30 to 45 feet, and is controlled by the fine-grained Yorktown confining unit at the base of the aquifer. The surficial aquifer has been subdivided for evaluation purposes into two different groundwater zones: the upper surficial aquifer (defined as the upper 10 to 15 feet) and the lower surficial aquifer (defined as the lower 20 to 30 feet). This is, in part, due to minor differences in aquifer properties, but primarily to facilitate spatial delineation of contamination vertically. The upper and lower surficial aquifers are in direct hydraulic communication and there is no confining unit or geologic boundary between them.

The Yorktown aquifer occurs beneath the Yorktown confining unit and is generally a confined to semi-confined aquifer. The saturated thickness is approximately 40 feet and is controlled by the Yorktown confining unit at the top and the Pungo River confining unit at its base, where present.

A regional paleochannel eroded portions of the Yorktown and Pungo River confining units and deposited younger-aged sediments in the southwestern portion of OU1 (**Figure 4**). As a result, the uppermost aquifers may be in direct hydraulic communication with each other within the paleochannel. Groundwater levels outside the paleochannel, where the Yorktown confining unit exists, show that the Yorktown confining unit acts as an aquitard, and a downward vertical gradient exists between the surficial and Yorktown aquifers. Groundwater levels within the paleochannel generally show similar groundwater levels between the surficial and Yorktown aquifers, and the vertical gradient is weakly upward from the Yorktown aquifer to the surficial aquifer.

Groundwater at OU1 generally flows to the west in the upper and lower surficial aquifers towards East Prong Slocum Creek and Sandy Branch. The average horizontal hydraulic gradient is approximately 0.004 foot per foot. Groundwater flow appears to have minimal discharge to Sandy Branch Tributaries 1 and 2 and parallels their general direction in this area. The average linear horizontal groundwater velocity in the upper and lower surficial aquifer is estimated at approximately 0.1 to 0.2 foot per day. Groundwater beneath OU1 is classified by the State of North Carolina as Class GA, which is groundwater that may be considered an existing or potential source of drinking water (CH2M HILL, 2009).

FIGURE 4
Conceptual Site Model



2.3 Previous Investigations

Previous environmental investigations and interim remedial actions have been conducted at OU1, beginning in 1983. **Table 1** briefly summarizes the purpose and scope of investigations completed to date.

A Focused RI/FS was conducted for OU1 groundwater in 1996 that identified data gaps that were recommended to be addressed in a comprehensive OU1 RI/FS and/or prior to proceeding with design activities for interim remedial actions for the OU1 CGWP and Site 16 groundwater (B&R, 1996a).

An Interim ROD was issued to treat areas with high cVOC concentrations within the OU1 CGWP, selecting a groundwater extraction and treatment system (commonly called "pump-and-treat") for groundwater remediation (B&R, 1996b). The pump-and-treat system began operation in 1998 within the central portion of OU1. However, as a result of system ineffectiveness, decreasing efficiency, and the potential for interference with ongoing investigation activities, the system was shut down in 2005.

In 1996, a pilot-scale air sparge/soil vapor extraction (AS/SVE) system was installed within Site 16 to treat groundwater at the downgradient extent of the OU1 CGWP prior to discharge to Slocum Creek (B&R, 1997), and a full-scale system was installed in 1998. However, the system was shut down in 2005 because it was not achieving the remedial action objectives (RAOs).

A second RI was completed in 2002 that included all of the sites within OU1 (TetraTech, 2002). Fish tissue samples were collected from Slocum Creek adjacent to OU1 in 1998, and the results indicated no potential unacceptable risk to human health from fish tissue ingestion (TetraTech, 1999). Enhanced bioremediation groundwater treatability studies were conducted in 2001 and 2004 at Buildings 133 and/or 137, which demonstrated that enhanced bioremediation was an effective treatment technology for cVOCs within the OU1 CGWP. However, during the 2004 treatability study, the groundwater plume beneath Building 133 was found to contain areas of significantly higher cVOC concentrations than previously identified as well as to extend beyond the previously characterized boundaries.

As a result of these findings, the Navy conducted additional investigations to further characterize the extent of the OU1 CGWP, primarily in the vicinity of Buildings 133 and 137, and documented the findings in the OU1 RI Addendum (CH2M HILL, 2009) and OU1 Feasibility Study (FS) Report (CH2M HILL, 2011).

A non-time-critical removal action (NTCRA) was conducted in 2008 to remove soil and sediment (approximately 1,500 tons) within the Sandy Branch Tributary #2 floodplain contaminated with several polycyclic aromatic hydrocarbons (PAHs), non-PAH semi-volatile organic compounds (SVOCs), pesticides, and metals. Further details of the NTCRA are provided in **Table 1**.

A multi-phased VI evaluation was initiated in 2008 to assess the potential migration of vapors from the OU1 CGWP through soil pore spaces into overlying industrial buildings at OU1, and to assess potential current risks to industrial workers from VI (CH2M HILL, 2012b). At the conclusion of Phase II, the evaluation determined that VI is not significant based on current conditions, and that VI mitigation is not required for existing buildings at this time. It was recommended that periodic VI monitoring be incorporated into the selected remedy for the OU1 CGWP sites to monitor for potential future VI risk in Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533. The Phase II evaluation also recommended that VI be considered during construction planning that would involve slab penetrations at buildings where exceedances of the generic and/or base-wide soil gas screening levels were detected (Buildings 131, 133, 137, 3997, 4026, 4225, and 4533) and that VI evaluations be conducted during the design phase for proposed building construction within the vicinity of the OU1 CGWP, to determine if VI mitigation measures (such as a vapor barrier) should be incorporated into building design.

Two pilot studies were implemented at the OU1 CGWP sites in 2012 to investigate the efficacy of potential groundwater treatment options to address the OU1 CGWP (CH2M HILL, 2012a and 2012c). The purpose of these pilot studies was to gather information to aid in the selection of potential remedies and also to contribute to the Remedial Design of the selected remedy. The first was a field-scale pilot study to evaluate the site-specific effectiveness of ISEB downgradient of Building 133. The second pilot study included the construction of a 600-ft long PRB in the downgradient portion of the OU1 CGWP, near East Prong Slocum Creek.

TABLE 1
Previous Studies, Investigations, and Removal Actions

Previous Investigation*	OU1 Sites	Date	Investigation Activities
Initial Assessment Study of Marine Corps Air Station Cherry Point, North Carolina (Water & Air Research, Inc., 1983)	15, 16, 17, 18	1983	Historical data from 32 potentially contaminated sites were examined and 18 were judged not to require additional assessment. Due to the potential for adverse environmental impact from contaminants of potential concern (COPCs) migrating to nearby surface waters (either Slocum or Hancock Creeks), the remaining **14 sites**[1] were recommended for further investigation.
Draft Final Resource Conservation and Recovery Act Facility Investigation Report, Units 5, 10, 16, and 17 (Halliburton NUS Corporation, 1991)	16, 17, 47	1985-1990	Groundwater, surface water, sediment, and soil samples were collected and a soil gas survey and hydraulic conductivity ("slug") testing were conducted. VOCs and inorganic constituents were detected in surficial aquifer groundwater and surface water, and inorganics were detected in sediments. Additional investigation to locate the source of the contamination, including the upgradient industrial area and the newly-identified Site 47 (industrial wastewater drainage system), was recommended.
Final Technical Direction Memorandum, Infiltration and Leakage Study. Second Phase (Halliburton NUS Corporation, 1993)	47, 92	1991-1993	Leak testing within the industrial wastewater sewer system was performed using video camera inspections and falling-head pressure tests. Soil and groundwater samples were collected to assess potential contamination resulting from historical leaks.
Focused RI/Feasibility Study (FS) Report for OU1 Groundwater (Brown & Root Environmental [B & R], 1996a)	15, 16, 40, 42, 47, 51, 52, 92	1994-1996	Data from previous investigations were examined and indicated widespread cVOC groundwater contamination within the surficial aquifer of OU1. Preliminary remedial alternatives and remedial action objectives (RAOs) were developed for the NADEP Central Hot Spot Area of the OU1 CGWP.
Interim Proposed Remedial Action Plan (PRAP) for OU1, NADEP Central Hot Spot Area Groundwater (B & R, 1996b)	15, 40, 42, 47, 51, 52	1996	Proposed groundwater extraction with treatment by air stripping and discharge to the IWTP or the sanitary sewage treatment plant as the preferred remedial alternative from those identified in the 1996 OU1 FS.
Interim Record of Decision (IROD) for OU1, NADEP Central Hot Spot Area Groundwater (B & R, 1996c)	15, 40, 42, 47, 51, 52	1996	Decision document that presented the selected interim remedial action for groundwater in the OU1 NADEP Central Hot Spot Area, the areal extent of which was defined by total cVOC concentration contours above 1,000 micrograms per liter (µg/L). The **selected interim remedial action**[2] consisted of groundwater extraction, pre-treatment of extracted groundwater via air stripping, and discharge to the IWTP.
OU1 Interim Groundwater Remediation, NADEP Central Hot Spot Area (B & R, 1996d)	15, 40, 42, 47, 51, 52	1996	Remedial design document that presented proposed construction details for the OU1 NADEP Central Hot Spot Area interim remedial action.
Treatability Study Work Plan for Pilot-Scale Air Sparging(AS)/Soil Vapor Extraction (SVE), Sandy Branch Landfill (B & R, 1996e)	16	1996	Based on RAOs and alternatives developed in the 1996 Focused RI/FS, it was recommended to proceed with a treatability study to design and operate a pilot-scale AS/SVE system that would generate relevant data to support full-scale design.
Action Memorandum, OU1, Site 16 - Landfill at Sandy Branch [Pilot Scale AS/SVE System] (B & R Environmental, 1997a)	16	1996-1997	Presents the decision document for the proposed remedial action at Site 16, a full-scale **AS/SVE system**[3], based on the results of a 16-week pilot-scale system study, which effectively removed VOCs from the groundwater.

TABLE 1
Previous Studies, Investigations, and Removal Actions

Previous Investigation*	OU1 Sites	Date	Investigation Activities
Declaration for the Explanation of Significant Differences, OU1 Interim Action, NADEP Central Hot Spot and the Stripper Barn (B & R, 1997b)	15, 40, 42, 47, 51, 52, 92	1997	Document presenting **modifications to the 1996 IROD[4]**: (1) Extend the area covered by the selected remedy for the NADEP Central Hot Spot Area to include other areas within OU1 where elevated concentrations of petroleum-related compounds and cVOCs were detected. (2) Use of the existing IWTP, in conjunction with any necessary pretreatment systems, to treat contaminated groundwater.
Fish Ingestion Report for Slocum Creek (TetraTech, 1999a)	OU1	1998-1999	Fish tissue samples were collected from Slocum Creek adjacent to OUs 1, 2, 3, and 4 in 1998; the results indicated no unacceptable risk to human health from fish tissue ingestion.
Background Evaluation Report for MCAS Cherry Point (TetraTech, 1999b)	OU1	1991-1996	A background study was conducted to develop a set of background values for inorganic constituents in Base soil and groundwater to help distinguish naturally-occurring or anthropogenic concentrations that occur in environmental media from those that are the result of site-related releases. The background inorganic constituent concentrations from this report were subsequently used for comparison with concentrations collected during the environmental investigations at OU1.
Enhanced Bioremediation Treatability Study (CH2M HILL, 2003a)	OU1	2001-2002	An **enhanced bioremediation treatability study involving the injection of hydrogen release compound (HRC)[5]** into the surficial aquifer at Building 137 to stimulate biodegradation of cVOCs. Groundwater monitoring was conducted over a 1-year period following HRC injection. At the end of the monitoring period, the concentration of total VOCs had been reduced more than 90 percent, but individual constituents remained at concentrations that exceeded regulatory criteria.
Final RI for OU1 (Tetra Tech, 2002)	OU1	1994-2000	Evaluated the **results[6]** of environmental samples collected from OU1 surface and subsurface soil; surface water and sediment from Sandy Branch, Schoolhouse Branch, and East Prong Slocum Creek; groundwater from the surficial, Yorktown, Pungo River, and Castle Hayne aquifers; and miscellaneous drainage ditches. An FS was recommended to address potential unacceptable risks.
Five-Year Review Report (CH2M HILL, 2002)	OU1	2002	Review showed that the OU1 NADEP Central Hot Spot Area groundwater extraction and treatment system and the Site 16 AS/SVE system were functioning as designed.
Step 3A Addendum to the Ecological Risk Assessment (CH2M HILL, 2003b)	OU1	1985-2003	Refined exposure scenarios and added more-detailed delineation of the sources and spatial extent of potential risks to ecological receptors. **Identified potential sources and COPCs[7]** affecting various trophic levels represented at OU1 and within the Sandy Branch aquatic system. Recommended conducting a Baseline Ecological Risk Assessment (BERA) to further assess potential impacts on the environment.
Voluntary Groundwater Monitoring (CH2M HILL, 2006)	OU1	2004-2005	Voluntary groundwater monitoring was conducted at select OU1 monitoring wells on a semiannual basis to track potential plume migration and to maintain awareness of plume configuration.
Treatability Study Report (CH2M HILL, 2007)	OU1	2005	An **enhanced bioremediation treatability study involving the injection of EHC[8]** into the surficial aquifer beneath Buildings 133 and 137 to stimulate biodegradation of cVOCs. The purpose of the study was to assess the effectiveness of the technique to remediate what was understood from the results of previous investigations to be relatively small VOC plume areas in the shallow groundwater beneath each building. However, investigation activities associated with the treatability study indicated that the cVOC concentrations beneath Building 133 (Site 52) were significantly higher than had been previously found, and that the cVOC plume at OU1 extended beyond the previously delineated boundaries identified in the 2002 OU1 RI. The treatability study included four post-injection monitoring events over a 10-month period. The treatability study was initially effective in reducing VOC concentrations in wells located near the injection points

TABLE 1
Previous Studies, Investigations, and Removal Actions

Previous Investigation*	OU1 Sites	Date	Investigation Activities
			and VOC mass reduction was achieved. However, the concentrations of some of the contaminants rebounded significantly with time, in part due to under-dosing of the injected substrate as well as the likely presence of dense non-aqueous phase liquid (DNAPL) beneath Building 133, which was not previously known to be potentially present.
BERA for OU1 (CH2M HILL, 2005)	OU1	2004	Sediment samples were collected and analyzed for VOCs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, inorganic constituents, cyanide, and toxicity to lower- trophic-level organisms from the Sandy Branch aquatic system. **No significant risks to sediment-associated receptors**[9] in the main Sandy Branch channel or at the confluence of Sandy Branch and East Prong Slocum Creek were identified, but some potentially unacceptable risk due to COCs within Tributary 2 and portions of its drainage area and floodplain was noted. Additional sampling was recommended to find the source and to better delineate COCs in Tributary 2.
System Closeout Report AS/SVE System, OU1, Site 16 (AGVIQ/ CH2M HILL, 2006)	16	2000-2006	After the Site 16 AS/SVE system had reached **asymptotic conditions**[10] and was becoming less cost-effective, it was recommended to shut the system down. The system had run for 8 years and removed approximately 3,100 pounds of cumulative VOC mass.
Engineering Evaluation/ Cost Analysis (EE/CA), Sandy Branch Tributary 2, OU1 (CH2M HILL, 2008a)	OU1	2004-2007	An EE/CA was conducted to evaluate alternatives for a non-time-critical removal action (NTCRA) to remove COC-contaminated soil/sediment within Sandy Branch Tributary 2 to levels protective of at-risk ecological receptors (benthic macroinvertebrates) in a manner that would be minimally invasive and/or harmful to the existing and functioning habitat.
Action Memorandum, Sandy Branch Tributary 2, OU1 (CH2M HILL, 2008b)	OU1	2008	Documented approval of the NTCRA (soil and sediment removal action) for Sandy Branch Tributary 2 and vicinity floodplain areas.
Five-Year Review Report (CH2M HILL, 2008c)	OU1	2008	Documented that earlier technical evaluations of the OU1 NADEP Central Hot Spot Area groundwater extraction and treatment system and the Site 16 AS/SVE system had concluded that neither system was providing significant protection to human health and the environment nor was operating in a cost-effective manner. It was also concluded that continued operation of these systems could interfere with ongoing investigations to more fully delineate the nature and extent of groundwater contamination in portions of OU1. As a result, these systems were shut down in 2005.
Final Construction Completion Report, Sandy Branch Tributary 2 - OU1 (Rhea, 2009)	OU1	2008	Report documenting the **NTCRA at Sandy Branch Tributary 2**[11]. Roughly 1,500 tons of soil and sediment were excavated from areas of ecological concern, including floodplains and streambeds of Tributary 2. Sediment/soil was disposed of as non-hazardous waste. Excavated areas were backfilled with clean material and restored.
OU1 RI Addendum (CH2M HILL, 2009)	16, 42, 47, 51, 52, 92, 98	2004-2008	Collected and evaluated subsurface characterization data for the surficial and Yorktown aquifers and conducted soil and groundwater sampling to sufficiently characterize the existing groundwater conditions and the nature and extent of cVOC contamination. Assessed the **potential risks to human health and the environment**[12] posed by this contamination within OU1. Recommended an FS be conducted.
Final Construction Closeout Report OU1 Site 16 AS/ASVE System Decommission (Rhea, 2010)	16	2009	Closed-out and decommissioned the Site 16 AS/SVE system by grouting all SVE wells and lateral header lines, removing all SVE fiberglass and metal vaults, dismantling and removing all AS/SVE equipment, demolishing Compound No. 2 concrete pad, and conducting site restoration, which included grading, backfilling, and re-vegetating disturbed areas.

TABLE 1
Previous Studies, Investigations, and Removal Actions

Previous Investigation*	OU1 Sites	Date	Investigation Activities
OU1 CGWP FS (CH2M HILL, 2011a)	OU1	2011	Evaluated **remedial alternatives**[13] to mitigate cVOCs in groundwater based on previous environmental investigations.
Phase I Vapor Intrusion Investigation Report (CH2M HILL, 2011b)	OU1	2009	A **VI evaluation**[14] was conducted to assess potential migration of cVOCs from contaminated groundwater via soil vapor into overlying industrial buildings at OU1. Soil vapor and groundwater samples associated with 21 buildings of interest were collected. Eleven buildings with co-located near-slab soil vapor and groundwater samples that exceeded generic screening levels, or those with the potential for vapor transport along subsurface utility lines located between contaminated areas, were retained as buildings of interest for a recommended Phase II VI investigation (Buildings 131, 133, 137, 143, 188, 3402, 3997, 4026, 4224, 4225, and 4525/129).
OU1 CGWP ISEB Pilot Study Implementation Report (CH2M HILL, 2012a) and **24-Month Post-Injection Activities Update Technical Memorandum** (CH2M HILL, 2014)	OU1	2011-2013	Implemented a field-scale **ISEB pilot study**[15] at OU1 to test the effectiveness of the ISEB alternative from the 2011 FS. Injected the commercially available slow release emulsified vegetable oil substrate and *Dehalococcoides* bacterial culture for bioaugmentation into a row of 14 injection wells, 7 screened in the upper and 7 in the lower surficial aquifer, with the intent of creating a treatment biobarrier. The overall pilot study results demonstrated that an ISEB biobarrier is a suitable remedy for the OU1 CGWP.
Phase II VI Investigation Report (CH2M HILL, 2012b)	OU1	2011	The overall objectives were to evaluate the potential for migration of site-related VOCs from contaminated groundwater and soil vapor into overlying industrial buildings at OU1, and to assess current potential risks to industrial workers from VI. Provided a second round of sampling to evaluate the potential for a complete or significant (greater than target risk levels) vapor pathway. The **Phase II VI evaluation**[16] found that VI was insignificant based on current conditions and, therefore, VI mitigation was not required for existing buildings at this time. It was recommended that periodic VI monitoring be incorporated into the selected remedy for the OU1 CGWP sites to monitor for potential future risk in Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533. The Phase II evaluation also recommended that VI be considered during construction planning that would involve slab penetrations at buildings where exceedances of the generic and/or base-wide soil gas screening levels were detected (Buildings 131, 133, 137, 3997, 4026, 4225, and 4533) and that VI evaluations be conducted during the design phase for proposed building construction within the vicinity of the OU1 CGWP, to decide if VI mitigation measures (such as a vapor barrier) should be incorporated into building design.
OU1 CGWP ZVI PRB Implementation Plan (CH2M HILL, 2012) and **Implementation Report** (CH2M HILL, 2015)	42, 47, 51, 52, 92, 98	2011-2014	Implemented a field-scale **ZVI PRB pilot study**[17] at OU1 to test the effectiveness of a 600-foot long ZVI PRB. The objectives of the ZVI PRB were to determine if a 45-ft bgs depth could be attained using the DeWind One-Pass Trench System and to evaluate the ability of the PRB to achieve 90 percent reduction of trichloroethene (TCE) and 75 percent reduction of overall VOCs over a 2-year time period in the monitoring wells immediately downgradient of the PRB. The pilot study determined that a depth of 45 ft bgs could not be attained due to site-specific conditions, and as a result, the PRB was installed to a depth of 35 ft bgs. The overall pilot study results demonstrated that a significant reduction in COC concentrations occurs across the PRB and that the PRB is a suitable remedy for the OU1 CGWP. In addition, the pilot study demonstrated that the 600-ft length of the PRB was sufficient to capture the downgradient width of the plume.

Notes:

* Documentation is available in the Administrative Record and provides detailed information that was used to support the remedy selection for the OU1 CGWP sites. The relevant referenced information is also accessible by the hyperlinks in this document.

2.4 Nature and Extent of Contamination

During sampling events conducted from 2002 to 2009, groundwater and soil samples were collected and analyzed for VOCs, SVOCs, pesticides, PCBs, and inorganic constituents. Although several compounds were detected in exceedance of regulatory standards in the soil at OU1, inorganic constituents were generally determined to be attributable to background conditions, and detected pesticide concentrations were found to be attributable to normal, historical applications to control termites and other pests, which are not considered releases under CERCLA (TetraTech, 2002).

The primary **COCs at the OU1 CGWP sites**[18] are VOCs, including TCE, cis-1,2-dichloroethene (DCE), and vinyl chloride (VC). Three distinct plumes of TCE and its degradation products occur in groundwater within OU1, which collectively constitute the OU1 CGWP (**Figures 5** and **6**). The first is where the most-elevated TCE concentrations occur beneath Building 133 (source area [Zone 1]), at concentrations that may be indicative of the presence of dense, non-aqueous phase liquid (DNAPL), with a maximum concentration of 62,000 μg/L. Beneath Building 133, TCE generally occurs only within the upper surficial aquifer, but extends into the lower surficial aquifer at locations downgradient of Building 133. The OU1 CGWP extends over 3,000 feet downgradient from Building 133 to where the groundwater discharges to East Prong Slocum Creek and Sandy Branch (downgradient area [Zone 2]).

The second distinct TCE plume occurs within the upper surficial aquifer beneath Building 137, and extends into the lower surficial aquifer downgradient of the building, where it mixes with the plume originating beneath the IWTP. The third TCE groundwater plume within the upper surficial aquifer occurs near the IWTP. The TCE plume from this area migrates downgradient within the upper and lower surficial aquifers beneath Sandy Branch Tributary #2, and also joins the larger plume that extends from beneath Building 133. Both the second and third plumes are part of the downgradient area (Zone 2).

Other VOCs, SVOCs, PCBs, and inorganic constituents have been detected in groundwater above screening criteria at low frequencies, as detailed in the OU1 RI Addendum (CH2M HILL, 2009) and OU1 FS Report (CH2M HILL, 2011). Benzene and other petroleum-related hydrocarbons detected in groundwater at OU1 are being investigated and addressed under the MCAS Cherry Point Underground Storage Tank Program and are not included as part of this ROD. However, the presence of petroleum compounds as a carbon source for micro-organisms involved in reductive dechlorination can potentially enhance biodegradation of cVOCs in groundwater.

2.5 Current and Potential Future Land and Water Uses

MCAS Cherry Point is located just north of Havelock, North Carolina. The area surrounding MCAS Cherry Point consists of commercial and residential developments, waterways, and the Croatan National Forest. Current land use at MCAS Cherry Point includes military operations, training, maintenance and production, supply, medical administration, troop and family housing, community support, recreation, and utilities. MCAS Cherry Point is expected to remain as an active military installation in the foreseeable future.

Groundwater from the Caste Hayne aquifer is used as a potable resource at MCAS Cherry Point for domestic and industrial supply and is classified by the State of North Carolina as an existing or potential source of drinking water. Only groundwater within the surficial aquifer has been impacted by OU1 activities, and the OU1 groundwater contamination does not pose a threat to the Castle Hayne aquifer. The surficial aquifer is not currently an active groundwater resource and is not anticipated to be used as a source of drinking water at MCAS Cherry Point. Under North Carolina's groundwater classification, the surficial aquifer is considered as Class GA, a potential source of drinking water; therefore, the Navy considered remedial alternatives to restore the aquifer to beneficial use.

There are no surface water resources used as potable water supplies in or around MCAS Cherry Point. The surface water bodies in and around MCAS Cherry Point are classified by the State of North Carolina as either Class C (freshwaters protected for secondary recreation, fishing, and aquatic life) or Class SC (saltwaters protected for secondary recreation, fishing, and aquatic life).

FIGURE 5
Trichloroethene Isoconcentration Map, Upper Surficial Aquifer

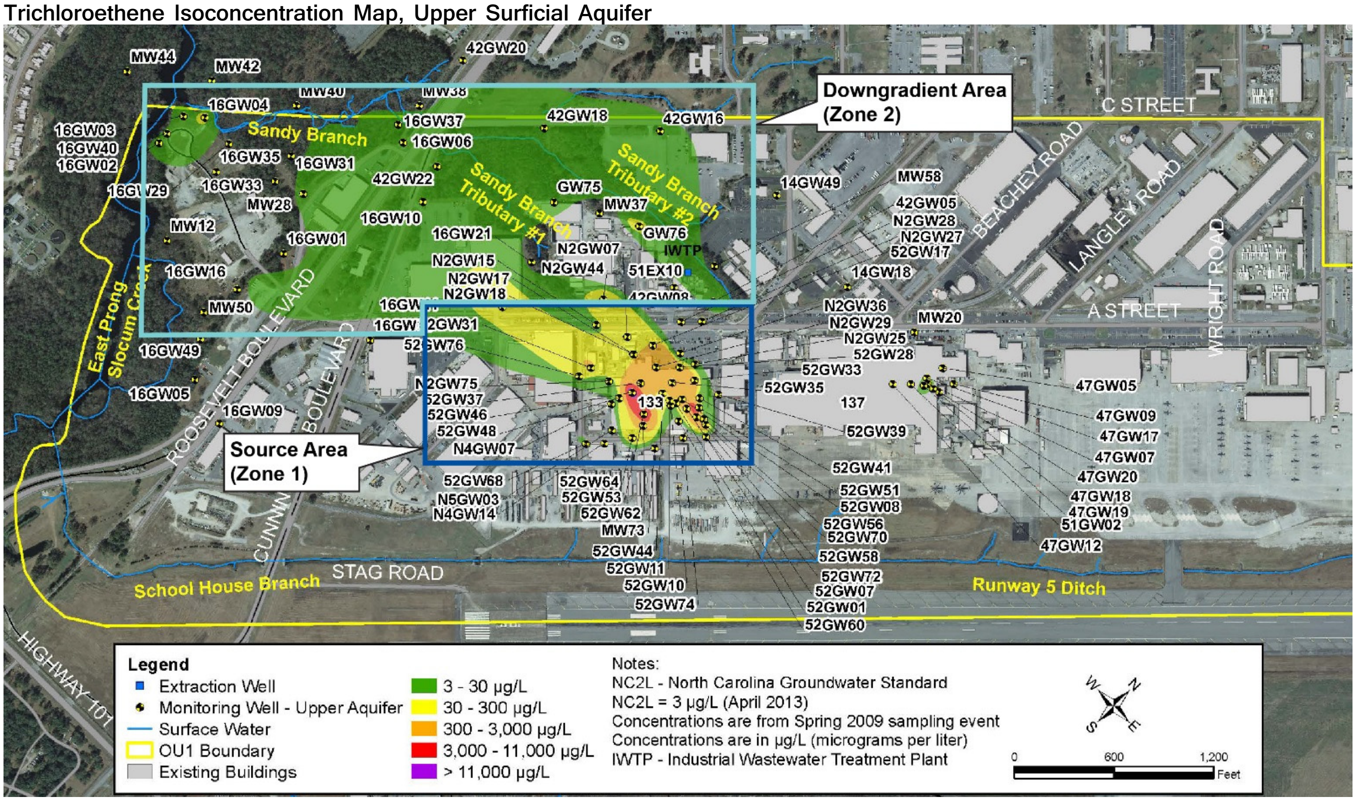
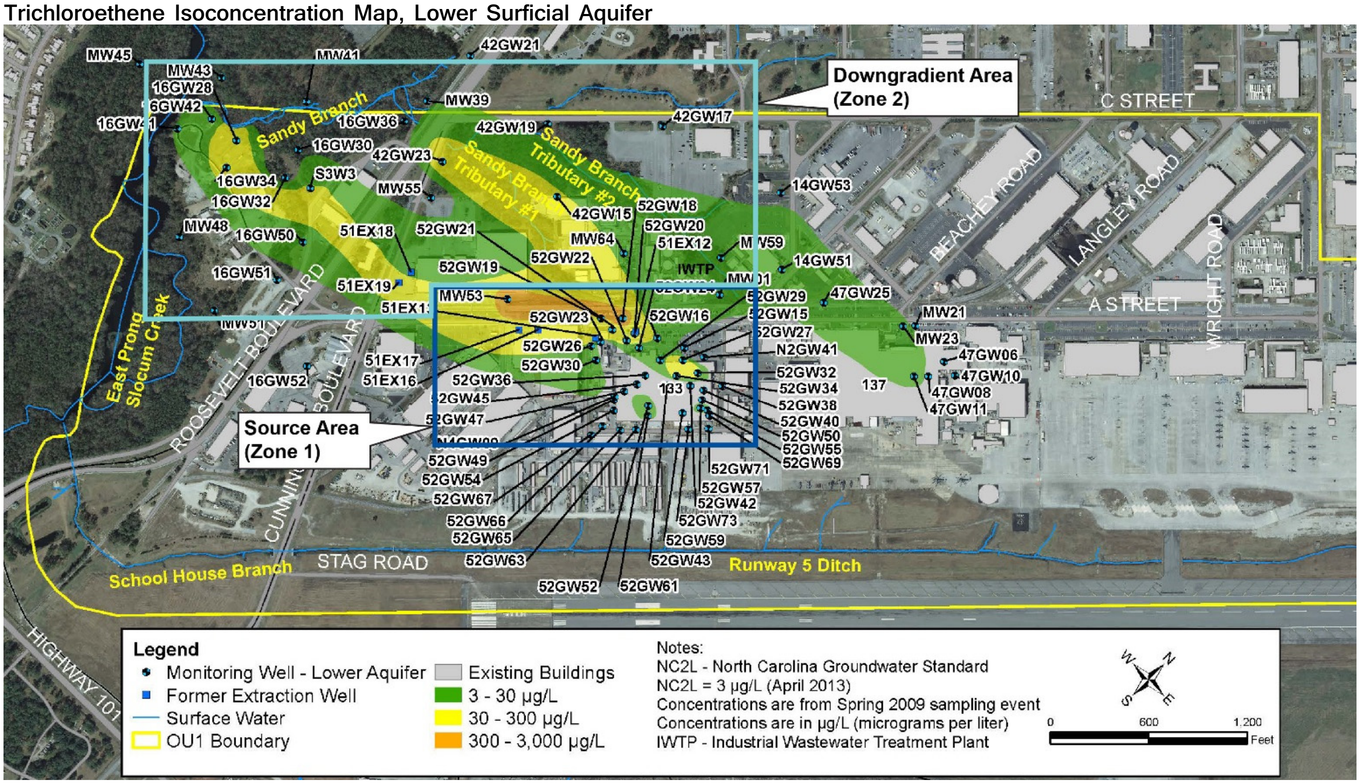


FIGURE 6
Trichloroethene Isoconcentration Map, Lower Surficial Aquifer



2.6 Summary of Site Risks

The potential historical sources of contamination at OU1 include metal plating, metal finishing, aircraft maintenance, solvent degreasing, paint stripping, painting, fuel storage, fueling, aircraft washing, general maintenance, vehicle maintenance as well as industrial, stormwater, and sanitary sewer lines. The primary transport mechanism of contamination at the site included infiltration of contamination from leaky pipes and drains through unsaturated soil to groundwater, which further migrated in groundwater downgradient as a dissolved-phase plume.

Potential human health and ecological risks at OU1 were quantitatively evaluated and documented during previous investigations (**Table 1**). The baseline Human Health Risk Assessment (HHRA) was performed as part of the 2002 RI to evaluate the potential human health risks for soil, groundwater, sediment, surface water, and air at OU1. Potential receptors that were evaluated included industrial workers, maintenance workers, full-time employee/military personnel, adolescent trespassers, adult recreational users under both current and hypothetical future land use conditions, and adult and child residents under the hypothetical future land use conditions (TetraTech NUS, 2002).

An updated HHRA was also conducted as part of the OU1 RI Addendum, which included a summary of risks associated with exposure to soil at Sites 47 and 52, and an evaluation of the magnitude and probability of actual or potential health risks associated with exposure to OU1 groundwater. Exposure to soil at Sites 47 and 52 was evaluated for current/future construction and maintenance workers and potential future residents and industrial workers. Exposure to groundwater from the surficial aquifer was evaluated for current industrial workers and hypothetical future construction workers and adult and child residents (CH2M HILL, 2009).

A VI investigation was conducted to assess potential human health risks to current industrial workers for inhalation of indoor air. Results of the investigation indicated that VI is not currently a significant pathway of concern at OU1. There is, however, the potential for the VI pathway to become complete and/or significant at Buildings 129, 131, 133, 137, 3997, 4026, 4225, and 4533 in the future.

Table 2 and the following subsections briefly summarize the findings of these risk assessments. A general summary of the baseline HHRA and the updated HHRA are discussed below by media type.

TABLE 2
Risk Summary

Medium	Human Health Risk	Ecological Risk
Surface/Subsurface Soil	Acceptable	Acceptable
Sediment	Acceptable	Acceptable
Groundwater – Surficial Aquifer	Unacceptable	Acceptable
Groundwater – Yorktown Aquifer	Acceptable	Acceptable
Surface Water	Acceptable	Acceptable
Indoor Air	Acceptable (Current Risk)	Not Applicable*

*Ecological receptors are not exposed to indoor air.

2.6.1 Human Health Risk Summary

A human health risk assessment (HHRA) was conducted to evaluate potential human health risks for **human receptors**[19] exposed to soil, sediment, groundwater, surface water, indoor air, and fish ingestion at OU1. Health risks are based on a health-protective estimate of the potential carcinogenic (cancer) risk and the potential non-cancer hazard, which is expressed as a hazard index (HI). Exposure scenarios based on current and future land uses that were evaluated in the HHRA for site media included construction workers, maintenance workers, full-time employees, adolescent trespassers, adult recreational users, child residents, adult residents, lifelong residents, and fish consumers. Conservative exposure pathways included ingestion, dermal contact, and inhalation of chemicals by direct contact with groundwater, either in the field or in a shower scenario. Estimated current human health risks were also calculated for the industrial scenario for the indoor air pathway using indoor air data collected from 14 buildings. Even though some of these exposure scenarios are not likely to occur, they were considered as a health-protective measure to ensure that appropriate decisions are made with respect to the need for remediation.

USEPA identifies an acceptable cancer risk range of 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}) and an acceptable non-cancer hazard as an HI of less than or equal to 1 (CH2M HILL, 2008a). The estimates of risk for the OU1 CGWP sites were used to determine if any further actions were required to sufficiently protect human health. Based on the results of the HHRA, it was concluded:

- There is no unacceptable risk from exposure to surface or subsurface soil.
- There is no unacceptable risk from exposure to surface water.
- There is a potential risk to hypothetical future residents (child, adult, and lifelong) from exposure to cVOCs in groundwater used as a potable water supply.
- There is currently no unacceptable risk from exposure to VOCs in indoor air, but there is uncertainty as to whether a VI pathway could become complete and/or significant at select buildings in the future.

Table 3 summarizes the potential human health risks for various receptors incurred by contact with each medium available at the OU1 CGWP sites. The conceptual site model (**Figure 4**) depicts several potential risks identified at the OU1 CGWP sites, including exposure media, exposure routes, and potential human health receptors.

2.6.2 Ecological Risk Summary

An ecological risk assessment was conducted to evaluate if potential unacceptable risks to **ecological receptors**[20] are present that warrant additional assessment or action at the OU1 CGWP sites. Step 3A of the risk assessment showed that ecological risks were present from a few organic chemicals and inorganic constituents in surface soil and sediment in specific areas at OU1 (TetraTech, 2002). A Step 3A Addendum report was prepared in 2003 (CH2M HILL, 2003) that identified several inorganic and organic COPCs for both terrestrial and aquatic receptors, and recommended that potential risk from these chemicals be evaluated in a BERA for OU1. The BERA was completed in 2005, and it concluded that significant ecological risk was present for aquatic, lower-trophic-level receptors (benthic macroinvertebrates) in Sandy Branch Tributary 2 and its adjacent floodplain areas from exposure to inorganic and organic COPCs (CH2M HILL, 2005).

Additional sampling within Sandy Branch Tributary 2 and adjacent floodplain areas was performed in 2006 to delineate the spatial extent of COPCs (several polycyclic aromatic hydrocarbons (PAHs), non-PAH SVOCs, pesticides, and inorganic constituents) and to establish preliminary remediation goals for a sediment cleanup of the tributary. An NTCRA was conducted in 2008 at Sandy Branch Tributary 2 that removed COPC-contaminated media to levels protective of at-risk ecological receptors (Rhēa, 2009). Following completion of the NTCRA, no unacceptable risks were identified and no further evaluation or action is warranted at the OU1 CGWP sites for ecological receptors.

TABLE 3
Human Health Risk, OU1

Receptors	Surface/ Subsurface Soil: Sites 42 and 47 (Soil Grouping 5 [2002 RI])	Surface/ Subsurface Soil: Sites 47 and 51 (Soil Grouping 6 [2002 RI])	Surface/ Subsurface Soil: Site 52 (Soil Grouping 7 [2002 RI])	Sediment (2002 RI)	Surface Water (2002 RI)	Vapor Intrusion (2012 VI)	Groundwater (by aquifer): Surficial (RI Addendum[7])	Groundwater (by aquifer): Yorktown (RI Addendum[7])	Groundwater (by aquifer): Castle Hayne (2002 RI)
Construction Workers	ILCR = 4.4E-07 HI = 0.07 Acceptable	ILCR = 3.2E-05 HI = 6.7 Acceptable*[1]	ILCR = 1.3E-05 HI = 2.7 Acceptable*[2]	ILCR = 7.5E-06 HI = 0.03 Acceptable	ILCR = 3.1E-07 HI = 0.1 Acceptable	NA[5]	ILCR = 2.2E-05 HI = 1.8 Acceptable[8]	NA	NA
Maintenance Workers	ILCR = 1.1E-07 HI = 0.002 Acceptable	ILCR = 2.7E-09 HI = 0.0008 Acceptable	ILCR = 0.0E+00 HI = 0.00005 Acceptable	ILCR = 4.2E-05 HI = 0.01 Acceptable	ILCR = 3.8E-06 HI = 0.2 Acceptable	NA[5]	NA	NA	NA
Full-Time Employees	ILCR = 3.0E-07 HI = 0.008 Acceptable	ILCR = 1.4E-08 HI = 0.002 Acceptable	ILCR = 0.0E+00 HI = 0.0001 Acceptable	ILCR = 2.4E-05 HI = 0.006 Acceptable	ILCR = 3.8E-06 HI = 0.2 Acceptable	ILCR = 7.3E-06 HI = 1.0 Acceptable	NA	NA	NA
Adolescent Trespassers	ILCR = 2.7E-08 HI = 0.001 Acceptable	ILCR = 5.6E-11 HI = 0.0003 Acceptable	ILCR = 0.0E+00 HI = 0.00002 Acceptable	ILCR = 1.1E-05 HI = 0.004 Acceptable	ILCR = 1.3E-06 HI = 0.1 Acceptable	NA[5]	NA	NA	NA
Adult Recreational Users	ILCR = 1.8E-07 HI = 0.002 Acceptable	ILCR = 2.8E-10 HI = 0.0007 Acceptable	ILCR = 0.0E+00 HI = 0.00004 Acceptable	ILCR = 7.3E-05 HI = 0.009 Acceptable	ILCR = 1.6E-05 HI = 0.4 Acceptable	NA[5]	NA	NA	NA
Child Resident	ILCR = 2.6E-06 HI = 0.1 Acceptable	ILCR = 4.3E-08 HI = 0.05 Acceptable	ILCR = 0.0E+00 HI = 0.003 Acceptable	ILCR = 1.3E-04 HI = 0.3 Acceptable[4]	ILCR = 7.6E-06 HI = 1.0 Acceptable	NA[6]	ILCR = NA HI = 61 Unacceptable (N)	ILCR = NA HI = 0.23 Acceptable	ILCR = 0.0E+00 HI = 6.1 Acceptable*[3]
Adult Resident	ILCR = 1.1E-06 HI = 0.02 Acceptable	ILCR = 2.4E-08 HI = 0.005 Acceptable	ILCR = 0.0E+00 HI = 0.0003 Acceptable	ILCR = 5.9E-05 HI = 0.009 Acceptable	ILCR = 1.3E-05 HI = 0.4 Acceptable	NA[6]	ILCR = NA HI = 25 Unacceptable (N)	ILCR = NA HI = 0.089 Acceptable	ILCR = 0.0E+00 HI = 2.6 Acceptable*[3]

TABLE 3
Human Health Risk, OU1

Receptors	Surface/ Subsurface Soil			Sediment (2002 RI)	Surface Water (2002 RI)	Vapor Intrusion (2012 VI)	Groundwater (by aquifer)		
	Sites 42 and 47 (Soil Grouping 5 [2002 RI])	Sites 47 and 51 (Soil Grouping 6 [2002 RI])	Site 52 (Soil Grouping 7 [2002 RI])				Surficial (RI Addendum7)	Yorktown (RI Addendum7)	Castle Hayne (2002 RI)
Lifelong Resident	ILCR = 3.7E-06 HI = NA Acceptable	ILCR = 6.7E-08 HI = NA Acceptable	ILCR = 0.0E+00 HI = NA Acceptable	ILCR = 1.9E-04 HI = NA Acceptable[4]	ILCR = 2.0E-05 HI = NA Acceptable	NA[6]	ILCR = 3.8E-03 HI = NA Unacceptable (C)	ILCR = 1E-04 HI = NA Acceptable	ILCR = 0.0E+00 HI = NA Acceptable

Notes:

ILCR - Incremental Lifetime Cancer Risk
(C) - Cancer Risk is Unacceptable
HI - Hazard Index
(N) - Non-Cancer Risk is Unacceptable
NA - Not applicable for this receptor

Unacceptable Risk based on EPA's target risks:

Unacceptable ILCR > 10^{-4}
Unacceptable HI > 1
Acceptable

* Pesticides and inorganic constituents contributed to potential unacceptable risks; pesticides are attributable to regulated pesticide application and not a result of a spill, improper storage, disposal, or use; inorganic constituents are attributable to background and are not site-related:
- Pesticides are present in environmental media at OU1 likely as a result of application to control pests. This type of regulated pesticide use is distinct from pesticide contamination that is the result of a spill or improper storage, disposal, or use, and the resulting concentrations are not required to be remediated under CERCLA. The concentrations of pesticides detected in OU1 media are consistent with concentrations detected across multiple sites and attributed to normal pesticide application. Therefore, pesticide COPCs were not identified as COCs.

1 Pesticides alpha chlordane, dieldrin, and heptachlor epoxide were the major contributors to HI at Site 51.
2 Pesticides dieldrin and heptachlor epoxide were the major contributors to HI at Site 52.
- Inorganic COPCs that are wholly or primarily attributable to background were not identified as COCs.

3 Inorganic constituent thallium was the major contributor to HI in Castle Hayne for child resident receptor. Due to uncertainty with the analytical method for thallium, and because it was not detected in historical groundwater samples and detected very infrequently and at low concentrations only in soil, the thallium detections are believed to be false detections and not site-related.
4 Benzo(a)pyrene equivalents was the major contributor to ICLR from only one sample from Schoolhouse Branch. Therefore, risk levels are considered acceptable because impacts are isolated and limited in extent.
5 Full-time employee represents the most conservative receptor scenario; construction workers, maintenance workers, adult trespassers, and adult recreational users have a lesser exposure time.
6 Evaluated as acceptable in the 2002 RI, but not re-evaluated in the multi-phase vapor evaluation.
7 The more conservative reasonable maximum exposure values are included.
8 No individual constituents or target organs had HIs above USEPA's target level of 1. The carcinogenic risk to a future construction worker from exposure to surficial aquifer groundwater is within USEPA's target risk range. Therefore, there were no calculated hazards or risks to a future construction worker above USEPA's target levels.

2.6.3 Basis for Response Action

Based on the HHRA, exposure to groundwater at the OU1 CGWP sites poses an unacceptable risk to human health due to the presence of cVOCs. In addition, under North Carolina's groundwater classification, the surficial aquifer is considered Class GA, a potential source of drinking water (North Carolina Administrative Code [NCAC], 2010). NCDEQ identified North Carolina Groundwater Quality Standards (NCGWQS) as 'relevant and appropriate,' chemical-specific requirements for groundwater remediation of this aquifer. Remedial action at this site is considered to be necessary due to unacceptable risk from potential human consumption of the contaminated groundwater and exceedances of the NCGWQS or maximum contaminant levels (MCLs) (measures that define unacceptable levels for drinking water). As a result, cVOCs identified in groundwater at the OU1 CGWP sites at concentrations exceeding the NCGWQS (**Table 4**) are all considered COCs.

It is the current judgment of the Navy and USEPA, in concurrence with NCDEQ, that the Selected Remedy in this ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

TABLE 4
Surficial Aquifer Groundwater Contaminants of Concern

Groundwater COCs	Maximum Concentration (µg/L)[1]	NCGWQS (µg/L)
1,1-Dichloroethane (1,1-DCA)	8,800 J	6
1,1-Dichloroethene (DCE)	2,900	350
1,2-Dichloroethane (DCA)	14	0.4
1,2-Dichloroethene (DCE) (total)[2]	16,000	70
1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)	6 J	0.2
1,1,1-Trichloroethane (1,1,1-TCA)	49,000	200
1,1,2-Trichloroethane (1.1.2-TCA)	39 J	5
Chloroform	25 J	70
cis-1,2-Dichloroethene (cis-1,2-DCE)	33,000	70
trans-1,2-Dichloroethene (trans-1,2-DCE)	1,100	100
Tetrachloroethene (PCE)	71	0.7
Trichloroethene (TCE)	62,000	3
Vinyl Chloride (VC)	8,000	0.03

[1] Data from additional investigations which took place between 2000 and 2007.

[2] Data not indicative of a straight sum of cis-1,2-DCE and trans-1,2-DCE concentrations, but rather of samples collected at different locations on separate sampling events.

2.7 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 they be exposed. As described in the USEPA's Guide to Principal Threat and Low-level Threat Waste (USEPA OSWER Pub.9380.3-06FS, Nov. 1991), liquids (e.g., in buried drums), non–aqueous phase liquids (NAPLs), and/or high concentrations of toxic compounds in soil are considered principal threat wastes. Contaminated groundwater generally is not considered to be a source material; however, NAPLs in groundwater may be viewed as a source material. Dissolved concentrations of a cVOC in groundwater between approximately 1 to 5 percent of a compound's solubility suggest the possible nearby presence of that compound in dense NAPL (DNAPL) form in the subsurface. USEPA generally expects that the quantity of free phase NAPL (i.e., "free product") should be reduced to the extent practicable and that an appropriately designed containment strategy should be developed for NAPLs that cannot be removed from the subsurface (USEPA - Rules of Thumb For Superfund Remedy Selection - OSWER 9355.0-69). The major source of the groundwater contamination for the OU1 CGWP is the likely TCE DNAPL area located beneath Building 133.

To most-expediently remediate the DNAPL area, an aggressive source treatment would be required and would need to encompass the entire DNAPL area. Treatment of the entire DNAPL area would require a dense network of treatment points. To implement such a design, unrestricted component placement and uninterrupted system operation would be needed. Due to the current industrial use of Building 133, extensive subsurface infrastructure beneath the building, low overhead clearance within the building, tight spacing of equipment and workspaces, and round-the-clock operational schedule, it would be difficult or impossible to properly implement an in situ treatment technology throughout the source area. In addition, a source zone treatment beneath Building 133 would have the potential to generate increased VI risks to the current workers at the building. Thus, implementation of a source treatment remedy would likely result in a greater overall risk to human health for current receptors. Therefore, it has been determined that source zone DNAPL treatment for the OU1 CGWP is not feasible while Building 133 remains in use. However, if the building use is significantly modified to mitigate the increased risks to current workers from remedy implementation, or if the building is demolished, the source zone DNAPL treatment component of the remedy for the OU1 CGWP would be implemented by the Navy and MCAS Cherry Point.

2.8 Remedial Action Objectives

An RAO is established based on regulatory requirements, standards, and guidance; contaminated media; chemicals of concern; potential receptors and exposure scenarios; and human health and ecological risks, as applicable. The RAOs for the OU1 CGWP sites are as follows:

1. Restore groundwater quality at OU1 to the NCGWQS and MCL standards, based on the classification of the aquifer as a potential source of drinking water (Class GA or Class GSA) under 15A NCAC 02L.0201.
2. Prevent human exposure to groundwater above levels that would cause unacceptable risks.
3. Prevent migration or discharge of COCs in groundwater to sediment and surface water in East Prong Slocum Creek and Sandy Branch at levels that would cause unacceptable risks to human or ecological receptors.
4. Prevent human exposure to inhalation risks resulting from VI to buildings.
5. Reduce source zone concentrations to ensure principal threat waste is not contributing significant additional contaminant mass into the central portion of the plume or migrating further downgradient.

The remediation goal (RG) concentrations for each of the COCs in groundwater are shown in **Table 5**. The RG for each COC was established by selecting the most conservative of the NCGWQS, MCL, or calculated risk-based performance standard. Petroleum-related compounds (investigated and managed by the MCAS Cherry Point Underground Storage Tank Program) and naturally occurring inorganic constituents were specifically excluded as COCs because they are not related to historical CERCLA-regulated releases at OU1. RGs are not necessary for soil, sediment, surface water, fish tissue, and indoor air because there are no unacceptable risks from exposure to these environmental media or sampling results exceeding applicable regulatory standards.

TABLE 5
Remediation Goals

Groundwater COCs	Groundwater RG (µg/L)
1,1-Dichloroethane (1,1-DCA)	6
1,1-Dichloroethene (DCE)	7
1,2-Dichloroethane (DCA)	0.4
1,2-Dichloroethene (DCE) (total)	70
1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)	0.2
1,1,1-Trichloroethane (1,1,1-TCA)	200
1,1,2-Trichloroethane (1.1.2- TCA)	5

TABLE 5
Remediation Goals

Groundwater COCs	Groundwater RG (μg/L)
Chloroform	70
cis-1,2-Dichloroethene (cis-1,2-DCE)	70
trans-1,2-Dichloroethene (trans-1,2- DCE)	100
Tetrachloroethene (PCE)	0.7
Trichloroethene (TCE)	3
Vinyl Chloride (VC)	0.03

RGs are based on North Carolina Groundwater Quality Standards (NC 2L Standards) except for 1,1,2-TCA and 1,1-DCE, which are based on the Maximum Contaminant Level (MCL).

2.9 Description and Comparative Analysis of Remedial Alternatives

The remedial alternatives developed and evaluated to address the OU1 CGWP sites are detailed in the OU1 FS report. As part of the screening of various technologies, remedial target areas were defined to support the development of remedial alternatives. Two separate groundwater zones were defined as part of remedial alternative selection: Source Zone (Zone 1) corresponds to areas with the highest dissolved-phase COC concentrations (concentrations greater than 1,000 μg/L), and Downgradient Zone (Zone 2) corresponds to areas with lower dissolved-phase COC concentrations.

The feasibility of a source zone treatment beneath Building 133 was evaluated in the OU1 FS, since the primary source of the OU1 CGWP occurs beneath this building. The evaluation concluded that, for several reasons, source zone treatment beneath Building 133 was not feasible at this time:

- It would be difficult or impossible to properly implement an in-situ treatment technology beneath Building 133 due to extensive subsurface infrastructure, low overhead clearance, dense spacing of equipment, and the 24 hours per day/7 days per week operational schedule for mission-critical activities in the building.
- Building 133 is a critical component of FRCE, which is the only source of repair within the continental U.S. for many military aircraft engines. FRCE also provides services for the Navy, Marine Corps, Air Force, Army, other federal agencies, and multiple foreign governments. Operations at Building 133 are considered mission-critical for these services during both peacetime and current wartime efforts. Disruption of Building 133 operations to implement a treatment remedy is not practicable.
- The exposure scenario with potentially unacceptable human health risk is for potable use by a hypothetical future resident. Since this exposure scenario does not currently exist, and can be prevented via institutional controls, source area treatment beneath Building 133 is not the only means to reduce the human health risk.
- Source zone treatment beneath Building 133 has the potential to generate increased VI risks to current workers in and around the building.

Therefore, it was agreed by the Navy and MCAS Cherry Point, in partnership with USEPA and NCDEQ, that the component of source zone treatment beneath Building 133 was not feasible at this time, and that the Source Zone remedial action would initially focus on the higher COC concentrations adjacent to the building. However, if Building 133 is ever taken out of service or demolished, the Source Zone remedial action component addressing the DNAPL source beneath Building 133 would be implemented. Previous treatability studies conducted in the Source Zone have demonstrated that ISEB technology is effective in treating the higher COC concentrations beneath Building 133.

2.9.1 Description of Remedial Alternatives

Three remedial alternatives within the Source Zone (Zone 1) and five remedial alternatives within the Downgradient Zone (Zone 2) were developed for detailed evaluation, and are summarized in **Tables 6** (Zone 1) **and 7** (Zone 2). Consistent with the NCP, a No Action Alternative was evaluated as a baseline for the comparative analysis.

TABLE 6
Summary of Remedial Alternatives for OU1 – Zone 1, Source Zone

Alternative	Components	Details	Cost	
1 - No Action	None	None	**Total Cost**	**$0**
			Time Frame	**Indefinite**
2 – MNA and LUCs	MNA/LUCs	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	MNA and LUC costs for the entire CGWP are included in the Downgradient Zone remedial alternative 2 (see **Table 7)**.	
3 – ISEB, MNA, LUCs[1]	ISEB Injections	Injection of a slow-release carbon source into injection wells covering the upper and lower surficial aquifers, every 2 years for a duration of 10 years. After 10 years, an evaluation will be performed to determine if and when additional injections are warranted. For cost estimating purposes, an additional injection event is assumed in Year 20.	Capital cost	$1,762,000
			Future Costs	$6,967,000
	MNA/LUCs	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	**Total present value**	**$8,729,000**
			Time Frame	**30 years**

[1] For cost-estimating purposes, assumes 50 biobarrier well pairs within the upper and lower surficial aquifer adjacent to Building 133 and 20 wells within the upper surficial aquifer at Building 133 (assuming Building 133 were to be removed); MNA was assumed for a duration of 30 years. The actual number of required wells will be determined in the Remedial Design.

TABLE 7
Summary of Remedial Alternatives for OU1 – Zone 2, Downgradient Zone

Alternative	Components	Details	Cost	
1 - No Action	None	None	**Total Cost**	**$0**
			Time Frame	**Indefinite**
2 – MNA and LUCs[1]	MNA/LUCs[1]	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	Capital Cost	$364,000
			Future Costs	$5,881,000
			Total Present Value	**$6,245,000**
			Time Frame	**100 years**
3 – PRBs, MNA, and LUCs[2]	PRB near leading edge of southern lobe of plume	Install a PRB constructed of a ZVI/sand mixture via trenching across the southern lobe of the CGWP	Capital Cost	$4,287,000
			PRB Operation	$3,418,000
	PRB near leading edge of northern lobe of plume	Install a PRB across the northern lobe of the plume via the installation of closely spaced vertical columns with injection of micro-scale ZVI.		
	MNA/LUCs	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	**Total Present Value**	**$7,705,000**
			Time Frame	**30 years**
4 – ISEB Barrier, MNA, and LUCs[3]	ISEB Injections	Injection of emulsified vegetable oil (EVO) carbon source and bioaugmentation culture every 2 years into rows of to a depth of 50 feet for a duration of 10 years	Capital Cost	$1,648,000
			Annual Monitoring	$8,119,000

TABLE 7
Summary of Remedial Alternatives for OU1 – Zone 2, Downgradient Zone

Alternative	Components	Details	Cost	
	MNA/LUCs	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	**Total Present Value** **Time Frame**	**$9,767,000** **30 years**
5 – AS Curtain, MNA, and LUCs[4]	Air Sparging Curtain	Installation of two directionally drilled AS wells roughly 1,100 feet long, installed at depths of 50 and 70 feet. Operation of system for 30 years.	Capital Cost Annual Monitoring	$1,486,000 $5,331,000
	MNA/LUCs	MNA to monitor the natural decreases in contaminant concentrations and LUCs to prevent exposure to groundwater	**Total Present Value** **Time Frame**	**$6,816,000** **30 years**

1 For cost-estimating purposes, MNA was assumed for a duration of 100 years.

2 For cost-estimating purposes, a 950-ft long PRB installed to a depth of 35 feet was assumed for the southern lobe. For cost-estimating purposes, 30 soil columns spaced 25-ft apart and installed to a depth of 50 feet were assumed for the northern lobe. The actual PRB specifications will be determined in the Remedial Design. MNA was assumed for a duration of 30 years.

3 For cost-estimating purposes, injection of an EVO carbon source and bioaugmentation culture was assumed every 2 years into 38 wells in rows spaced 25 feet apart to a depth of 50 feet for a duration of 10 years. MNA was assumed for a duration of 30 years.

4 For cost-estimating purposes, installation of two directionally drilled AS wells was assumed, roughly 1,100 feet long installed at depths of 50 and 70 feet with 400-to 500-foot slotted pipe. MNA was assumed for a duration of 30 years.

2.9.2 Comparative Analysis of Alternatives

A comprehensive analysis of each remedial alternative with respect to the **nine evaluation criteria**[21] was completed for the OU1 FS, and is described below. Summary rankings of the alternatives relative to the criteria are presented in **Tables 8** (Zone 1) **and 9** (Zone 2). It was determined that the No Action Alternative does not comply with the threshold criteria and is not discussed further in the following sections.

TABLE 8
Comparative Analysis of Remedial Alternatives - Zone 1, Source Zone

CERCLA Criteria	Alternative 1 No Action	Alternative 2 MNA/LUCs	Alternative 3 ISEB, MNA, LUCs
Threshold Criteria			
Protection of human health and the environment	❍	●	●
Compliance with ARARs	❍	●	●
Primary Balancing Criteria			
Long-term effectiveness and permanence	❍	⭘	●
Reduction in toxicity, mobility, or volume through treatment	❍	❍	●
Short-term effectiveness	❍	●	⭘
Implementability	●	●	⭘
Present Value Cost	$0	Costs for entire CGWP included in Downgradient Zone Alternative 2	$8.7 M

Ranking: ● High ⭘ Moderate ❍ Low

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

ARARs = applicable or relevant and appropriate requirements

TABLE 9
Comparative Analysis of Remedial Alternatives - Zone 2, Downgradient Zone Comparison

CERCLA Criteria	Alternative 1 No Action	Alternative 2 MNA/LUCs	Alternative 3 PRBs, MNA, LUCs	Alternative 4 ISEB Barrier, MNA, LUCs	Alternative 5 AS Curtain, MNA, LUCs
Threshold Criteria					
Protection of human health and the environment	❍	●	●	●	●
Compliance with ARARs	❍	●	●	●	●
Primary Balancing Criteria					
Long-term effectiveness and permanence	❍	◉	●	●	●
Reduction in toxicity, mobility, or volume through treatment	❍	❍	●	●	●
Short-term effectiveness	❍	●	●	●	◉
Implementability	●	●	◉	●	◉
Present Value Cost	$0	$6.2 M	$7.7 M	$9.8 M	$6.8 M

Ranking: ● High ◉ Moderate ❍ Low

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

Threshold Criteria

Overall Protection of Human Health and the Environment

Alternative 1 (No Action) does not achieve the RAOs. All of the other alternatives are protective of human health and the environment, prevent exposure to contaminants by the implementation of LUCs, and reduce groundwater COC concentrations via MNA, ISEB, PRB, or AS.

Compliance with ARARs

All alternatives except the No Action alternative can comply with the **applicable or relevant and appropriate requirements (ARARs)**. The ARARs include any Federal or State standards, requirement, criteria, or limitations that are determined to be legally applicable or relevant and appropriate to a CERCLA site or action and are provided in **Appendix A**, **Tables A-1** through **A-3**. TBC criteria are non-promulgated advisories or guidance issued by Federal or State government and do not have the status of potential ARARs but are evaluated along with ARARs. The timeframe for compliance with Chemical-specific ARARs will vary with different remedial alternatives. Location-specific ARARs remain the same for each alternative, and Action-specific ARARs may vary to some extent with the different remedial alternatives. All alternatives, except the No Action Alternative (Alternative 1 for each area), are expected to comply with ARARs.

Primary Balancing Criteria

Long-term Effectiveness and Permanence

Long-term effectiveness and permanence addresses the expected residual risk that will remain at the site after completion of the remedial action and the ability of a remedy to maintain reliable protection of human health and the environment in the future and in the short term. Each of the alternatives, with the exception of the No Action Alternative, is expected to achieve long-term effectiveness and permanence. Alternative 2 for both zones relies on natural attenuation to reduce COC concentrations, which can take considerably longer than the alternatives with active treatment, which vary in duration and effectiveness. In the end, all will reduce the contaminant concentrations to below the RGs.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, and volume through treatment refers to the anticipated performance of the treatment technologies that a remedy may employ in their ability to reduce toxicity, mobility or volume of contamination. Aside from the No Action Alternative, all remedy alternatives for both zones reduce the toxicity, mobility, and volume of COCs in groundwater through either anaerobic biodegradation (MNA, PRB, and/or ISEB) or mechanical stripping of volatiles (AS).

Short-term Effectiveness

In addition to evaluating the timeframe required to achieve protection and potentially adverse impacts during the implementation phase, a sustainability analysis was conducted for each of the eight remedial alternatives as part of this criterion for consideration. Sustainability is a "green remediation" consideration focused on energy conservation, reduction of greenhouse gases such as carbon dioxide, waste minimization, and re-use and recycling of materials.

Alternative 1 for both zones has the least short-term construction impacts and the lowest environmental footprint since there would be no remedial construction activities. The other alternatives would include construction activities with varying levels of potential impacts to construction workers, the community, and the environment. The amount of impact is proportional to the amount of time spent drilling and injecting treatment substrates and the engineering controls put in place to protect workers during these activities. Alternatives with more operations and maintenance or injection events also require more heavy truck traffic and disruption of the natural system.

Implementability

Alternative 1 for both zones would not obtain administrative approval since it does not meet the RAOs. For the Source Zone, Alternative 2 (MNA and LUCs) is relatively easy to implement. However, current site operations, infrastructure, and the presence of subsurface utilities make it difficult to install the injection wells included in Alternative 3 (ISEB), although the subsequent injection events would not be hindered. For the Downgradient Zone, Alternatives 4 (ISEB Barrier) and 5 (PRBs) are roughly equivalent in implementability, with only minor disruptions probable. One of the PRBs has already been installed as part of a pilot study and is currently successfully treating the groundwater plume.

Cost

Tables 6 and 7 summarize the capital costs, as well as long-term operations and maintenance costs (as applicable) for the alternatives. For comparative purposes, a 100-year time frame was used for Alternative 2 for both zones and a 30-year time frame was used for the other alternatives. For the Source Zone, the Alternative 2 (MNA and LUCs) **present-worth cost**[22] would be covered under the selected Downgradient Zone remedy. Alternative 3 (ISEB) has an estimated present-worth cost of $8,729,000. For the Downgradient Zone, Alternative 4 (ISEB) is substantially more expensive, at an estimated present-worth cost of $9,767,000, than Alternative 3 (PRBs) ($7,705,000) and Alternative 5 (AS) ($6,816,000). One of the PRBs has already been installed as part of a pilot study and significantly reduces the capital costs for Alternative 3 (PRBs).

Modifying Criteria

State Acceptance

State involvement has been solicited throughout the CERCLA process. NCDEQ, as the designated state support agency in North Carolina, concurs with the selected remedy.

Community Acceptance. The **public meeting** was held on May 21, 2014 to present the Proposed Plan and answer community questions regarding the proposed remedial action for the OU1 CGWP sites. The questions and concerns raised at the meeting were general inquiries for informational purposes only. No comments requiring amendment to the Proposed Plan were received from the public during the meeting and public comment period.

2.10 Selected Remedy

The selected remedy for the OU1 CGWP sites has three components: (1) Zone 1 - Source Zone - Alternative 3 includes ISEB using vertical wells to treat areas of groundwater with high contaminant concentrations, MNA to allow natural attenuation processes to continue while maintaining regular monitoring of the plume, and LUCs to prevent aquifer use and mitigate exposure to VI; (2) Zone 2 – Downgradient Zone - Alternative 3 includes two

PRBs utilizing ZVI to treat the contaminated downgradient groundwater and prevent it from impacting surface water bodies, MNA, and LUCs; and (3) Subslab soil vapor and indoor air performance monitoring in identified buildings of interest to monitor the potential for VI from the groundwater plume to overlying buildings.

2.10.1 Rationale for the Selected Remedy

Based on the evaluation of the data and information currently available, the Navy, in partnership with USEPA, believes 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 ISEB plus MNA and LUCs alternative (Zone 1 – Alternative 3) for the source zone was selected because it has been proven to be effective at the OU1 CGWP sites during multiple pilot/treatability studies, it complies with ARARs, it will enhance conditions for reductive dechlorination of cVOCs, and it will reduce the toxicity, mobility, and volume of the COCs through treatment.

The PRBs, MNA and LUCs alternative (Zone 2 – Alternative 3) was selected to address downgradient groundwater contamination because it has also been proven effective at the OU1 CGWP sites through the PRB pilot study and an evaluation of natural attenuation, it protects human health and the environment, it complies with ARARs, and it will reduce the toxicity, mobility, and volume of the COCs through treatment. The downgradient portion of the remedy is designed to ensure that any COCs reaching surface water bodies (East Prong Slocum Creek and Sandy Branch) through groundwater discharge are at concentrations well below levels that would generate potentially unacceptable risks to human health or the environment.

LUCs are part of both the Zone 1 and 2 alternatives, and are part of the selected remedy in order to prevent aquifer use, restrict intrusive activities with the potential to cause human exposure to groundwater, and monitor potential VI impacts until RGs have been reached. LUCs will protect human health and the environment until the active and passive treatment components of the selected remedy have been completed.

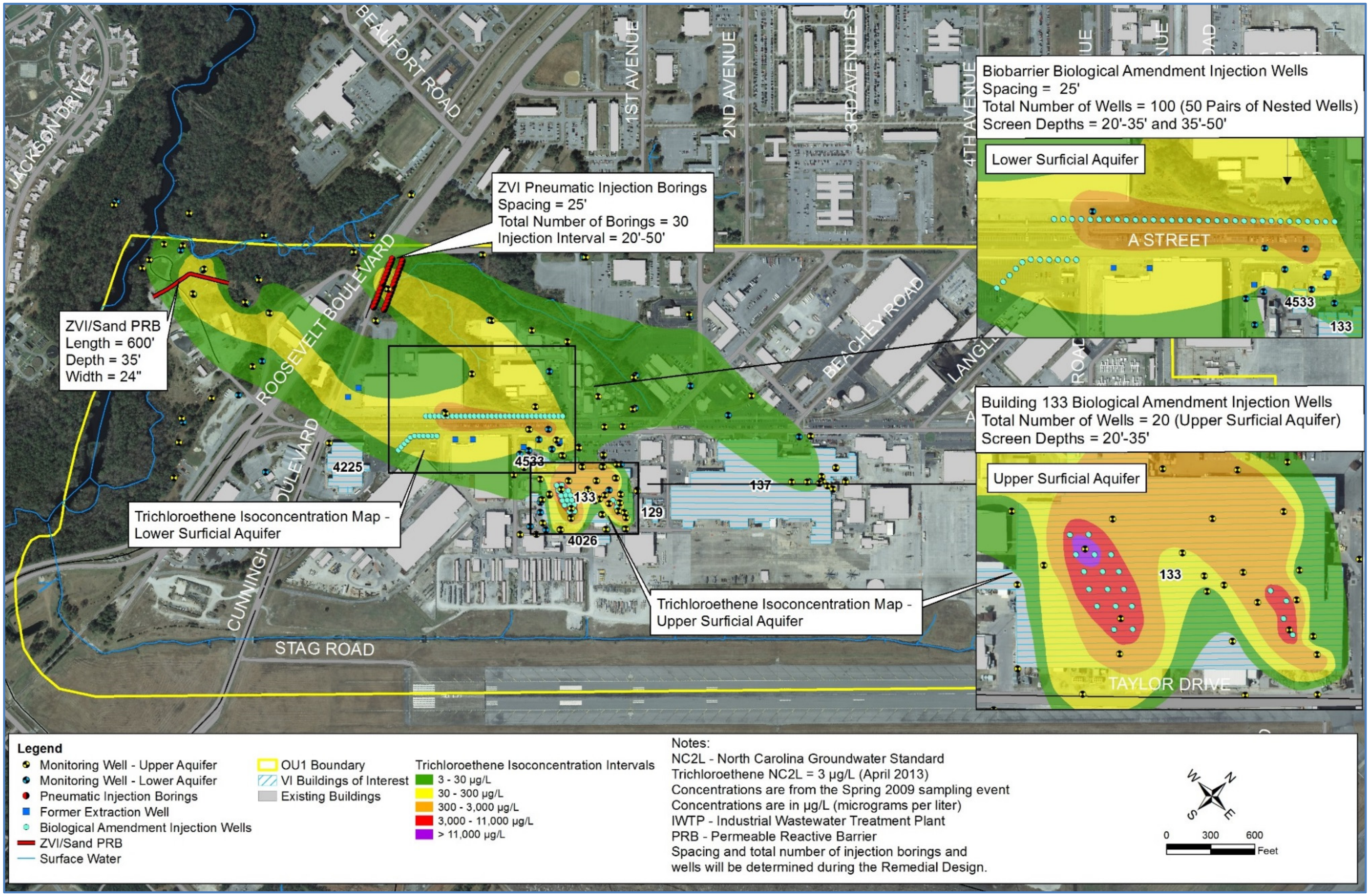
2.10.2 Detailed Description of the Selected Remedy

The proposed locations of the ISEB injection wells and PRBs are presented on **Figure 7**. The final detailed specifications for the components of the selected remedy will be determined and documented in the Remedial Design, to be completed following approval of this ROD. Conceptual specifications employed during the evaluation of remedial alternatives are presented below.

ISEB is anticipated to be conducted using 120 injection wells to distribute EVO substrate through the source area subsurface at depth intervals of 25 to 30 feet bgs and 35 to 50 feet bgs[1]. The EVO substrate will be injected into the subsurface every two years for an anticipated duration of 10 years. However, actual ISEB specifications will be determined in the Remedial Design. Long-term monitoring will be conducted to measure the effectiveness of the ISEB and changes in COC concentrations. The treatment will be considered complete when the RAOs have been met.

[1] As indicated in Sections 2.7 and 2.9, it was agreed by the Navy and MCAS Cherry Point, in partnership with USEPA and NCDEQ, that the component of Source Zone treatment beneath Building 133 (20 injection wells) was not feasible at this time, and that the Source Zone remedial action would initially consist of ISEB to address the higher COC concentrations adjacent to the building (100 injection wells). However, if the building use is significantly modified to mitigate the increased risks to current workers from remedy implementation, or if the building is demolished, the component of the Source Zone remedy beneath Building 133 would be implemented by the Navy and MCAS Cherry Point.

FIGURE 7
Selected Remedial Alternative



A 600-ft ZVI PRB was installed across the southern lobe of the OU1 CGWP during the 2012 ZVI PRB pilot study. The pilot study results demonstrated that a significant reduction in COCs has been observed downgradient of this PRB and that it would represent a suitable remedy component for the OU1 CGWP. In addition, the pilot study demonstrated that the 600-ft PRB length was sufficient to capture the downgradient width of the plume and does not need to be extended to a width of 950 ft (as evaluated in the OU1 FS).

In addition to the existing PRB installed across the southern lobe of the OU1 CGWP, one new downgradient PRB will be installed perpendicular to groundwater flow along Roosevelt Boulevard and upgradient of Sandy Branch. The PRB along Roosevelt Boulevard is anticipated to consist of two staggered rows of closely spaced soil borings (15 per row) with micro-scale ZVI, dosed at 0.7 percent iron, injected from 20 to 50 feet bgs. However, actual PRB specifications will be determined in the Remedial Design. In order to extend the life-span of this PRB, ZVI will be re-injected into the barrier approximately every 6 years for a total of 30 years.

Performance monitoring will be conducted to assess changes in COC concentrations and overall effectiveness of the PRBs. It is presumed that the PRBs will no longer be necessary when active treatment has met the RAOs and when treated groundwater from the Source Zone has reached the PRB; this is estimated to occur after approximately 30 years.

In addition to performance monitoring of the treatment components of the selected remedy, MNA will be conducted to monitor plume stability and analyze natural attenuation parameters. Groundwater samples will be collected and analyzed for site-specific COCs to assess site-wide groundwater conditions and trends. Frequency of sampling and the extent of the monitoring well network will be determined in the Remedial Design.

LUCs including, but not limited to, land use restrictions in the Base Master Plan, filing a Notice of Contaminated Site with the Register of Deeds of Craven County, and administrative procedures to prohibit unauthorized intrusive activities (for example, excavation below the water table, drinking water well installation, or construction activities that might result in groundwater exposure) will be implemented as part of the remedy to prevent exposure to the residual contamination on the site that exceeds the cleanup levels. Consideration of potential VI impacts will be required before any new construction or changes to existing building use or structures within the LUC boundary takes place. LUCs will be maintained until the concentrations of hazardous substances in the groundwater are at such levels to allow for unlimited land use and unrestricted exposure. The Navy and MCAS Cherry Point are responsible for implementing, maintaining, reporting on, and enforcing LUCs. Although the Navy and MCAS Cherry Point may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy and MCAS Cherry Point will retain ultimate responsibility for the remedy integrity. The LUC performance objectives will include:

- Prohibiting all uses of groundwater and construction activities with the potential to result in worker exposure to groundwater from the surficial aquifer within the LUC boundaries (except for monitoring and remediation purposes), including but not limited to, human consumption, dewatering, irrigation, heating/cooling and industrial processes, unless prior written approval is obtained from USEPA and NCDEQ.
- Evaluating the potential for VI impacts from new building construction or from major physical modifications or changes in occupancy/usage of existing structures within the LUC boundaries prior to their implementation.
- Maintaining the integrity of any existing or future monitoring or remediation system at the site.

LUCs will be developed during the Remedial Design phase following approval of the ROD for the OU1 CGWP sites. The LUCs will be implemented and maintained by the Navy and MCAS Cherry Point until the concentrations of the hazardous substances in the groundwater are at levels that allow for unlimited use/unrestricted exposure.

The LUC implementation actions, including monitoring and enforcement requirements, will be provided in a Land Use Control Implementation Plan (LUCIP) that will be prepared as part of the Remedial Design document. The Navy will submit the LUCIP to USEPA and NCDEQ for review and approval pursuant to the primary document review procedures stipulated in the FFA. The Navy and MCAS Cherry Point will maintain, monitor (including conducting periodic inspections), and enforce the LUCs according to the requirements contained in the LUCIP and the ROD. The need for LUCs to prevent exposure and ensure protection will be periodically reassessed as COC concentrations are reduced over time.

2.10.3 Expected Outcomes of the Selected Remedy

The expected outcome of the Selected Remedy is to allow for unrestricted use of the groundwater.

Current land uses for military purposes are expected to continue at OU1 for the foreseeable future. Cleanup levels for the selected remedy are based on unlimited use and unrestricted exposure. Exposure will be controlled through LUCs until COCs in groundwater are reduced to the RGs.

With respect to long-term monitoring of groundwater associated with the MNA remedy component, the Navy and MCAS Cherry Point, in partnership with USEPA and the NCDEQ, will evaluate based on site conditions the discontinuation of monitoring for individual COCs that have met the RGs at all locations for four consecutive sampling events.

The time required for the selected remedy to meet cleanup levels is conservatively estimated to be 100 years. However, the estimate does not account for several factors at OU1 that may facilitate the attenuation of COCs, such as the presence of petroleum-related contamination in some areas. Long-term monitoring as part of the MNA remedy component and performance monitoring associated with the treatment remedy components will provide temporal and geochemical data to more accurately estimate the time to achieve RAOs.

Within 90 days following signature of the ROD, the Navy will prepare, in accordance with USEPA guidance, and submit to USEPA and NCDEQ for review and approval, a Remedial Design containing LUC implementation and maintenance actions, including periodic inspections. The Navy and MCAS Cherry Point are responsible for implementing, maintaining, inspecting, reporting on, and enforcing the LUCs described in this ROD in accordance with the ROD and the approved Remedial Design.

2.10.4 Statutory Determinations

In accordance with the NCP, the selected remedy meets the following statutory determinations:

Protection of Human Health and the Environment — The selected remedy is appropriate to restore groundwater quality at OU1 to meet drinking water standards, to prevent use of groundwater that would potentially pose an unacceptable risk, and to prevent migration or discharge of groundwater to sediment and surface water in East Prong Slocum Creek and Sandy Branch at levels that would cause unacceptable risks to human or ecological receptors using a combination of ISEB, PRBs, MNA, and LUCs. Performance monitoring will be conducted for the treatment components of the remedy and also to monitor the potential for VI from the groundwater plume to potential receptors in overlying buildings. The implementation of LUCs will prevent exposure to surficial aquifer groundwater and maintain the integrity of any existing or future monitoring or remediation system.

Compliance with ARARs — The selected remedy will attain the Federal and State ARARs presented herein (**Appendix A, Tables A-1 through A-3**).

Cost-Effectiveness — The selected remedy provides the best value relative to cost. Although the ISEB component adds significantly more cost than MNA alone, the enhanced biodegradation will reduce toxicity, mobility, and volume of COCs and achieve the RAOs more rapidly.

Use 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 OU1. The selected remedy treats the high concentrations of dissolved-phase COCs in the Source Zone, achieving significant reductions in COC concentrations before groundwater migrates to the Downgradient Zone remedy component. The downgradient remedy component will also provide reductions in COC concentrations prior to groundwater discharge to downgradient surface water bodies. In addition, the downgradient PRBs will serve as a long-term, sustainable component of the remedy, with limited operation and maintenance needed. The selected remedy is expected to attain the RAOs.

Preference for Treatment as a Principal Element — The selected remedy uses treatment as a principal element, and therefore satisfies the statutory preference for treatment. The selected remedy includes ISEB to actively treat surficial groundwater in the Source Zone and PRBs to passively treat groundwater in the Downgradient Zone before it reaches downgradient surface water bodies.

Five-Year Review Requirements — Until the RAOs are met, the Navy and MCAS Cherry Point will maintain LUCs and conduct a statutory remedy review every five years after the initiation of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. If the remedy is determined not to be protective of human health and the environment, then additional remedial actions will be evaluated by the Navy, MCAS Cherry Point, USEPA, and NCDEQ for potential implementation.

2.11 Documentation of Significant Changes

The Proposed Plan for OU1 was released for public comment on May 9, 2014. The Navy reviewed all comments submitted during the public comment period, which extended until June 23, 2014. One significant change to the remedy, as originally identified in the Proposed Plan, included the addition of 20 injection wells at Building 133 as part of the Source Zone (Zone 1) remedy, such that if Building 133 use is changed or the building is demolished, the Building 133 component of the Source Zone remedy would be implemented.

2.12 Community Participation

The Navy and MCAS Cherry Point, in consultation with USEPA and NCDEQ, established a community relations program for the MCAS Cherry Point environmental restoration program in the late 1980s. The program promotes communication regarding site investigations and remediation activities between the Navy, MCAS Cherry Point, USEPA, and NCDEQ and the public. A Restoration Advisory Board (RAB) was formed in 1995 to further encourage and facilitate community involvement. RAB meetings are held approximately every three months and are open to the public as an opportunity for public comment and input.

The Proposed Plan for the OU1 CGWP sites was released for public comment on May 1, 2014. A public meeting to present the Proposed Plan was held on May 20, 2014 at the Havelock Tourist Center.

The Administrative Record files, Community Involvement Plan, IRP fact sheets, and final technical reports concerning OU1 can be obtained from the IRP web site: http://go.usa.gov/Dy59. Internet access is available to the public at the following location:

Havelock-Craven County Library
301 Cunningham Blvd.
Havelock, NC 28532
Phone (252) 447-7509

3 Responsiveness Summary

The participants in the public meeting held on May 21, 2014 included representatives of the Navy, MCAS Cherry Point, USEPA, and NCDEQ. Two community members attended the meeting. Questions received during the public meeting were general inquiries and are described in the public meeting minutes in the Administrative Record and included in **Appendix B**. There were no comments received at the public meeting requiring amendment to the Proposed Plan, and no additional written comments, concerns, or questions were received from community members during the public comment period.

4 Acronyms and Abbreviations

µg/L	micrograms per liter
ARAR	applicable or relevant and appropriate requirement
AS	air sparging
B & R	Brown and Root Environmental
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CGWP	Central Groundwater Plume
COC	contaminant of concern
COPC	contaminant of potential concern
cVOC	chlorinated volatile organic compound
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DRMO	Defense Reutilization and Marketing Office
EE/CA	Engineering Evaluation/Cost Analysis
EVO	emulsified vegetable oil
FFA	Federal Facilities Agreement
FRCE	Fleet Readiness Center-East
FS	Feasibility Study
HHRA	human health risk assessment
HI	hazard index
ILCR	incremental lifetime cancer risk
IROD	Interim Record of Decision
IRP	Installation Restoration Program
ISEB	in-situ enhanced bioremediation
IWTP	Industrial Wastewater Treatment Plant
LUC	land use control
LUCIP	Land Use Control Implementation Plan
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
mg/L	milligram per liter
MNA	monitored natural attenuation
msl	mean sea level
NA	not applicable
NADEP	Naval Aviation Depot
Navy	Department of the Navy
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
NCGWQS	North Carolina Groundwater Quality Standards
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action

NPL	National Priorities List
NTCRA	non-time-critical removal action
O&M	operations and maintenance
OU	Operable Unit
OU1	Operable Unit No. 1
PAH	polycyclic aromatic hydrocarbon
PCA	tetrachloroethane
PCB	polychlorinated biphenyl
PRAP	Proposed Remedial Action Plan
PRB	permeable reactive barrier
RAO	remedial action objective
RG	remediation goal
RI	Remedial Investigation
ROD	Record of Decision
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to-be-considered
TCA	trichloroethane
TCE	trichloroethene
USEPA	U.S. Environmental Protection Agency
VC	vinyl chloride
VI	vapor intrusion
VOC	volatile organic compound
ZVI	zero-valent iron

References

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
1	**14 sites**	Table 1	Water & Air Research, Inc. 1983. *Initial Assessment Study of Marine Corps Air Station Cherry Point, North Carolina.* March.
2	**selected interim remedial action**	Table 1	Brown & Root Environmental. 1996. *Interim Record of Decision (IROD) for OU1, NADEP Central Hot Spot Area Groundwater. Marine Corps Air Station, Cherry Point, North Carolina*. August.
3	**AS/SVE system**	Table 1	Brown & Root Environmental. 1997. *Action Memorandum, OU1, Site 16 - Landfill at Sandy Branch [Pilot Scale AS/SVE System]. Marine Corps Air Station, Cherry Point, North Carolina*. December.
4	**modifications to the 1996 IROD**	Table 1	Brown & Root Environmental. 1997. *Declaration for the Explanation of Significant Differences, Operable Unit 1 (Naval Aviation Depot [NADEP] Central Hot Spot Area Groundwater). Marine Corps Air Station, Cherry Point, North Carolina*. December.
5	**enhanced bioremediation treatability study involving the injection of hydrogen release compound (HRC)**	Table 1	CH2M HILL. 2003. *Interim Remedial Action for Groundwater Hotspot Remediation, Treatability Study Final Technical Memorandum. MCAS Cherry Point, Operable Unit 1, Site 47 (Stripper Barn)*. March.
6	**results**	Table 1	TetraTech NUS, Inc. 2002. *Final Remedial Investigation for Operable Unit 1 (OU 1), Marine Corps Air Station Cherry Point, North Carolina*. March.
7	**Identified potential sources and COPCs**	Table 1	CH2M HILL. 2003. *Step 3a Addendum to the Ecological Risk Assessment, Operable Unit 1, MCAS Cherry Point. Prepared for Atlantic Division, Naval Facilities Engineering Command, Norfolk, Virginia*. March.
8	**enhanced bioremediation treatability study involving the injection of EHC**	Table 1	CH2M HILL and Applied Research Center. 2007. *Groundwater Treatability Study, Operable Unit 1, Marine Corps Air Station Cherry Point, Cherry Point, North Carolina*. December.
9	**No significant risks to sediment-associated receptors**	Table 1	CH2M HILL. 2005. *Baseline Ecological Risk Assessment, Operable Unit 1, Marine Corps Air Station, Cherry Point, North Carolina*. August.
10	**asymptotic conditions**	Table 1	AGVIQ/CH2M HILL. 2006. *System Closeout Report, Air Sparge/Soil Vapor Extraction System, Operable Unit, Site 16, Marine Corps Air Station Cherry Point, North Carolina*. August.
11	**NTCRA at Sandy Branch Tributary 2**	Table 1	Rhēa. 2009. *Construction Closeout Report, Operable Unit 1, Sandy Branch Tributary 2, Non Time Critical Removal Action. MCAS Cherry Point, North Carolina*. June.

Reference Number	Reference Phrase in ROD	Location in ROD	Identification of Referenced Document Available in the Administrative Record
12	**potential risks to human health and the environment**	Table 1	CH2M HILL. 2009. *OU1 Remedial Investigation Addendum. Marine Corps Air Station, Cherry Point, North Carolina*. April.
13	**remedial alternatives**	Table 1	CH2M HILL. 2011. *Operable Unit 1 Central Groundwater Plume Feasibility Study, Marine Corps Air Station, Cherry Point, North Carolina*. August.
14	**VI evaluation**	Table 1	CH2M HILL. 2011. Final *Phase I Vapor Intrusion Investigation Report*, *Marine Corps Air Station Cherry Point, Cherry Point, North Carolina*. January.
15	**ISEB pilot study**	Table 1	CH2M HILL. 2014. *24-Month Post-Injection Activities Update Technical Memorandum. Marine Corps Air Station, Cherry Point, North Carolina*. March.
16	**Phase II VI evaluation**	Table 1	CH2M HILL. 2012. *Final Phase II Vapor Intrusion Investigation Report, Marine Corps Air Station, Cherry Point, North Carolina*. May.
17	**ZVI PRB pilot study**	Table 1	CH2M HILL. 2014. *Operable Unit 1 Central Groundwater Plume Zero-Valent Iron Permeable Reactive Barrier Pilot Study Implementation Plan*. Marine Corps Air Station Cherry Point, North Carolina. (pending).
18	**COCs at the OU1 CGWP sites**	Section 2.4	CH2M HILL. 2011. *Operable Unit 1 Central Groundwater Plume Feasibility Study, Marine Corps Air Station, Cherry Point, North Carolina*. August.
19	**human receptors**	Section 2.6.1	CH2M HILL. 2009. *OU1 Remedial Investigation Addendum. Marine Corps Air Station, Cherry Point, North Carolina*. April.
20	**ecological receptors**	Section 2.6.2	CH2M HILL. 2005. *Baseline Ecological Risk Assessment, Operable Unit 1, Marine Corps Air Station, Cherry Point, North Carolina*. August.
21	**nine evaluation criteria**	Section 2.9.2	CH2M HILL. 2011. *Operable Unit 1 Central Groundwater Plume Feasibility Study, Marine Corps Air Station, Cherry Point, North Carolina*. August.
22	**present-worth cost**	Section 2.9.2	CH2M HILL. 2011. *Operable Unit 1 Central Groundwater Plume Feasibility Study, Marine Corps Air Station, Cherry Point, North Carolina*. August.

Appendix A
ARARs and TBC Criteria

TABLE A-1
Chemical-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
Chemical-Specific ARARs			
Classification of contaminated groundwater	Groundwaters in the state naturally containing 250 mg/L or less of chloride are *classified as GA* under 15A NCAC 02L .0201(1)	Groundwaters located within the boundaries or under the extraterritorial jurisdiction of the State of North Carolina — **applicable**	15A NCAC 02L .0302(1)
Restoration of contaminated groundwater	Shall not exceed the groundwater quality standards[1] for contaminants specified in Paragraphs (g) or (h) for the site related contaminants of concern. 1,1,1-Trichloroethane (200 µg/L) 1,1,2,2-Tetrachloroethane (0.2 µg/L) 1,1-Dichloroethane (6 µg/L) 1,2-Dichloroethane (0.4 µg/L) 1,2-Dichloroethene (total) (70 µg/L) Chloroform (70 µg/L) cis-1,2-Dichloroethene (70 µg/L) Tetrachloroethene (0.7 µg/L) trans-1,2-Dichloroethene (100 µg/L) Trichloroethene (3 µg/L) Vinyl Chloride (0.03 µg/L)	Class GA or GSA groundwaters with contaminant(s) concentrations exceeding standards listed in 15A NCAC 02L .0202 — **applicable**	15A NCAC 02L .0202(a) and (b)
	Shall not exceed the Safe Drinking Water Act National Revised Primary Drinking Water Regulations: maximum contaminant levels (MCLs) for organic contaminants specified in 40 CFR 141.61(a). 1,1,2-Trichloroethane (5 µg/L) 1,1-Dichloroethene (7 µg/L)	Groundwaters classified as GA or GSA which are an existing or potential source of drinking water— **relevant and appropriate**	40 CFR 141.61(a) 15A NCAC 18C .1517

[1] Groundwater quality standards established on the basis of a National secondary drinking water standards are not utilized as remediation goals since these are based on taste, odor and other considerations unrelated to human health.

TABLE A-1
Chemical-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
	Chemical-Specific ARARs		
Protection of adjacent surface water body	Monitor and undertake management practices for sources of pollution such that water quality standards and best usage of receiving waters and all downstream waters will not be impaired.	Indirect discharges of waste or other source of water pollution into surface waters classified as Class C[2] — **relevant and appropriate**	15A NCAC 02B .0203
	The concentrations of toxic substances, either alone or in combination with other wastes, in surface waters shall not render waters injurious to aquatic life or wildlife, recreational activities, public health, or impair the waters for any designated uses.	Nonpoint discharges into surface waters classified as Class C (see footnote 2) — **relevant and appropriate**	15A NCAC 02B .0208
	Toxic substances: shall not exceed the numerical quality standards designed to protect human health from carcinogens through consumption of fish (and shellfish). Tetrachloroethene (3.3 µg/L) Trichloroethene (30 µg/L) Vinyl Chloride (2.4 µg/L)	Class C waters with chemical concentrations exceeding 15A NCAC 02B standards (see footnote 2) — **relevant and appropriate**	15A NCAC 02B .0208(a)(2)B)
	Shall not exceed 50 NTU turbidity level (unless due to natural background conditions). Compliance with this standard can be met when land management activities employ Best Management Practices [as defined by Rule .0202 of this Section].	Nonpoint discharges into surface waters classified as Class C in 15A NCAC 02B .0211 — **relevant and appropriate**	15A NCAC 02B .0211(21)
	Toxic substances: shall not exceed the numerical quality standards designed to protect aquatic life.	Surface water concentrations of toxic substances at levels potentially injurious to aquatic life or wildlife — **relevant and appropriate**	15A NCAC 02B .0208(a)(1)

[2] The unnamed stream at OU14, Sandy Branch, and East Prong Slocum Creek are classified as Class C estuarine water by NCDENR. These waters are suitable for fish and wildlife and secondary recreation (i.e., not considered suitable for swimming or potable use).

TABLE A-2
Location-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
	Location-Specific ARARs		
Presence of floodplain as determined based on best-available information and the Federal Emergency Management Agency's effective Flood Insurance Rate Map.	Shall consider alternatives to avoid, to the extent possible adverse effects and incompatible development in the floodplain.	Federal actions that involve potential impacts to, or take place within, floodplains — **TBC**	Executive Order 11988 Section 2(a)(2), as amended by Executive Order 13690
Presence of federally endangered or threatened species, as designated in 50 CFR 17.11 and 17.12 -or- critical habitat of such species listed in 50 CFR 17.95	Actions that jeopardize the existence of a listed species or results in the destruction or adverse modification of critical habitat must be avoided or reasonable and prudent mitigation measures taken.	Action that is likely to jeopardize fish, wildlife, or plant species or destroy or adversely modify critical habitat — **Applicable**	16 USC 1531 et seq., Sect. 7(a)(2)

TABLE A-3
Action-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
	General Construction Standards — All Land-disturbing Activities (i.e., excavation, clearing, grading, etc.)		
Managing fugitive dust emissions	Shall not cause or allow fugitive dust emissions to cause or contribute to substantive complaints, or visible emissions in excess of that allowed under paragraph (e) of this Rule.	Activities within facility boundary that will generate fugitive dust emissions — **relevant and appropriate**	15A NCAC 02D .0540(c)
	Implement methods (e.g. wetting dry soils and keeping roads clean of soil) to control dust emissions that could travel beyond the facility boundary.		15A NCAC 02D .0540(g)
	Monitoring Well Installation, Operation, and Abandonment		
Construction of groundwater monitoring well(s)	No well shall be located, constructed, operated, or repaired in any manner that may adversely impact the quality of groundwater.	Installation of wells (including temporary wells, monitoring wells) other than for water supply - **applicable**	15A NCAC 02C.0108(a)
	Shall be located, designed, constructed, operated and abandoned with materials and by methods which are compatible with the chemical and physical properties of the contaminants involved, specific site conditions, and specific subsurface conditions.		15A NCAC 02C.0108(c)
	Monitoring well and recovery well boreholes shall not penetrate to a depth greater than the depth to be monitored or the depth from which contaminants are to be recovered. Any portion of the borehole that extends to a depth greater than the depth to be monitored or the depth from which contaminants are to be recovered shall be grouted completely to prevent vertical migration of contaminants.		15A NCAC 02C.0108(d)
	Shall be constructed in such a manner as to preclude the vertical migration of contaminants with and along borehole channel.	Installation of wells (including temporary wells, monitoring wells) other than for water supply - **applicable**	15A NCAC 02C.0108(f)
	The well shall be constructed in such a manner that water or contaminants from the land surface cannot migrate along the borehole annulus into any packing material or well screen area.		15A NCAC 02C.0108(g)

Action	Requirements	Prerequisite	Citation
Construction of groundwater monitoring well(s) (cont'd)	Packing material placed around the screen shall extend at least one foot above the top of the screen. Unless the depth of the screen necessitates a thinner seal, a one foot thick seal, comprised of chip or pellet bentonite or other material approved by the Department as equivalent, shall be emplaced directly above and in contact with the packing material.	**applicable**	15A NCAC 02C.0108(h)
	Grout shall be placed in the annular space between the outermost casing and the borehole wall from the land surface to the top of the bentonite seal above any well screen or to the bottom of the casing for open end wells. The grout shall comply with Paragraph (e) of Rule .0107 of this Section except that the upper three feet of grout shall be concrete or cement grout.		15A NCAC 02C.0108(i)
	All wells shall be grouted within seven days after the casing is set. If the well penetrates any water-bearing zone that contains contaminated or saline water, the well shall be grouted within one day after the casing is set.		15A NCAC 02C.0108(j)
	Shall be secured with a locking well cap to ensure against unauthorized access and use. Shall be equipped with a steel outer well casing or flush-mount cover, set in concrete, and other measures sufficient to protect the well from damage by normal site activities.		15A NCAC 02C.0108(k) and (l)
	The well casing shall be terminated no less than 12 inches above land surface unless all of the following conditions are met: (1) site-specific conditions directly related to business activities, such as vehicle traffic, would endanger the physical integrity of the well; and (2) the well head is completed in such a manner so as to preclude surficial contaminants from entering the well.		15A NCAC 02C.0108(n)

Action	Requirements	Prerequisite	Citation
Construction of groundwater monitoring well(s) (cont'd)	Shall have permanently affixed an identification plate. The identification plate shall be constructed of a durable, waterproof, rustproof metal or other material approved by the Department as equivalent and shall contain the following information: (1) well contractor name and certification number; (2) date well completed; (3) total depth of well; (4) a warning that the well is not for water supply and that the groundwater may contain hazardous materials; (5) depth(s) to the top(s) and bottom(s) of the screen(s); and (6) the well identification number or name assigned by the well owner.	**applicable**	15A NCAC 02C.0108(o)
	Shall be developed such that the level of turbidity or settleable solids does not preclude accurate chemical analyses of any fluid samples collected or adversely affect the operation of any pumps or pumping equipment.		15A NCAC 02C.0108(p)
	Shall be constructed in such a manner as to preclude the vertical migration of contaminants with and along borehole channel.	Installation of temporary wells and all other non-water supply wells **- applicable**	15A NCAC 02C.0108(s)
Implementation of groundwater monitoring system	Shall be constructed in a manner that will not result in contamination of adjacent groundwaters of a higher quality.	Installation of monitoring system to evaluate effects of any actions taken to restore groundwater quality, as well as the efficacy of treatment **— applicable**	15A NCAC 02L .0110 (b)

TABLE A-3
Action-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
Maintenance of groundwater monitoring well(s)	Every well shall be maintained by the owner in a condition whereby it will conserve and protect groundwater resources, and whereby it will not be a source or channel of contamination or pollution to the water supply or any aquifer.	Installation of wells (including temporary wells) other than for water supply — **applicable**	15A NCAC 02C .0112(a)
	Broken, punctured, or otherwise defective or unserviceable casing, screens, fixtures, seals, or any part of the well head shall be repaired or replaced, or the well shall be abandoned pursuant to 15A NCAC 02C .0113		15A NCAC 02C .0112(d)
	All materials used in the maintenance, replacement, or repair of any well shall meet the requirements for new installation.		15A NCAC 02C .0112(c)
	No well shall be repaired or altered such that the outer casing is completed less than 12 inches above land surface. Any grout excavated or removed as a result of the well repair shall be replaced in accordance with Rule .0107(f) of this Section.		15A NCAC 02c.0112(f)
Abandonment of groundwater monitoring well(s)	Shall be abandoned by filling the entire well up to land surface with grout, dry clay, or material excavated during drilling of the well and then compacted in place; and	Permanent abandonment of wells (including temporary wells) other than for water supply — **applicable**	15A NCAC 02C .0113(d)(1)
	Shall be abandoned by completely filling with a bentonite or cement - type grout.	Permanent abandonment of wells (including temporary wells, monitoring wells, and test borings) other than for water supply less than 20 feet in depth and which do not penetrate the water table — **applicable**	15A NCAC 02C .0113(d)(2)
	All wells shall be permanently abandoned in which the casing has not been installed or from which the casing has been removed, prior to removing drilling equipment from the site.	Permanent abandonment of wells (including temporary wells) other than for water supply – **applicable**	15A NCAC 02C .0113(f)

TABLE A-3
Action-Specific ARARs
Record of Decision
Operable Unit 1, Central Groundwater Plume Sites 42, 47, 51, 52, 92, and 98
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Action	Requirements	Prerequisite	Citation
	Underground Injection Well Installation, Operation, and Abandonment		
Construction of injection well(s) for *in-situ* treatment of groundwater	Shall not be constructed, operated, maintained, converted, plugged, abandoned, or conducted in a manner that allows the movement of fluid containing any contaminant into underground sources of drinking water if the presence of that contaminant may cause a violation of any applicable groundwater quality standard specified in Subchapter 02L or may otherwise adversely affect human health.	Installation of a Class 5 underground injection well (In-situ Groundwater Remediation Well) -- **applicable**	15A NCAC 02C .0211(c)
Location of injection well(s) for *in-situ* treatment of groundwater	Shall not be located in an area generally subject to flooding. Areas which are generally subject to flooding include those with concave slope, alluvial or colluvial soils, gullies, depressions, and drainage ways.	Installation of Class 5 underground injection well (In-situ Groundwater Remediation Well) — **applicable**	15A NCAC 02C .0225(g)(1)
Construction of injection well(s) for *in-situ* treatment of groundwater	Shall follow the procedures, methods, specified materials, and requirements specified in the subparagraphs (3) through (24) of this Rule.	Installation of Class 5 underground injection well (In-situ Groundwater Remediation Well) — **applicable**	15A NCAC 02C .0225(g)(3) through (24)
Operating an injection well(s) for *in-situ* treatment of groundwater	Pressure at the well head shall be limited to a maximum which will ensure the pressure in the injection zone does not initiate new fractures or propagate existing fractures in the injection zone, initiate fractures in the confining zone, or cause the migration of injected or formation fluids outside the injection zone or area.	**applicable**	15A NCAC 02C .0225(i)(1)
	Injection between the outermost casing and the well borehole is prohibited.		15A NCAC 02C.0225(i)(2)

Action	Requirements	Prerequisite	Citation
	Control of Diffuse VOC Emissions from Groundwater Treatment		
Emissions of VOCs from groundwater treatment (e.g., sparging system)	Shall not emit any of the toxic air pollutants listed in the table of the Rule in such quantities that may cause or contribute beyond the premises (adjacent property boundary) to any significant ambient air concentration that may adversely affect human health.	Emissions of toxic air pollutants (e.g., VOCs) from facility into the ambient air — **applicable**	15A NCAC 02D .1104
	Shall install and operate reasonable available control technology to limit emissions of VOCs.	Air emissions of VOCs from facilities where there is no other applicable emissions control rule — **relevant and appropriate**	15A NCAC 02D .0951(c)
	One of the applicable test methods in Appendix M in 40 CFR part 51 or Appendix A in 40 CFR Part 60 shall be used to determine compliance with VOC emission standards.	VOC emission source not covered by 15A NCAC 02D.2613(b) through (e) — **relevant and appropriate**	15A NCAC 02D .2613(g)
	Control emissions by meeting limitations and work practice standards reflecting application of the maximum achievable control technology. Periodic inspection of equipment and monitoring are required for the life of the remediation.	Air emissions of organic Hazardous Air Pollutants (e.g.,VOCs) from site remediation — **relevant and appropriate**	40 CFR 63 Subpart GGGGG, NESHAPS for Site Remediation
	Waste Characterization and Storage — Primary Wastes (i.e., excavated contaminated soils)		
Characterization of solid waste (e.g., well soil cuttings)	Must determine if solid waste is hazardous waste or if waste is excluded under 40 CFR 261.4(b); and	Generation of solid waste as defined in 40 CFR 261.2 and which is not excluded under 40 CFR 261.4(a) — **applicable**	15A NCAC 13A.0107 only as it incorporates 40 CFR 262.11(a)
	Must determine if waste is listed under 40 CFR Part 261; or		15A NCAC 13A.0107 only as it incorporates 40 CFR 262.11(b)
	Must characterize waste by using prescribed testing methods or applying generator knowledge based on information regarding material or processes used.		15A NCAC 13A.0107 only as it incorporates 40 CFR 262.11(c)

Action	Requirements	Prerequisite	Citation
Characterization of solid waste (e.g., well soil cuttings) - Continued	Must refer to Parts 261, 262, 264, 265, 266, 268, and 273 of Chapter 40 for possible exclusions or restrictions pertaining to management of the specific waste.	Generation of solid waste which is determined to be hazardous —**applicable**	40 CFR 262.11(d)
Storage of solid waste	All solid waste shall be stored in such a manner as to prevent the creation of a nuisance, insanitary conditions, or a potential public health hazard.	Generation of solid waste which is determined *not* to be hazardous —**relevant and appropriate**	15A NCAC 13B .0104(f)
	Containers for the storage of solid waste shall be maintained in such a manner as to prevent the creation of a nuisance or insanitary conditions. Containers that are broken or that otherwise fail to meet this Rule shall be replaced with acceptable containers.		15A NCAC 13B .0104(e)
Characterization of hazardous waste	Must obtain a detailed chemical and physical analysis on a representative sample of the waste(s), which at a minimum contains all the information that must be known to treat, store, or dispose of the waste in accordance with pertinent sections of 40 CFR 264 and 268.	Generation of RCRA-hazardous waste for storage, treatment or disposal —**applicable**	40 CFR 264.13(a)(1)
	Must determine the underlying hazardous constituents [as defined in 40 CFR 268.2(i)] in the waste.	Generation of RCRA characteristic hazardous waste (and is not D001 non-wastewaters treated by CMBST, RORGS, or POLYM of Section 268.42 Table 1) for storage, treatment or disposal — **applicable**	40 CFR 268.9(a)
	Must determine if the waste is restricted from land disposal under 40 CFR 268 *et seq.* by testing in accordance with prescribed methods <u>or</u> use of generator knowledge of waste.		40 CFR 268.7
	Must determine each EPA Hazardous Waste Number (Waste Code) to determine the applicable treatment standards under 40 CFR 268.40 *et. seq*.		40 CFR 268.9(a)

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Action	Requirements	Prerequisite	Citation
Temporary storage of hazardous waste in containers	A generator may accumulate hazardous waste at the facility provided that:	Accumulation of RCRA hazardous waste on site as defined in 40 CFR 260.10 — **applicable**	40 CFR 262.34(a)
	• waste is placed in containers that comply with 40 CFR 265.171-173; and		40 CFR 262.34(a)(1)(i)
	• the date upon which accumulation begins is clearly marked and visible for inspection on each container		40 CFR 262.34(a)(2)
	• container is marked with the words "hazardous waste"; or		40 CFR 264.34(a)(3)
	• container may be marked with other words that identify the contents.	Accumulation of 55 gal. or less of RCRA hazardous waste at or near any point of generation — **applicable**	40 CFR 262.34(c)(1)
Use and management of hazardous waste in containers	If container is not in good condition (e.g. severe rusting, structural defects) or if it begins to leak, must transfer waste into container in good condition	Storage of RCRA hazardous waste in containers — **applicable**	40 CFR 265.171
	Use container made or lined with materials compatible with waste to be stored so that the ability of the container is not impaired		40 CFR 265.172
	Keep containers closed during storage, except to add/remove waste		40 CFR 265.173(a)
	Open, handle and store containers in a manner that will not cause containers to rupture or leak		40 CFR 265.173(b)
Waste treatment and disposal—primary wastes (excavated contaminated soils)			
Disposal of solid waste	Shall ensure that waste is disposed of at a site or facility which is permitted to receive the waste.	Generation of solid waste intended for off-site disposal — **relevant and appropriate**	15A NCAC 13B .0106(b)
Disposal of RCRA-hazardous waste in a land-based unit	May be land disposed if it meets the requirements in the table "Treatment Standards for Hazardous Waste" at 40 CFR 268.40 before land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted RCRA waste —**applicable**	40 CFR 268.40(a)

Action	Requirements	Prerequisite	Citation
Disposal of RCRA-hazardous waste in a land-based unit - Continued	Must be treated according to the alternative treatment standards of 40 CFR 268.49(c) or Must be treated according to the UTSs [specified in 40 CFR 268.48 Table UTS] applicable to the listed and/or characteristic waste contaminating the soil prior to land disposal.	Land disposal, as defined in 40 CFR 268.2, of restricted hazardous soils —**applicable**	40 CFR 268.49(b)
	Transportation of Wastes		
Transportation of hazardous waste on-site	The generator manifesting requirements of 40 CFR 262.20–262.32(b) do not apply. Generator or transporter must comply with the requirements set forth in 40 CFR 263.30 and 263.31 in the event of a discharge of hazardous waste on a private or public right-of-way.	Transportation of hazardous wastes on a public or private right-of-way within or along the border of contiguous property under the control of the same person, even if such contiguous property is divided by a public or private right-of-way — **applicable**	40 CFR 262.20(f)
Transportation of hazardous waste off-site	Must comply with the generator requirements of 40 CFR 262.20–23 for manifesting, Sect. 262.30 for packaging, Sect. 262.31 for labeling, Sect. 262.32 for marking, Sect. 262.33 for placarding, Sect. 262.40, 262.41(a) for record keeping requirements, and Sect. 262.12 to obtain EPA ID number.	Off-site transportation of RCRA-hazardous waste — **applicable**	40 CFR 262.10(h)
	Must comply with the requirements of 40 CFR 263.11–263.31. A transporter who meets all applicable requirements of 49 CFR 171–179 and the requirements of 40 CFR 263.11 and 263.31 will be deemed in compliance with 40 CFR 263.	Transportation of hazardous waste within the United States requiring a manifest — **applicable**	40 CFR 263.10(a)
Transportation of hazardous materials	Shall be subject to and must comply with all applicable provisions of the HMTA and DOT HMR at 49 CFR 171-180.	Any person who, under contract with a department or agency of the federal government, transports “in commerce,” or causes to be transported or shipped, a hazardous material **— applicable**	49 CFR 171.1(c)

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Action	Requirements	Prerequisite	Citation
	Institutional Controls for Contamination Left in Place		
Notice of Contaminated Site	Prepare and certify by professional land surveyor a survey plat which identifies contaminated areas which shall be entitled "NOTICE OF CONTAMINATED SITE". Notice shall include a legal description of the site that would be sufficient as a description in an instrument of conveyance and meet the requirements of NCGS 47-30 for maps and plans.	Contaminated site subject to current or future use restrictions included in a remedial action plan as provided in G.S. 143B-279.9(a) — **TBC**	NCGS 143B-279.10(a)
	The Survey plat shall identify: • the location and dimensions of any disposal areas and areas of potential environmental concern with respect to permanently surveyed benchmarks; • the type location, and quantity of contamination known to exist on the site; and •any use restriction on the current or future use of the site.		NCGS 143B-279.10(a)(1)-(3)
	Notice (survey plat) shall be filed in the register of deeds office in the county which the site is located in the grantor index under the name of the owner.		NCGS 143B-279.10(b) and (c)
	The deed or other instrument of transfer shall contain in the description section, in no smaller type than used in the body of the deed or instrument, a statement that the property is a contaminated site and reference by book and page to the recordation of the Notice.	Contaminated site subject to current or future use restrictions as provided in G.S. 143B-279.9(a) that is to sold, leased, conveyed or transferred — **TBC**	NCGS 143B-279.10(e)

Appendix B
Public Meeting Minutes

PUBLIC MEETING

PROPOSED REMEDIAL ACTION PLAN
OPERABLE UNIT 1 CENTRAL GROUNDWATER PLUME
MARINE CORPS AIR FORCE BASE
CHERRY POINT, NORTH CAROLINA

MAY 21, 2014
HAVELOCK TOURIST AND EVENT CENTER
201 TOURIST CENTER DRIVE
HAVELOCK, NORTH CAROLINA 28532

* *

MEETING MODERATOR - MR. WILLIAM POTTER

PRESENTER - MR. DOUG BITTERMAN

COURT REPORTER - AIMEE C. RIGSBY

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COURT REPORTER'S NOTE: The public meeting convened at 6:10 P.M. at Havelock Tourist and Event Center, Havelock, North Carolina on Wednesday, May 21, 2014.

MR. WILLIAM POTTER: Well, thank you, everyone. My name is William Potter from Marine Corps Air Station Cherry Point. I am the Installation Restoration Program Manager, as you guys all know. Many of you are pretty well versed in all this, but tonight we are going to have a meeting on the proposed plan for Operable Unit 1. And, as you know, this is one of our largest and most complex Operable Units, and we are really glad to have you guys here tonight so that we can present the plan to you guys, hopefully, get some feedback, and we'll go from there. And, if we could, just go around the room and everyone introduce themselves. Bill, if you'll start?

MR. BILL HANNAH: My name is Bill Hannah. I'm with CH2M Hill, contractor to the Navy.

MR. GEORGE LANE: I am George Lane. I am with NC DENR.

MS. ERICA DELATTRE: I am Erica DeLattre with Rhea Engineers, also a contractor.

MS. GENA TOWNSEND: Gena Townsend, EPA out of Atlanta.

MR. BRAD CALLA: Brad Calla, Rhea Engineers.

MR. BRYAN REVELL: Bryan Revell, Department of

Navy, ~~immediate program manager~~ [Remedial Program Manager] at ~~(inaudible) Power Plant~~ [NAVFAC Midlant] (inaudible).

MR. RAY SILVERTHORNE: I am Ray Silverthorne. I am just a citizen.

MR. JEFF CHRISTOPHER: Jeff Christopher. I am with the Marine Corps Air Station, Cherry Point.

MR. NEIL SCARBOROUGH: I am Neil Scarborough. I am from Havelock, here.

MR. HARRY ZINN: Harry Zinn, North Carolina Superfund.

MR. DOUG BITTERMAN: And I am Doug Bitterman with CH2M Hill, Navy contractor.

MR. WILLIAM POTTER: Okay. And, with that, we'll go ahead and get started. We're going to turn it over to Doug, and he is going to give the presentation for the proposed plan.

MR. DOUG BITTERMAN: Well, welcome, everyone. I appreciate you coming out. This -- this is for you, gentlemen. As Will said, we're going to be talking about the proposed plan for Operable Unit 1; specifically six sites within Operable Unit 1. The six sites that make a large groundwater plume beneath OU1 that we call the central groundwater plume. So, with that, I'll move into the purpose of this meeting. I'm going to basically walk you through the information that's in the ~~proposed plan~~ [Proposed Plan] document that you have there, hopefully facilitate your review of it, and, hopefully, get your feedback; any questions you might have about the remedy that's been proposed. Basically, the Proposed Plan ~~proposed plan~~ is the presentation to the public of the preferred remedy that the Cherry Point partnering team has come up with for the six sites in Operable Unit 1. So I'm going to walk through background information about OU1. I will summarize briefly the investigations that went on there. We have done a number of pilot studies, as you'll see, testing different remedial technologies to see if they work at Cherry Point. I'll talk about the Feasibility Study, which is when we developed remedial alternatives and evaluated whether they are appropriate for Operable Unit 1. And then I'll present the rationale for the alternative that we've come up with -- that we propose for -- for these sites. The public comment period is underway. I don't know, Neil or Ray, did you all see in the newspaper any of the advertisements posting -- good. It was posted in several area newspapers. And it's a 45-day public comment period. It started May 9th, and extends until the 23rd of June. So tonight is an opportunity for you all to provide comments. There is also a comment form in the Proposed Plan ~~proposed plan~~ document that you could submit later if you think of a question ~~an application~~ that you don't think of tonight.

I really want this to be informal. So, please, interrupt me at any time with a question or a comment. If I have a tendency to state acronyms without explaining them, please call me on that. I'll try to spell them out. Or if I use technical jargon that you don't understand, just -- just ask at that time. The one caveat, though, is if you do have a question, if you could just state your name for the stenographer so that she can know who the speaker was for the public record.

Okay. The -- the regulation, basically, that oversees all the work that we do at Cherry Point including up at OU1 is called the Comprehensive Environmental Response, Compensation, and Liability Act of 1980. We call it CERCLA. It's also commonly known as the ~~superfund~~ Superfund program. And these boxes represent the different steps of that process. So I'll quickly walk you through it. It starts with the ~~preliminary~~ Preliminary ~~assessment~~ Assessment and ~~site inspection~~ Site Inspection stage. That's the stage where you are trying to determine if a release has occurred at a site. The ~~preliminary assessment~~ Preliminary Assessment is a desktop kind of study looking at historical records and whatnot to see if a release has occurred. If there does appear to have been a release or a chance of a release, you do a ~~site inspection~~ Site Inspection, which usually involves some sampling to see if there has been a release. If that step leads to evidence that there has been a release, you move on to the next stage, which is a Remedial Investigation/Feasibility Study, or we call it RI/FS. And the

Remedial Investigation is the full blown, comprehensive investigation of the environmental media at a site. We -- we try to define vertically and horizontally the extent of contamination. We assess human health and ecological risk. And basically we gather all the information that you need in order to make a -- a remedial decision about the site. The next phase is the ~~feasibility study~~ Feasibility Study. That's when you take the information you learned from the ~~remedial investigation~~ Remedial Investigation and develop alternative technologies, look at the available technologies, craft them into specific remedial actions that could happen at your site, and then evaluate them to see which -- what the trade offs are and which ones might work better than others at your site. After that, you move onto the ~~proposed plan~~ Proposed Plan stage, which is where we're at now with these sites at Operable Unit 1. And that's when you -- you pick a remedial alternative that you believe is the best one and you present it to the public. And that's what this ~~proposed plan~~ Proposed Plan does, and that's what this public meeting is about. After that, assuming the public -- public comments are taken into consideration and it's possible that the public comments may result in a change to this selected alternative, all of that is factored into the next stage which is the ~~record~~ Record of ~~decision~~ Decision. Which is the documentation of the final selection of a remedial action, taking into account public comments. And then, after that, you actually get into implementing the remedial action. There is a Remedial Design, RD. And then after -- after the design, you implement the remedial action. So you may look at this and think that we're only halfway through in terms of the boxes, but we are actually 98 percent of the way through. I don't know what percent, but we are really -- this -- this phase right here was about 20 years. This -- this site -- these sites are so complicated and the issues are so complex that it took many phases of investigation and decades of work to get to this point. So we are very excited to be here. We are kind of in the home stretch. So we are hoping that we are at this -- starting this phase within a year from now, if not even shorter. Does anyone have any questions about the regulation, and where we're at, and just the process? Does that make sense?

Okay. I wanted to point out several reference documents that are out there in the public record for Operable Unit 1. If you have an interest in seeing some of the documents that we use to come up with these proposed remedies for Operable Unit 1, these are kind of the three documents that are probably your best bet to look at. There is actually probably hundreds of documents that we prepared, but these are the ones that kind of roll up a lot of the information into one place, if you will. There is a 2002 Remedial Investigation report. That was followed on in 2009 with an addendum report that really rolls out all the investigations that had occurred by that time. And then in 2011 we published a Feasibility Study, which was the evaluation of the remedial alternatives. All of the documents for Operable Unit 1, including these three, and all the other ones are available through the Cherry Point administrative record, which you can get to through that URL from home. If you don't have a computer, internet access at home, you can go to the Havelock Public Library where there is, I believe, a dedicated work station that's prioritized for use to access the administrative record for Cherry Point. That URL is in the printed hard copies that you have, so you can just check there instead of trying to jot it down.

This is basically an outline of what's in the ~~proposed plan~~ Proposed Plan. It starts off with background information and it goes back through summaries of the investigations that have happened; describes the site and the characteristics of the site; the geology, the contamination that we found through our investigations. It goes through a summary of the risks that we found; human health and ecological risks. It presents the remedial active objective -- remedial action objectives, which are the team's goals for the remedial action with what they hope to achieve. There is a summary of the ~~feasibility study~~ Feasibility Study evaluation of the remedial technologies. And then it presents the preferred alternative and the rationale for that alternative. And it also explains the community participation process, which I touched on earlier, public comment period that we're in the middle of. There is also a several page long glossary of terms. So if any of the terminology in the document is not understandable, you can look in that glossary for a definition of some of the terms.

So, with that, I'll get into the meat of this. This shows a close up of the flight line areas of the air station. And Operable Unit 1 is the largest Operable Unit, or group of sites, at Cherry Point. And it's about 565 acres. And it basically covers most of the industrial part of the air station. As you can imagine, industrial activities are what often result in contamination. So it is the most complex as well as the largest site that we have had to tackle as a team here at Cherry Point.

There are 12 sites that make up Operable Unit 1. Five of those sites have already been closed with no further action within the last several years. There was another site that we are addressing separately, site 16. And then the remaining six sites are the ones we are here to talk about tonight. They are the ones that make up the Central Groundwater Plume, which I will explain in more detail later. I am just going to briefly touch on the different sites. Site 42 is the industrial wastewater treatment plant at

Cherry Point, which is located here. There happens to be groundwater contamination in that vicinity. Site 47 is basically the sewer line -- the industrial sewer lines that -- that go through Operable Unit 1. They are shown in brown here. They connect the different buildings to the industrial wastewater treatment plant. Sites 51 and 52 are former plating shops within some of the major buildings in Operable Unit 1. And then sites 92 and 98 are just areas where -- where we noticed groundwater contamination in the vicinity of a building. We don't really have any specific process or activity at the building that we know caused it. It's just that it's in the vicinity of that building. The other features I wanted to point out with regard to Operable Unit 1 are the surface water bodies. Over to the right -- I don't want to walk in front of the screen, but all the way down at the left end there, which is the southwest corner, is East Prong Slocum Creek. If I could back up a slide, this is East Prong Slocum Creek here. It flows downstream to Slocum Creek, which is the larger water body there. And then just off from that, to the north, Slocum Creek enters the Neuse River. I am sure you are all familiar with that. Another one is Sandy Branch, which is on the top left there, which is a small tributary of East Prong Slocum Creek, and it has a couple of tributaries which were imaginatively named Tributaries One and Two.

The other really significant feature of Operable Unit 1 is that it includes Fleet Readiness Center East. I'm sure you are familiar with that institution. It used to be called the Naval Aviation ~~Depo~~ Depot, or ~~NADA~~ NADEP, and it is basically a very large aircraft maintenance and repair facility. And essentially all of these six sites are related to FRCE. And the central groundwater plume originates from industrial activities within FRC East. And that's kind of a cool picture. The fading sun seems to be illuminating the -- just FRCE like it was meant to highlight it. Jeff or Will, correct me if I'm wrong, but I believe this is building 133 here; is that correct? And this is 137?

MR. JEFF CHRISTOPHER: No, 133 where your -- where your finger was.

MR. DOUG BITTERMAN: This?

MR. JEFF CHRISTOPHER: No, up -- up there.

MR. BILL HANNAH: The next one.

MR. DOUG BITTERMAN: That one?

MR. BILL HANNAH: That one. 137 is that one.

MR. JEFF CHRISTOPHER: Is the hanger.

MR. DOUG BITTERMAN: Okay. We'll be talking -- these -- these two will figure in prominently in our discussion later on, buildings 133 and 137. That's where most of the aircraft repair activities take place within FRC East.

There has been quite a bit of environmental investigations at Operable Unit 1. Basically, it began in 1983. So there has been 25 years, more or less, of investigations, and virtually every environmental medium has been sampled at -- at Operable Unit 1. Soil, the groundwater, surface water, sediment, fish tissue; and also, because of the nature of the contamination, which I'll talk abut in a minute, we had to look at soil vapor. The contaminants volatilize into the air in the unsaturated zone and can migrate upwards towards the surface. So we also collected soil vapor and indoor air samples to evaluate that. So throughout all these investigation activities, we evaluated the nature and extent of contamination, and we also assessed human health risks and -- and ecological risks associated with the contamination.

The contaminants that we have in this groundwater plume are known as chlorinated volatile organic compounds or chlorinated VOCs. Volatile organic compounds are called that because their dominant physical property, if you will, is the tendency to want to evaporate or volatilize, as opposed to dissolving in water or adhering to organic matter. They have high vapor pressure. They want to volatilize and they are only weakly soluble. And chlorinated just means that there is chlor -- one or more chlorine atoms on each molecule. And, unfortunately, the chlorine adds toxicity to the compounds. And chlorinated VOCs are generally powerful solvents. That's why they are commonly used in industrial activities. They are excellent degreasers and they are very commonly used historically at places where industrial activities are taking place. Well through the -- early on in the history of Operable Unit 1, there was an Interim Remedial Action to try to address some of the contamination in groundwater. And it led to what's called an Interim Record of Decision. When I was going through the process before, I said one of the last steps was the Record of Decision. Well, we actually did an Interim Record of Decision to implement this preemptive -- preemptive, if you will, remedy back in 1996. And it was a groundwater extraction and treatment system. We often called them "pump-and-treat" systems where you pump contaminated groundwater out, treat it, and then discharge it into a stream of treated groundwater. This "pump-and-treat" system was installed in the late '90s and operated from 1998 to 2005. By 2005 the team realized that the system was not particularly effective in remediating the plume at Operable Unit 1. It was very expensive to operate. We had -- we were trying to do an investigation at that time. And, when you pump groundwater, you influence the water table and change groundwater flow directions, and that was interfering with our ability to understand how contamination had migrated to where it had. So it was making our life difficult in terms of our investigation. So for all of those reasons, the system was shut down in 2005. So that was the earliest remedial action.

MR. NEIL SCARBOROUGH: Is this a procedure where they pump the water up in the -- in the environment and then blew a fan across it so it would treat some of the compounds or --

MR. DOUG BITTERMAN: It's -- it's sort of like that. There is an air stripper is the -- is one of the -- Erica might be able to answer the full treatment train~~ing~~. But there was a treatment system installed at the industrial wastewater treatment plant specifically to deal with the groundwater. And it did include air stripping, which in this case is a tower with these little balls that are just sort of like wire balls that create a lot of surface area. And the air blows up through it, and the water is sprayed into that tower, so you get maximum contact with the air, and that strips all of the volatiles out of the water. But I believe there were other treatment technologies, too.

MS. ERICA DELATTRE: Yeah.

MR. DOUG BITTERMAN: Carbon filtration and so forth. So there was a whole treatment process there.

MR. NEIL SCARBOROUGH: A whole family.

MR. DOUG BITTERMAN: Yeah, at the --

MS. ERICA DELATTRE: Yeah.

MR. DOUG BITTERMAN: I think it actually went through the industrial wastewater treatment plant's process.

MS. ERICA DELATTRE: Yeah. When it was discharged from the initial treatment, then it went to the IWTP to be processed. And then the wastewater treatment plant from the base.

MR. DOUG BITTERMAN: Right. Just the sanitary wastewater treatment plant --

MS. ERICA DELATTRE: Yeah.

MR. DOUG BITTERMAN: -- as well. So it went through a lot of treatment.

MS. ERICA DELATTRE: But the carbon stripped a lot of it out as well.

MR. DOUG BITTERMAN: So that was the -- the first remedial action to ~~adjust~~ address this plume, and it only had so-so effect in this. I -- I mentioned that the FRC East was really the -- the story behind the releases. The -- the plume originates from Fleet Readiness Center East, and the plume exists in what we call the surficial aquifer, which is the uppermost groundwater zone at the air station. I'll have a picture to show that. The main ~~contaminate~~ contaminant of concern is ~~Trichloroethane~~ trichloroethene, or TCE, which is probably the most common of these chlorinated solvents that I mentioned before, used all over the place; and it was at FRC East. And beneath building 133, one of those major aircraft repair facilities, that is sort of ground zero, if you will, for this plume. There is -- the highest concentrations that we found in groundwater are beneath part of that building. And some of the concentrations are high enough that we believe that TCE may even exist as free product TCE. The TCE itself ~~is~~ has soaked into the ground and there is enough of it to migrate down into the soil beneath the -- the building. We call that dense non-aqueous phase liquid, or DNAPL, which is that free phased TCE. And the significance of that is that because it's a weakly soluble compound, when it -- it's heavier than water. So when it encounters groundwater, it keeps sinking until it encounters a fine, geologic zone that impedes its progress basically. And groundwater passing through that TCE, that free product TCE, can -- it can -- it can have a long life of creating dissolved phase TCE because it doesn't dissolve very readily. So very slowly, over decades, it can be an ongoing source of TCE. So that's the -- the main area beneath building 133. There is also two other, smaller, less high concentration areas where we found -- where it appears part of the plume originate; site 42, the industrial wastewater treatment plant, and then building 37, that other large building appears to be a source. But both of those other two are relatively small and -- and lower concentration areas compared to the building 133 source. The plume then, from this heart of FRCE, basically extends about 3,000 feet downgradient to the southwest towards East Prong Slocum Creek. We have -- through our investigations, we tracked it that far now.

MR. NEIL SCARBOROUGH: That's from the point 133 then?

MR. DOUG BITTERMAN: From -- from building 133.

MR. NEIL SCARBOROUGH: How -- how deep does it go?

MR. DOUG BITTERMAN: I will explain that in a second. It goes to the -- to the bottom of the surficial aquifer, and I am going to use this picture here. This is basically a block of the earth beneath Operable Unit 1, and it kind of shows you a cross section of what the -- the geology looks like underneath. And I mentioned the surficial aquifer, which is this uppermost zone. Basically beneath most of Cherry Point and most of the Coastal Plain of North Carolina, it's like a layer cake. There are intermittent layers of sandy material that is very transmissive to groundwater, and those are called aquifers. They can be water supplies. And, in between them, are clay layers which are very -- are relatively impermeable to water movement, and they are called confining units. And there is actually alternating layers. It goes deeper than what is shown here, but these are the top three aquifers; the surficial aquifer, the Yorktown aquifer, and the ~~Pongo~~ Pungo River aquifer.

Fortunately, these confining units make it difficult for groundwater to migrate downwards, so they stop the contamination from migrating down in the deeper aquifer. So it doesn't extend below the bottom of the surficial aquifer, which is about 50, maybe 55 feet at the deepest, below the ground surface. So relatively shallow is the answer to your question about the contamination. So I explained the geology here. Ignore the left-hand side for the moment. What -- what we have here with sort of these rainbow colors is the plume of contamination. The red and the orange are the greater concentrations, and yellow and green are increasingly lower concentrations. So you can see here in the red area, directly beneath building 133, this is where we think that DNAPL TCE may exist. Fortunately, there is occasional fine grain lenses within the aquifers and we -- we seem to have a fortuitously placed one in that area because the DNAPL -- the very high concentrations, are relatively low or shallow depth beneath building 133. More like the top 25 and 30 feet. The plume then moves -- moves down gradient. And, as it does, the plume spreads out and -- and that spreading out causes the concentrations to decline through dilution. The plume also degrades. I'll talk more about that later. But natural bacteria occurring in the ground actually can consume these organic compounds, and that helps to bring the concentration down. So as it migrates the 3,000 feet down towards the stream, the concentrations decline as you can see the way we depicted it with the colors. Now an interesting development here with this cut, and you see a different color geology. I said that most of the Coastal Plain and most of Cherry Point looks like a layer cake. Well, the United States Geological Survey discovered an interesting thing about the southwestern part of Operable Unit 1. What -- what has happened is that probably the Neuse River -- rivers actually migrate over -- over time, over millions of years. Well, a river of some sort, either the Neuse or a former river in the area, basically migrated and eroded away the existing sediments that had been laid down earlier and deposited new, younger sediments. In this case, instead of being a nice layer cake, it's just sort of a hodgepodge of sand, and clays in -- in, you know, no real regular formation. So here where we have the layer cake, these confining units tend to create pressure in the aquifers. There is a -- there is a downward gradient consistently throughout this whole area, meaning that vertically the groundwater tends to go down. In this paleo channel, which is what we call this area where the erosion occurred and the redeposition, there are no confining units. The general direction of groundwater flow is upward in that area. So you can sort of see the way we depicted it, the plume tends to sink. And then, when it gets to the paleo channel area, it rises back up towards the stream; the East

Prong Slocum Creek. Anything else I'm missing about this picture, Bill, that you can think of?

MR. BILL HANNAH: Just pretty much the pressure from the Yorktown aquifer. It's under pressure of the confining units. And then, as it gets into the paleo channel, that pressure gets released and all of that aquifer water wants to discharge towards the surface water body. That's why you get that upward pressure gradient.

MR. WILLIAM POTTER: And that's working in our favor because we don't have contamination getting into those lower aquifers.

MR. BILL HANNAH: Right.

MR. WILLIAM POTTER: We got very lucky with that.

MR. DOUG BITTERMAN: And, by the way, drinking water at Cherry Point is actually from an aquifer even deeper than what is shown here.

MR. BILL HANNAH: Castle Hayne.

MR. DOUG BITTERMAN: So there are several -- yeah. The ~~Pongo~~ Pungo River, there is a confining unit below that; and then the next one is the Castle Hayne. Most of the drinking water wells are in the Castle Hayne aquifer. So there is three confining units protecting them, if you will, from any contamination. But we haven't found any significant contamination in any aquifer other than the very topmost surficial one. So that's good. Any questions about the geology or the -- I know it's a lot of information.

Here is another view of the plume just looking down at it. We have drawn contours. We used the same color scheme. The reds and the orange are the higher concentrations and the yellow and the green represent lower concentrations. We actually -- even though the surficial aquifer is only one aquifer, we divided it up in -- in looking at the contamination because it is thick enough that we see differences in where contamination is located at the top of the aquifer versus the bottom of the aquifer. So we -- if you read the documents, it will refer to an upper surficial aquifer and a lower surficial aquifer. The upper just means the top half of the same aquifer and the lower means the bottom half. But you can see when you -- when you look at the data from wells screened in those different parts, you see different distribution of contamination. In the shallow area you see really high concentrations right beneath building 133. And then, downgradient, you see contamination, but it doesn't really reach all the way to the stream -- to East Prong Slocum Creek. Here you can see, in the lower part of the aquifer, this is building 133 here. So, as it moves downgradient, it actually sinks. So this is how we figured out in that other drawing that -- that the plume sinks down in the bottom of the aquifer. And here you can see it reaches all the way down to East Prong Slocum Creek; but then, in the upper left, you can see that little island of contamination. That shows the -- the plume coming back up to -- to the stream. Does that make sense?

MR. NEIL SCARBOROUGH: It makes sense.

MR. DOUG BITTERMAN: It's kind of interesting. All right. Another important thing that I am going to talk about is the degradation of these chlorinated solvents in the groundwater. We have investigated natural attenuation, which is what we call it when you allow the groundwater to just be degraded by nature. And we found that it is happening at Cherry Point. And the biggest process is biodegradation. The bottom is a -- is a chart that shows what a -- at the left is a TCE molecule. It's trichloroethene ~~Trichloroethane~~, so it has three chlorine atoms on the molecule. That's the Cls on the -- on the molecule. As bacteria consume these chemicals, there is a sequential removal of the chlorine atom from the molecule. So at each step it becomes a different compound. So trichloroethene ~~Trichloroethane~~ is the original chemical with three chlorines. As the bacteria work on the -- on the TCE, one of the chlorine atoms is stripped off and it becomes 1,2-DCE, dichlorethene, which di means two. That has two chlorine atoms. And then it continues on to only one chlorine atom, which is vinyl chloride. And then, when the final chlorine is removed, it becomes ethene ~~ethane~~, which is -- when all the chlorines are gone, it's a harmless, non-toxic compound that has no negative effects. Each of the three with chlorine atoms have varying degrees of toxicity. And, through our investigations, we find all of these different chemicals. And that provides evidence that the TCE is breaking down naturally with the bacteria that are present in the groundwater. So we see these other -- we could draw a plume -- those plume maps I showed you with the ~~Trichloroethane~~ trichloroethene, but we could also have drawn similar plume maps for ~~2,3~~ 1,2-DCE and vinyl chloride. And, in general, they would be smaller than the TCE, but they would be similar. And then there is a smattering of other volatile organics, as well, but these are the main drivers.

We looked at risk, both human health risk and ecological risk. And -- so this distills down into one slide a lot -- a lot of work. Basically, for ecological risk, there -- there is no ecological risk related to this plume. In general, groundwater -- the only ecological risk is when the groundwater discharges to surface water bodies. They can -- it can contaminate the sediments and the surface water itself which fish and other organisms come into contact with. We evaluated that and there is no ecological risk associated with the plume. Human health, on the other hand, there is some risk with regard to groundwater but I want to just rattle off the ones that, you know, the media for which there are no risk. There is no risks of contaminants in soil within these sites. Groundwater in other aquifers, deeper ones like the Yorktown, there is no risk there -- surface water, sediment, or from vapor intrusion. With regard to vapor intrusion, the caveat is the existing buildings and existing conditions at Operable Unit 1 today. There is no risk with where the buildings are located. There is, however, risks associated with 13 different volatile organics in the plume if that aquifer were to be used for potable drinking water supplies; it would represent risk. It is not being used for potable drinking water, but, theoretically, there would be if it was used in that way. We can't rule it out, it's probably unlikely, but if someone were to build a new building somewhere over the plume or modify an existing building, it's possible that that action could result in risk from vapor intrusion to the occupants of that building. So we had to keep that risk in mind when fashioning a remedy for the site.

So this table summarizes all of our contaminants of concern; the 13 volatile organics that I mentioned. And you can see on the right the -- the numbers here are the remedial goal. And for almost all of them, it's the North Carolina sub-chapter 2L groundwater quality standard is the number. For a couple of them it's the Federal maximum contaminant level. And you can kind of get an idea of how toxic or potentially carcinogenic a compound is based on the number. The lower the number, the more potentially toxic or carcinogenic it is. So these are the compounds we are trying to address.

Over the years we have done quite a number of pilot studies within the central groundwater plume to test different technologies to see if they would work within -- in the plume. The earliest one was back in 1998 down near East Prong Slocum Creek where the -- where the plume is rising up to join and discharge into the stream. Obviously, that was a concern of the teams, so one of the earliest pilot tests was to come up with a technology to prevent groundwater from discharging to the stream with -- with contaminants in it that might cause a problem. And they installed what's called an Air Sparge/Soil Vapor Extraction System. The Air Sparge part is basically injecting air into the ground beneath the contamination, and -- and the air bubbles up through. And, since the volatile organics would rather be in the air than in the water, they tend to go into the air and then rise up with the bubbles. And then the Soil Vapor Extraction is like a vacuum, if you will. Sticking a well point into the unsaturated zone and sucking that air out to capture it so it doesn't just go into the atmosphere. So this shows some of the components. I think this is one of the blowers, is that right? Right here, for the Air Sparge system. It operated for about seven years. By about 2005 it was not -- similar to that "pump-and-treat" system I mentioned earlier, it was not operating particularly well. It was very costly. There were a whole sort of operational problems with water getting into the Soil Vapor Extraction well points. And it really just wasn't doing what it was designed to do any more. It was ineffective at -- at treating the plume that was passing through there. So in 2005, we shut the system down because it wasn't achieving its remedial goals.

MR. NEIL SCARBOROUGH: Did it work to a certain level? In other words, did it remove some of the --

MR. DOUG BITTERMAN: It did at first, but it became less effective over time. One of the things that happens with Air Sparge systems is channels form, preferential pathways. So instead of the air catch -- capturing the whole plume, it goes through familiar pathways that are established so groundwater is able to get through it and not be treated as effectively as it was initially. Does that make sense?

MR. NEIL SCARBOROUGH: Yes.

MR. DOUG BITTERMAN: So that's one of the phenomenon -- phenomenon that happened. And then, also, it was becoming a maintenance nightmare.

MR. NEIL SCARBOROUGH: Yeah.

MR. DOUG BITTERMAN: Breakdowns. It's a very maintenance-intensive system. Another kind of treatability study that we've done a number of involves injecting -- I told you that there is natural bacteria that want to break down the contaminants. Well, one strategy is to enhance that process. So there were several treatability studies to try to enhance that natural biodegradation by injecting a substrate down into the groundwater that would create conditions that are more ideal than naturally occurring to enhance that biodegradation process. And in the early 2000's we did a couple of those. The first one was 2001. We used a compound called Hydrogen Release Compound, or HRCE -- HRC, excuse me. Beneath building 137 there is a small plume area there. So we injected that. In 2005, we did a similar study with a different substrate -- proprietary one called EHC. But, in general, they are designed to create more ideal conditions than naturally exist to rev up this biodegradation to make it speed up and be more effective.

MR. NEIL SCARBOROUGH: In other words, breed more bugs down there.

MR. DOUG BITTERMAN: Right. Make them reproduce and -- and create the conditions that they need in order to metabolize all that contamination. They worked. One of the things that we learned, though, is that, you know, we were only injecting them in a very isolated area. The technology worked in that little area, but it was clear that in order to address the larger plume, you would need to scale up what we were doing. And, you know, a much more extensive system would be needed. But they were -- they did show that the technology worked.

More recently we have done another similar pilot study. This one was -- the way the injection points were laid out was meant to form a barrier, if you will. So they were in an alignment. The objective there is to sort of create a zone. And, as groundwater passes through that barrier, it gets -- it goes through the -- an area where those conditions are ideal and gets treated. So way over to the right there, that little black box shows you one of the more highly concentrated areas of the plume. We found an area to test this biobarrier concept. This happened in 2011 to 2013. And here we -- we had a product called SRS which is based on emulsified vegetable oil, which is one of the compounds that has been shown to have in its ingredients what these bacteria need to metabolize TCE and other compounds. We also did what's called bioaugmentation, which basically means injecting more bacteria. Scientists have figured out the bacteria that are ideal for this, so we actually injected some of them into the ground to help boost the natural population of those bacteria and it was a product called TSI DC. There are companies out there that develop these bacteria. And here you can see some of the equipment that was used in the -- in the pilot studies. Quite a -- quite an involved process, the injection of the substrate.

So it -- it worked really well. This -- this slide is meant to show you some of the results of this barrier -- biobarrier pilot study. Our goal was to see whether this would be potential technology we could use to treat the plume. What we found is we achieved up to 96 -- 96 percent TCE reduction through this technology. Here are a couple of graphs of different compounds at specific wells. TCE is in orange here. You can see that early on, it was close to 500 micrograms per liter and, once we started injecting, it dropped down to almost 0 and stayed -- stayed low. Some of them there was an initial drop, but a tendency over -- as years go by for the concentrations to rise up just because groundwater, you know, tends to move and the substrate doesn't last forever when we inject it into the ground. But we did prove that the technology works. We also learned a lot that would enable us to use this technology if we were going to develop a full scale system. We learned some things that you would need to consider to -- to do it. One was what the ideal pH; you know, the acidity of the groundwater. We found some potential impacts from changes in pH, so we may -- may have learned to be able to manipulate that. We also learned about when we inject, what the radius of influence is of -- of the treatment zone around a well. So we learned some valuable information. The bottom line is the technology is a suitable remedy to apply at Operable Unit 1. Any questions about that?

The other major pilot study that we have done recently was to install what's called a Permeable Reactive Barrier. This pilot study was not in the source zone of the plume. It was down near Slocum Creek where that Air Sparge system operated that I mentioned that -- that was taken out of service. The team has obviously been concerned about groundwater discharge to those water bodies with contamination. So we tried a different technology. A Permeable Reactive Barrier has the same objective as that Air Sparge system, but it works completely differently. This giant trenching device is the tool that we use to install the barrier. And this is a -- a drawing that shows how it works. Basically, what it does is it -- it cuts and trenches through the earth and places a thin layer of a material, in this case Zero Valent Iron mixed with sand, to form sort of a thin layer in the earth. And this red line shows the approximately 600-foot long alignment through which we installed this barrier. It -- groundwater is able to pass through it, so the word barrier is misleading. It's a barrier to the contamination. The groundwater freely passes through it. And the Zero Valent Iron completely oxidizes the TCE and the other chlorinated compounds to harmless constituents very, very effectively. It's a chemical process; it's not a biological process. It's a chemical process. So we installed this in 2012 and 2013. This pilot study is ongoing. It's a 600-foot long barrier. It basically covers the width of the plume down in that area. It's 35 feet deep, which we determined was the proper -- the appropriate depth that it needed to be at, and it's about two feet wide. And the barrier itself is a mixture of the Zero Valent Iron and sand. Before we went out there and installed this, we did a lot of testing and thinking to make sure we designed it properly. There were some bench laboratory -- bench scale laboratory work to figure out how much Zero Valent Iron you would need in the barrier and how thick it would need to be. In other words, what the residence time for groundwater passing through would need to be to treat all of the contamination. So we figured out all that -- all that out, and that led to designing the thickness of the barrier as well as the percentage of Zero Valent Iron that was in place there. And then during -- during the placement, we did a lot of testing to make sure that the -- the sand mixture that they were putting down had the designed specification for the concentration of Zero Valent Iron.

This -- these two pictures here show the mixing of the sand. These squarish, cube-shaped bags are Zero Valent Iron, and they are very heavy. And this is a giant mixer.

So they put the iron in and then dump some sand in. And this thing churned like a giant dryer and mixed the sand and the Zero Valent Iron together.

And then this picture here shows the -- the tool in action. That giant blade is now vertical in the earth. You can see that the trailing edge -- the thing basically backs up as it -- as it works and there is almost like a chainsaw blade cutting through the earth, and then the trailing edge is an open slot. So the Zero Valent Iron sand mixture is dumped down in there. And so as it -- as it moves, it leaves behind a layer of that sand and Zero Valent Iron. The left-hand picture shows the site after we restored it after the placement. So kind of a neat thing about the PRB is that it's a very low maintenance. Once you install it, you basically just let it -- let it do its thing. There is no -- no maintenance. It lasts about 20 plus years. So it's a very green, sustainable kind of remedy that lasts for a long time and requires virtually no maintenance.

MR. RAY SILVERTHORNE: Doug, do you remember the grain size that was --

MR. DOUG BITTERMAN: Yeah. I think I forgot to mention that. We had to test the grain size because if the -- if the barrier was less permeable than the natural formation, then groundwater would be impeded moving through it, and that would be a big problem. So we -- I don't remember what the grain size analysis --

MR. BILL HANNAH: It's a course sand.

MR. DOUG BITTERMAN: Yeah. So what we had placed was more permeable than the native formation so that groundwater would readily pass through the PRB without being impeded. But that was one of the tests that we had to do.

MR. BILL HANNAH: But not too large so that the water just flows past and doesn't interact with the iron as well.

MR. DOUG BITTERMAN: Right.

MR. NEIL SCARBOROUGH: In other words, you had to find the right sand to put in there.

MR. DOUG BITTERMAN: Right. The right grain size sand.

MR. BILL HANNAH: That's what a lot of that bench ~~steel~~ scale testing was designed for that he mentioned earlier.

MR. NEIL SCARBOROUGH: What happened to the dirt to come out of that trench?

MR. BILL HANNAH: That's a good -- we actually used that dirt to help restore some other sites within OU1. It's called site 83. There's a -- there's a slope.

MR. WILLIAM POTTER: Yeah. So we actually got to reuse it for another project, as opposed to having to pay to truck it off somewhere else and dispose of it. We were able to use it as a soil stabilization effort.

MR. DOUG BITTERMAN: Yeah, a different site that had severe erosion problems needed a lot of dirt to stabilize the -- you know, too -- slopes were too steep and they were eroding. So it was able to be reused. So that was --

MR. NEIL SCARBOROUGH: Recycled.

MS. ERICA DELATTRE: Yes. And it should be noted that site was within OU1 as well. So it wasn't taken really off site. It was within Operable Unit 1, yeah.

MR. DOUG BITTERMAN: Very close, actually. Just slightly off this picture, actually. This slide is just meant to show you that we -- we have done performance monitoring since we placed the PRB, and it is working very effectively. This shows you the results of a well upgradient. Groundwater flow is in this direction. This well at the top is upgradient, so the untreated groundwater is approaching the -- the PRB. And then we have a well just downgradient, which is the bottom graph. The first data point is before the PRB was installed. You can see that the well is upgradient. There is no impact. This groundwater is not treated by the PRB. It's -- it's just doing its thing maintaining a relatively steady concentration. Downgradient you can see that the very first sampling point after installation, the contamination went to zero from I think -- I think the blue is cis-1,2-DCE. It was in the teens of micrograms per liter. But all the constituents went from what they were to zero and stayed that way since that time. So it works very effectively.

That one well is 100 percent. Not -- not all the wells achieved 100 percent, but part of the issue is that when we installed the PRB, there was already existing groundwater contamination on both sides of it. So some of our wells still show -- showed early on the contamination that pre-existed the PRB. So it -- it will take some years because groundwater moves very slowly in Operable Unit 1, for all of the pre-PRB groundwater to move away. And over time we are seeing that. That it's moving away. What we found early on in the first year or so after the installation is we had up to a 94 percent reduction and 54 -- 54 percent total VOC reduction. And we expect -- and we have been seeing it. We just got some data back very recently that shows an improvement over this, actually. We didn't have time to update the slides. We also saw that the -- the length of the PRB is able to treat the entire width of the plume that's passing through. We don't -- we're not seeing contamination beyond the width of it. And, bottom line, it -- it has proved to be a suitable remedy for -- for this site.

MR. NEIL SCARBOROUGH: Did they do any cost analysis based on, I guess, dollar per effectiveness or something like that that --

MR. DOUG BITTERMAN: I'm not sure we have it in those exact terms, but in a few slides I am going to talk about costs for all the different alternatives that we looked at, so you'll get an idea. Do you know what the total cost out was on that specific PRB, roughly?

MR. ~~JEFF~~ BILL HANNAH: Off the top of my head, it was about one and a half million or two.

MR. BRYAN REVELL: That sounds right.

MR. DOUG BITTERMAN: It's somewhere in there. Less than two, more than one million dollars to install that 600 foot. But it's a one time --

MR. NEIL SCARBOROUGH: Yeah, that's one of those things --

MR. DOUG BITTERMAN: -- laying and there is no operation and maintenance costs.

MR. NEIL SCARBOROUGH: Yeah.

MR. DOUG BITTERMAN: Some of the other technologies have a small --

MR. NEIL SCARBOROUGH: My question is it costs me a dollar per cost per unit of effectiveness, so to speak. You know, like you've got 10 percent now, and you use this method, and now you've got 5 percent or something like that.

MR. DOUG BITTERMAN: Yeah. It's easier to do that when you're talking about a technology where there's a specific volume of water being treated like a "pump-and-treat" system because you know how many gallons of water you are treating --

MR. NEIL SCARBOROUGH: Right.

MR. DOUG BITTERMAN: -- and you know what the concentrations are, and you can say that for every pound of treatment it costs me X dollars to treat it. It's a lot harder because we -- we can't really quantify where precisely the volume of groundwater passing through the PRB. We could make an estimate out of it -- at it, but we haven't done it in those specific terms, per unit --

MR. NEIL SCARBOROUGH: That's okay.

MR. DOUG BITTERMAN: -- of treated compound. We just haven't done it that way. Okay. The next couple of slides are about the Feasibility Study. Which was, as I said earlier, it's the evaluation of the technologies. The basis of the Feasibility Study was that we have these chlorinated solvents and concentrations that exceed regulatory standards. And if the aquifer was a potential groundwater source, that would represent a human health risk. And then, again, our concern about downgradient surface water bodies being potentially impacted by the plume migrating downgradient. So our purpose was to develop remedial alternatives and evaluate them, and come up with viable alternatives that would mitigate this -- this issue.

So the team came up with what we call Remedial Action

Objectives, or RAOs. And these are kind of a paraphrasing of the exact wording, but you get the gist of it. The first Remedial Action Objective was to restore groundwater quality to below the regulatory standards at -- at Operable Unit 1. The second objective was -- this first one is obviously going to take a little bit of time. During that time, prevent human exposure to groundwater that exceeds regulatory standards so there wouldn't be any human health impacts. The third one, prevent the migration and discharge of that contamination into those downgradient surface water bodies above levels that would impact them negatively. And then the final RAO had to do with indoor air. I mentioned before that we were concerned about the volatilization coming up through cracks in the foundation of the building and potentially impacting workers inside. So our last objective is to prevent human exposure to inhalation risks from these potential vapors coming up through the ground. Any questions about that? Because that's really the basis for what we were trying to achieve with these Remedial Action -- or these remedial alternatives.

One problem that we had right from the get-go was the fact that the high -- highest area of contamination was directly beneath building 133. It created a big problem for us. I said that building 133 was at ground zero for the -- for the plume. It's very difficult to implement remedial technology beneath a -- a building that's being actively used. And what you see here is just some of the sub-surface utilities that are around building 133. It's like a mine field of electrical, and water, and sewer, and all different utilities. If you have ever been inside building 133, it's very tight. It's a -- it's a tall ceilinged building, but in much of it, there is actually two levels. There is, like, a mezzanine level. So there is these very low ceilings in -- in many parts of it. It's densely packed with equipment. Very -- very hard to maneuver any kind of equipment to institute a technology inside there. It's also mission critical to the -- to the Navy. Extremely vital. They are repairing helicopters and other aircraft in there in shifts 24 hours a day, seven days a week, all year round. So it is very difficult to implement technology without interrupting their work. And then I mentioned before about vapor intrusion. Well, some of these remedial technologies and the process of treating the groundwater actually can create -- enhance conditions for vapor intrusion from the contaminants or even other things like methane that are -- can be generated during the process. So we realize that if we -- even if we tried to engineer a treatment to get around all the active workers, there was a great deal of risk that we might create conditions that might cause the building to have to be evacuated or shut down. And we all realized that we wouldn't have jobs very long if that happened.

MR. NEIL SCARBOROUGH: You'd be in trouble.

MR. DOUG BITTERMAN: Right. So there's just a great deal of risk that we could end up seriously impairing the military's mission in this building. So bottom line, we determined it was not feasible to install technology directly beneath that hottest part of the plume. However, there are -- are technologies that could be implemented that would be almost as effective at doing -- as doing that, but would not have to be right in that -- that area. So that's the -- kind of the approach we took was to be just downgradient of -- of that building where we wouldn't impact the mission and -- but still achieve our objectives.

So we defined two remedial target areas. We called them Zone 1 and Zone 2. It may be hard to see on here, but Zone 1 is this box in here that basically encompasses the orange and the red; the higher concentration parts of the plume.

MR. BILL HANNAH: Greater than 1,000.

MR. DOUG BITTERMAN: Right. Greater than 1,000 micrograms per liter. In that area our objective was to basically significantly reduce those concentrations so that eventually what was migrating out of that source zone would be of a low enough concentration that, as it migrated down towards these surface water bodies, natural degradation processes would allow it to be consumed before it reached those water bodies. That's our long-term goal. So knocking down the mass within that source zone so that what little does get out will not impact anything downstream. Does that make sense?

MR. RAY SILVERTHORNE: Is this still TCE we're talking about?

MR. DOUG BITTERMAN: Yeah, this -- this shows TCE. But the other constituents would look -- their plumes would look very similar. They're about the same extent and slightly different concentrations. We believe that TCE was the primary product and that we see these other -- many other constituents as it -- as it degrades.

Okay. So that's this -- Zone 1 here, that was our goal. The larger plume area we called Zone 2 or the downgradient zone. There our primary objective -- and this area has lower -- much lower concentrations than the source zone. There our objective is just to prevent groundwater from discharging to those surface water bodies above levels that would impact the surface water bodies and the organisms that live in them. So we had two different zones and two different objectives. So you see these technologies, they are targeted at those different zones. So there is more than one component to the remedy that we've come up with here.

Before I get into the remedial alternative, just a little bit about how we evaluated them. There is the National Oil and Hazardous Substances Pollution Contingency Plan, or the NCP, which lays out the criteria that we used under CERCLA to evaluate the technologies, and there are nine criteria divided into three different categories. There is Threshold Criteria, Primary Balancing Criteria, and then Modifying Criteria. I will explain more of them -- more about them in detail. But the Threshold Criteria are the bare minimum. For an alternative to be acceptable, it has to meet those criteria. The minimum bar, if you will. The other criteria, there will always be pluses and minuses. Cost, for example is one of them. You know, there will be pluses and minuses with those. So here are the list of all the nine criteria. The two in the Threshold are the ones that have to be met to be acceptable. Overall protection of human health and the environment. And then compliance with what are called applicable or relevant and appropriate requirements, or ARARs. One of the worst acronyms I have ever heard in my life.

MR. BILL HANNAH: Regulations.

MR. DOUG BITTERMAN: Yeah. Bottom line, it's the regulations that apply like the North Carolina Groundwater Standard. That's one of the primary ARARs, so that's all this means. So it's fairly self-evident why these are the minimum bar that an alternative has to -- has to be.

If it doesn't do that, it isn't worth anything. These Primary Balancing Criteria is really where most of our work is in evaluating the criteria because that's where -- they all have pluses and minuses, advantages, disadvantages. So we're looking at those. Things like short and long-term effectiveness, the permanence of the remedy. Does it use treatment to more quickly reduce the toxicity or the mobility of the constituents? How easy is it to implement? How costly is it? Those are the kind of trade-offs that -- that we look at. And then the final set of criteria are also very important. And that's acceptability by the State and also acceptability by the community. And that's partly why we're here today, to talk about that and that criteria. So these are the nine criteria that we use to evaluate.

Then we came up with different remedial alternatives to evaluate for each of those two zones; remember Zone 1 being the source zone and Zone 2 being the downgradient zone. In the source zone, our first alternative was no action. We always compare -- we always have no action as one of our alternatives. It's required. No action means zero cost. Literally doing nothing. Not monitoring; not doing anything. So everything is compared to that option. Alternative two is monitored natural attenuation and land use controls. Basically, that just means letting nature take its course, but monitoring the progress of nature's breakdown of the constituents. And then land use controls are just administrative controls put in place to prohibit humans from coming into contact or prevent humans from coming into contact with constituents. Like a deed restriction that says you can't use the groundwater or a rule that says at Cherry Point you can't excavate below the water table without permission from the State. Something like that; that's a land use control. So alternative two was -- was just that. And I'll talk more about the cost of that later, because in the downgradient zone, we also had that same alternative. Alternative three was the treatment alternative for zone one. And it -- it had that same biobarrier concept that I explained in the pilot study. It's called In-situ Enhanced Bioremediation, or ISEB. And it incorporated that as well as monitored natural attenuation and land use controls to collectively address the plume. And this cost is the -- these costs are in present value terms over the life of the remedy. The -- the treatment remedies were estimated to require about 30 years to be completed. So this 6.5 million dollars is the total cost of, in present value terms, over a 30-year period. For the -- without treatment the monitored natural attenuation was more like 100 years, just by comparison. So those are the alternatives that we evaluated for Zone 1, the source zone.

And this figure is meant to show, conceptually, how the treatment part of that alternative three would work. We did a pilot study early which was just a tiny little area. But zooming in on this orange, highly concentrated part of the plume, the full scale implementation is much, much larger. We had 100 wells, basically. And you might wonder why we didn't just have a nice straight line. We had to work around utilities, and roads, and buildings, and so forth. So we had to find an alignment that would actually be feasible. So we had this -- this alignment on the north side of A street and then a little curved area south of A street. But if you look at it here, you can see that it basically forms a barrier. As groundwater flows this way, all of that yellow and orange highly concentrated groundwater would touch that alignment at some point. So it is, like, a complete biobarrier across that highest concentration part of the plume. So we would be injecting this substrate into the ground in the surficial aquifer at each of those hundred well points to form a biobarrier across the most concentrated part of the plume.

Then, in the downgradient zone, we had five different alternatives that we evaluated there. Again, we had no action. Again, we had the alternative two to monitor natural attenuation and land use controls. And over a hundred year period, that was estimated to cost about 6.245 million dollars. Just the natural attenuation -- monitor the natural attenuation and land use controls over a hundred year period. Alternative three was installing two Permeable Reactive Barriers to prevent groundwater discharge downgradient near those streams. There is a PRB -- I'm going to show you a figure in a minute -- on the southern lobe of the plume. That actually already exists because of our pilot study. A second one would be necessary because, when you look at the plume map I'll bring up in a second -- well, I'll just bring it up now. The plume sort of forms two fingers as it moves downgradient. The PRB that already exists is installed across that -- that lobe of the plume that's going to East Prong Slocum Creek. But then there is this other lobe going towards Sandy Branch. So the second PRB would be installed along that lobe. The plume is slightly deeper in that northern lobe, so the trenching technology that we used in our pilot study which could only go to 35 feet is too shallow to achieve the depth that we would need in this northern lobe, which is about 50 feet. We -- we tried to go deeper than 35 feet and the tool literally bent, so 35 feet is it with that trenching technology. So in order to overcome that, we have to use a different technology to install the PRB. So instead of a -- a trenching tool that installs a continuous wall, we use vertical points and install it in just a series of vertical bore holes. Installing the same Zero Valent Iron and sand mixture, but through a series of vertical well points so you can achieve deeper depth that way. And the conceptual design has two -- two alignments, basically. Are they the same depth?

MR. BILL HANNAH: Yes.

MR. DOUG BITTERMAN: Okay. We estimated 30 borings and it's 20 to 50 feet is the zone where the ZVI and the sand mixture would be placed. So alternative three has the two PRBs, plus monitored ~~monitor~~ natural attenuation, and land use controls combined. Alternative four is similar to what we had back in the source zone, the In-situ Enhanced Bioremediation Barrier concept. But, instead of being the source zone, implementing that same technology downgradient. So I'll just jump ahead to the figure for that. So here you can see a series of injection points across the two lobes of the plume. But, instead of injecting a permeable reactive barrier, we are injecting that biodegradation substrate to create a treatment zone along those two lobes. So one of them we estimated 30 wells and the other one -- what does that say, Bill? 38.

MR. BILL HANNAH: Yeah, about 38.

MR. DOUG BITTERMAN: My eyes aren't great. About 38 wells. These are just conceptual designs based on the width of the plume. And then there was also monitored natural attenuation. So it's similar to that source zone concept, but applied downgradient. And then the final alternative was an Air Sparge curtain along with monitored natural attenuation and LUCs. This is similar to that earlier pilot technology where you are injecting air into the aquifer and bubbling it up. The difference here, instead of a series of vertical wells, the concept was to install a horizontal directional drilled well. Two of them at 1,000 feet long each. A little hard to see, but they are in black here. A tool would -- would install a horizontal well down into the heart of the plume. The dashed segment within the plume is where the screen would be. And then you would inject air down into that and it would bubble up like a bubble curtain up through the aquifer so that, as groundwater passed through that, the -- the bubbles would remove a lot of the volatiles. So that alternative has two Air Sparge curtains. And I think I skipped over the cost. But you can see it's about 6.2 million dollars over 100 years for alternative two, the monitored natural attenuation. The PRBs is over a 30-year period. So about 7.7 million. However, one of those PRBs has already been installed. This cost assumes that it hasn't. So it's a bit higher than it would be today to implement. Alternative four, about 9.8 million dollars, and that's the In-situ Enhanced Bioremediation. One of the reasons why that's so high is we have to inject over and over. You can't just inject one time; you have to do it over and over. And then, finally, the Air Sparge curtain is about 6.8 million dollars.

All right. So those are the alternatives. So how did they come through the evaluation? In the source zone, you may not remember what the numbers are, but I'll remind you. Alternative two is just monitored natural attenuation and land use controls. That's obviously going to take a lot longer than the treatment alternative. We're guessing around 100 years versus 30 years for the treatment alternative, which is alternative three. By implementing alternative three, reducing that mass in the source area, it would also lessen the time that it would take natural attenuation to treat the rest of the plume. So it helps speed up the downgradient part of the remedy. And then also we did a pilot study using the same technology that alternative three incorporated, and we showed that it was successful and could be implemented at OU1. In the downgradient zone, alternative three which is the PRB alternative -- I'm sorry -- yes, that's correct. It does have a higher initial cost, but there are a couple of advantages to it. One is that there is almost no maintenance after it is installed, and that's very appealing. The ZVI, the Zero Valent Iron, uses a chemical rather than a biological process that really just removes almost 100 percent of the constituents; so it's extremely effective at treatment. And we -- we showed that in our pilot study. It was very successful. Alternative four, which was the injection of the substrate, the ISEB technology, we estimated that there would need to be many injection periods. So, with that, that really drove the costs up with that alternative. Alternative five, which was the Air Sparge, it was slightly less expensive. But we also learned from the earlier pilot study that it was a very difficult technology to -- to do in the long term. That it very quickly -- its effectiveness drops off and it becomes very expensive to maintain. So the -- we learned from that earlier pilot study that -- that it could be problematic, which creates some concern on the team's part. Any questions about -- about that?

So it gets to the bottom line. What -- what are we proposing as the final remedy for the site. In Zone 1, the source zone, we are proposing alternative three, which is the biobarrier concept at full scale implementation level, along with monitored natural attenuation and land use controls. In Zone 2, the downgradient zone, we are proposing alternative three, also, which is installing those two PRBs, one of which already exists, and also using monitored natural attenuation and land use controls.

And then there is an additional component across the entirety of both zones. Because there is this remote risk of vapor intrusion through future modifications to buildings or building a new building, until the groundwater levels subside, we need to continue monitoring that to make sure that there is no risk to any inhabitants of the buildings. So there is going to be an ongoing monitoring program looking at both soil vapor and indoor air in selected buildings that are near the plume during the remedy implementation. And the Navy, and the EPA, and the state -- the partnering team concurred on these remedy components.

Any questions or comments at this point, because this is the -- coming to the end of the presentation. Closing comments. I just wanted to remind everybody that the public comment period extends for about another month until June 23rd. If you do want to go back to any of the source documents that we used from our investigations and get more details, go to that URL that I pointed out earlier. It's on page one of the Proposed Plan ~~proposed plan~~. And if you have any -- think of any questions later, you can use that form on the back of the Proposed Plan ~~proposed plan~~; the e-mail; whatever is convenient for you. But, with that, does anyone have any questions while you are here now? Comments? Hopefully, I was understandable. I appreciate your patience.

MR. RAY SILVERTHORNE: The -- you were talking about doing the permeable --

MR. DOUG BITTERMAN: Reactive barrier.

MR. RAY SILVERTHORNE: -- barrier and having to drill horizontally -- or drill down --

MR. DOUG BITTERMAN: Vertically, yeah.

MR. RAY SILVERTHORNE: -- vertically in points rather than horizontally across. And I'm getting back to the grain size. If -- if you have the grain size higher where you have more flow, would it channel more through that rather than the other natural selecting as a confining or slow --

MR. DOUG BITTERMAN: We would need to do the same kind of study where we make sure that the grain size is the appropriate. I believe that's why they have two alignments instead of one using the vertical is to add some additional insurance that groundwater will -- in fact, I believe the vertical borings are kind of offset in those two alignments so that groundwater pretty much has to encounter at least one of those as it passes through.

MR. NEIL SCARBOROUGH: Yeah, I thought they'd be offset.

MR. DOUG BITTERMAN: Yeah.

MR. NEIL SCARBOROUGH: Yeah.

MR. DOUG BITTERMAN: That's why there's two. If you notice, there are two alignments instead of just the single where the trench is. Which the trench is not -- it's a complete placement. There is no break up in it. But that's why the designers came up with the two. And then they are offset. So is it possible for groundwater to get through? Maybe some tiny component of it. But I think if it's designed right, the vast majority will be. And I believe that the vertical placement method has been used many times at different sites. So there is a history showing that it can be designed and made to work.

MR. NEIL SCARBOROUGH: And there's probably not that much difference in the distance between the bore holes.

MR. DOUG BITTERMAN: I think they're pretty tightly spaced.

MR. NEIL SCARBOROUGH: Yeah.

MR. DOUG BITTERMAN: And I think they use some sort of a soil mixing. Like, I don't believe they are as narrow as, like, a well borer. Like a -- I'm pretty sure they use, like, a big auger-type device and mix the -- mix the soil within that hole wider. I don't know what the diameter is exactly, but I -- yeah, I mean, I think it's bigger.

MR. BILL HANNAH: It's going to be determined as part of the design of it as well. I mean, as you know, it's two feet wide for the PRB down there. We're going to have to do the same thing to see about the bore hole size. And that's why there's two -- two layers.

MR. RAY SILVERTHORNE: It -- it sounds good.

MR. DOUG BITTERMAN: Good question. Yeah. Any other questions?

MR. RAY SILVERTHORNE: Good deal. Good

presentation.

MR. DOUG BITTERMAN: It's been a long time coming. It's -- it's been about 30 years since we started working up at Unit 1 and this is really the -- the most complex problem at the air station that we've faced. So it's kind of exciting that we're getting to the finish line or closer to it.

MR. NEIL SCARBOROUGH: So you couldn't hurry mother nature up a little faster by pumping more bugs down there, huh?

MR. DOUG BITTERMAN: Well, we're -- that's going to be part of that alternative three is pumping bugs down in there -- in the ground to speed up mother nature. The problem is it's such a big plume that you can't -- you can't touch every square --

MR. NEIL SCARBOROUGH: Yeah.

MR. DOUG BITTERMAN: -- cubic meter of it. You couldn't -- it's just not cost effective to.

MR. RAY SILVERTHORNE: The -- one other question. When you talk about pumping that down, this is the emulsified vegetable oil stuff that you're -- and that's in a water solution? It's emulsified in water, or --

MR. DOUG BITTERMAN: Yeah. It's -- I believe it's designed to -- I mean, it physically contains the constituents that the bugs need to really get fired up to metabolize the contaminants. But it's also designed to not migrate as quickly as groundwater itself would. If you could imagine, oil is a little bit more viscous.

MR. RAY SILVERTHORNE: Right.

MR. DOUG BITTERMAN: And I think it's also designed to retain its place for as long as possible so that it -- its effectiveness isn't diminished, you know, almost immediately.

MR. RAY SILVERTHORNE: And that's what you're using as a carbon source to feed the --

MR. DOUG BITTERMAN: Yes, yes.

MR. BRYAN REVELL: And it would be reinjected over --

MR. DOUG BITTERMAN: Yes.

MR. BRYAN REVELL: -- every so many years.

MR. DOUG BITTERMAN: Yes. There is performance monitoring associated with it. So, basically, as you saw its performance tapering off, you would plan for another injection. And I don't recall what they assumed the interval is. But it's probably five years. No longer than five years between injections in order to maintain that active treatment. But we definitely learned a lot during those pilot studies to make the design more effective. There were several key things, like I said, the pH and there were some other things. Radius of influence so we'll be able to put the wells at the right spacing to maximize their effectiveness, so doing those treatability studies was good. That way, when we're doing full scale, we're not learning those lessons later so --

MR. DOUG BITTERMAN: All right. Well, no more questions? Thank you all so much. We appreciate it.

MR. WILLIAM POTTER: As Doug said, the comment period goes until June 23rd. You guys have my contact information. Feel free to send comments to me or send them directly to either Bryan Revell, Gena at EPA, and George at the state. And their contacts are listed on page 27. With that, thank you for your time and thank you for coming out here and letting us share our plan with you. And, with that, we will adjourn the meeting.

* * * * * THE PUBLIC MEETING CONCLUDED AT 7:37 P.M. * * * *

STATE OF NORTH CAROLINA)

) C-E-R-T-I-F-I-C-A-T-I-O-N

COUNTY OF PITT)

I, AIMEE C. RIGSBY, A COURT REPORTER AND NOTARY PUBLIC IN AND FOR THE AFORESAID COUNTY AND STATE, DO HEREBY CERTIFY THAT THE FOREGOING PAGES ARE AN ACCURATE TRANSCRIPT OF THE PUBLIC MEETING OF THE PROPOSED PLAN FOR OPERABLE UNIT 1 CENTRAL GROUNDWATER AT MCAS CHERRY POINT, WHICH WAS TAKEN BY ME BY STENOMASK, AND TRANSCRIBED BY ME.

I FURTHER CERTIFY THAT I AM NOT FINANCIALLY INTERESTED IN THE OUTCOME OF THIS ACTION, A RELATIVE, EMPLOYEE, ATTORNEY OR COUNSEL OF ANY OF THE PARTIES, NOR A RELATIVE OR EMPLOYEE OF SUCH ATTORNEY OR COUNSEL.

THIS THE 12TH DAY OF JUNE, 2014.

NOTARY PUBLIC NUMBER 200525000114.

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