M00146.AR.001072
MCAS CHERRY POINT
5090.3a

FINAL GROUNDWATER PLUME ZERO-VALENT IRON PERMEABLE REACTIVE BARRIER PILOT STUDY IMPLEMENTATION PLAN OPERABLE UNIT 1 (OU1) MCAS CHERRY POINT NC

5/1/2012

CH2M HILL

Final

Operable Unit 1 Central Groundwater Plume Zero-Valent Iron Permeable Reactive Barrier Pilot Study Implementation Plan

Marine Corps Air Station
Cherry Point, North Carolina

Naval Facilities Engineering Command

Prepared for

Department of the Navy

Naval Facilities Engineering Command
Mid-Atlantic

Contract No.
N62470-08-D-1000
CTO-0097

May 2012

Prepared by

CH2MHILL

Final

Operable Unit 1
Central Groundwater Plume
Zero-Valent Iron Permeable Reactive Barrier
Pilot Study Implementation Plan

Marine Corps Air Station
Cherry Point, North Carolina

Contract Task Order 097

May 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina
Charlotte, North Carolina 28226
NC Engineering License #F-0699

Contents

Appendixes

Tables

Figures

Acronyms and Abbreviations

AOC	area of concern
ASTM	American Society for Testing and Materials
bgs	below ground surface
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	contaminant of concern
CQMP	Construction Quality Management Plan
CTO	Contract Task Order
DCA	dichloroethane
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DPT	direct-push technology
DRMO	Defense Reutilization and Marketing Office
EAD	Environmental Affairs Department
Eh	redox potential
EPP	Environmental Protection Plan
FFA	Federal Facilities Agreement
FRCE	Fleet Readiness Center
FS	Feasibility Study
ft	feet
ft/day	feet per day
ft/ft	foot per foot
FTL	Field Team Leader
GPR	ground-penetrating radar
GPS	global positioning system
H&S	health and safety
HSP	Health and Safety Plan
ID	inner diameter
IDW	investigation-derived waste
IR	Installation Restoration
ISCR	in-situ chemical reduction
IWTP	Industrial Wastewater Treatment Plant
LEL	lower explosive limit
μg/L	micrograms per liter
MCAS	Marine Corps Air Station
MCL	maximum contaminant level
MFSP	Master Field Sampling Plan
mg/L	milligrams per liter
mm	millimeter
NADEP	Naval Aviation Depot
NAVFAC	Naval Facilities Engineering Command
NCAC	North Carolina Administrative Code
NC 2B	North Carolina Administrative Code Title 15A, Subchapter 2B Surface Water and Wetland Standards

NCDENR	North Carolina Department of Environment and Natural Resources
NCGWQS	North Carolina Groundwater Quality Standards
ORP	oxidation-reduction potential
OU	Operable Unit
PCA	tetrachloroethane
PCE	tetrachloroethene
PM	Project Manager
PPE	personal protective equipment
PRB	permeable reactive barrier
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SWMU	solid waste management unit
TCE	trichloroethene
TDEM	time domain electromagnetic
TSD	treatment, storage, or disposal
UFP	Uniform Federal Policy
ULOCO	North Carolina One Call Center
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VC	vinyl chloride
VOC	volatile organic compound
ZVI	zero-valent iron

SECTION 1
Introduction

This document presents the Zero-Valent Iron (ZVI) Permeable Reactive Barrier (PRB) Pilot Study Implementation Plan for Operable Unit (OU) 1, specifically the portion of OU1 denoted as the OU1 Central Groundwater Plume, located at Marine Corps Air Station (MCAS) Cherry Point, North Carolina (**Figures 1-1** and **1-2**). This Implementation Plan was prepared under the Naval Facilities Engineering Command (NAVFAC)—Mid-Atlantic, Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000 Contract N62470-08-D-1000, Contract Task Order (CTO) 0097.

The *Final Feasibility Study, Operable Unit 1, Central Groundwater Plume, Marine Corps Air Station, Cherry Point, North Carolina* (FS) (CH2M HILL, 2011) evaluated potential remedial alternatives to address groundwater impacts identified at OU1 (**Figure 1-2**). A PRB using ZVI to treat trichloroethene (TCE), 1,2-dichloroethene (1,2-DCE), vinyl chloride (VC), and other site-related contaminants of concern (COCs), was evaluated in the FS to limit further migration of the groundwater plume. In May 2011, the Partnering Team agreed to conduct a field-scale pilot study at OU1 to evaluate the constructability and site-specific effectiveness of a ZVI PRB.

This ZVI PRB Pilot Study Implementation Plan is organized as follows:

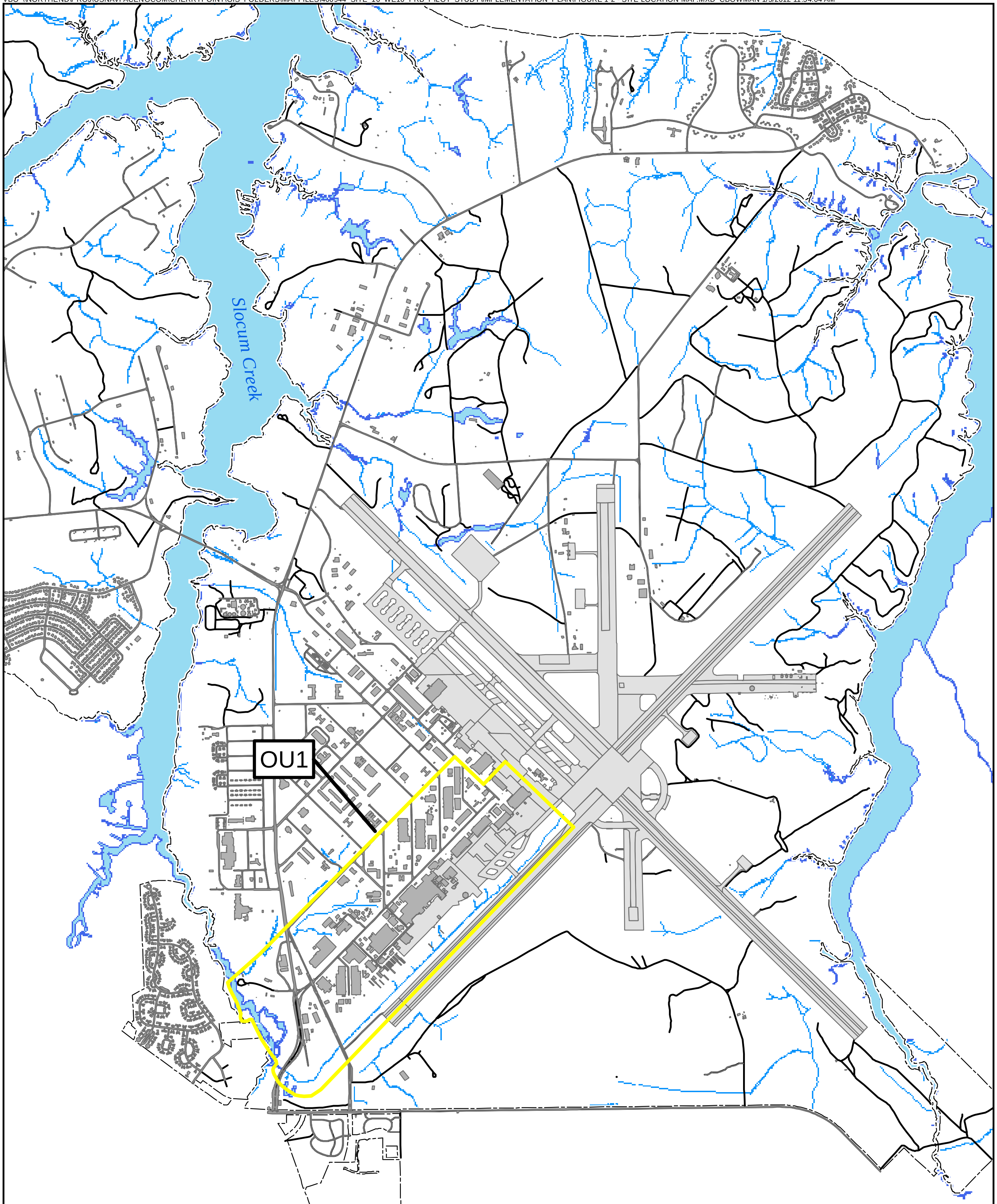
- **Section 1, Introduction—**Presents an overview of the project and Implementation Plan.
- **Section 2, Site Background—**Presents the general site background and description of OU1 and the pilot study area.
- **Section 3, Pilot Study Description—**Presents an overview of the pilot study objectives and goals and a conceptual technical approach for the pilot study.
- **Section 4, Pilot Study Implementation—**Discusses how the pilot study will be conducted and the site-specific requirements and constraints applicable during field implementation.
- **Section 5, Health and Safety and Residuals Management—**Outlines issues to be presented in the Health and Safety Plan (HSP) for the project and presents the process for managing investigation-derived waste (IDW).
- **Section 6, Reporting—**Describes the reporting that will occur for implementation.
- **Section 7, Project Management—**Provides the project schedule and organization.
- **Section 8, References—**Provides the references used in this document.

Tables and figures are included at the end of each section. The *Tier II Uniform Federal Policy Sampling and Analysis Plan (UFP-SAP), Groundwater Treatment Zero-Valent Iron, Permeable Reactive Barrier Pilot Study, Operable Unit 1, Marine Corps Air Station, Cherry Point, North Carolina* (UFP-SAP) to address the collection of analytical data specific to the pilot studies has been issued under separate cover (CH2M HILL, 2012).

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 1-1 - BASE LOCATION MAP.MXD CBOWMAN 2/16/2012 12:43:02 PM

Figure 1-1
Base Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.



Legend
- OU Boundary
- Base Boundary
- Buildings
- Runway
- Road
- Surface Water

Figure 1-2
OU1 Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

SECTION 2
Site Background

Comprehensive information concerning site history, contaminant concentrations, plume distribution, and subsurface geology/hydrogeology was presented in the *Final Remedial Investigation for Operable Unit 1 (OU1)* (TetraTech NUS, 2002) (2002 Remedial Investigation [RI]) for the results of historical site investigations performed at OU1 from 1983 to 2000. Results of historical site investigations performed at OU1 from 2000 to 2008 are included in the *Final OU1 Remedial Investigation Addendum* (CH2M HILL, 2009) (2009 RI Addendum) and in the FS (CH2M HILL, 2011) for results of the 2009 additional investigation activities.

2.1 Site Description

MCAS Cherry Point is a 13,164-acre military reservation located adjacent to the city of Havelock in southeastern Craven County, North Carolina (**Figure 1-1**). 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 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.

OU1 is an industrial area approximately 565 acres in size, located in the southwestern portion of MCAS Cherry Point (**Figure 1-2**). OU1 is bounded by C Street and Sandy Branch to the northwest, portions of the MCAS Cherry Point flightline and runway to the northeast and southeast, and East Prong Slocum Creek to the southwest (**Figure 2-1**).

On May 12, 2005, the Navy, United States Environmental Protection Agency (USEPA), and the North Carolina Department of Environment and Natural Resources (NCDENR) executed a Federal Facilities Agreement (FFA) for MCAS Cherry Point. Under the FFA, all past and future work at Installation Restoration (IR) Program sites, solid waste management units (SWMUs), and areas of concern (AOCs) were to be reviewed, and a course of action for future work requirements at each site was to be developed. Eleven sites at OU1 were initially identified in the FFA as requiring additional investigation, and a twelfth site, Site 98, was discovered by MCAS Cherry Point during an investigation of underground storage tanks (USTs) at Building 4032 and identified as a new site for inclusion in the FFA in 1999 (NAVFAC, 2005). These OU1 sites are shown on **Figure 2-1** and are listed as follows:

- Site 14 - Motor Transportation
- Site 15 - Ditch and Area Behind NADEP
- Site 16 - Landfill at Sandy Branch
- Site 17 - DRMO Drainage Ditch
- Site 18 - Facilities Maintenance Compound
- Site 42 - Industrial Wastewater Treatment Plant (IWTP)
- Site 47 - Industrial Area Sewer System
- Site 51 - Building 137 Plating Shop
- Site 52 - Building 133 Plating Shop and Ditch
- Site 83 - Building 96 Former Pesticide Mixing Area
- Site 92 - Volatile Organic Compounds (VOCs) in Groundwater near the Stripper Barn
- Site 98 - VOCs in Groundwater near Building 4032

Of the 12 sites identified in the FFA to be investigated as part of the 2002 RI (**Figure 2-1**), 6 were identified as potential source areas contributing to the OU1 Central Groundwater Plume as described in the 2009 RI Addendum (CH2M HILL, 2009). The OU1 RI Addendum concluded that Site 16 is not a source of elevated chlorinated VOC (cVOC) concentrations within the surficial aquifer, and that these concentrations are the result of upgradient OU1 sources. The sites identified as potential source areas consist of Sites 42, 47, 51, 52, 92, and 98, and information about each is summarized in **Table 2-1**. **Figures 2-2** and **2-3** show the extent of the TCE plume in OU1. **Figure 2-4** presents a graphical representation of the conceptual site model for the OU1 Central Groundwater Plume and supports the discussion in the following sections.

2.2 Description of Pilot Study Area

2.2.1 Hydrostratigraphy

The pilot study will be conducted within the surficial aquifer, in the western corner of OU1 (**Figure 2-1**). A physical description of the surficial aquifer is provided below. The locations of hydrogeologic cross-sections through OU1 are shown in **Figure 2-5**, and the conceptual cross-sections of A-A’ and B-B’, representing the area in the vicinity of where the pilot study is to be conducted, are shown in **Figures 2-6** and **2-7**. VOC isoconcentrations are also shown in these cross-sections, illustrating vertical plume distribution. Regional and additional site-specific geological information is presented in the 2002 RI and 2009 RI Addendum.

Surficial Aquifer

The surficial aquifer consists of the Holocene (Quaternary) undifferentiated sands and Pleistocene (Quaternary) Flanner Beach Formation. The aquifer consists of unconsolidated, interfingered beds of fine-grained sand, silt, clay, shell, and peat beds, and scattered deposits of coarse-grained material as part of relic beach ridges and alluvium (USGS, 1996; TetraTech NUS, 2002).

The surficial aquifer is the first-encountered groundwater beneath OU1 and is unconfined (**Figures 2-6** and **2-7**). The saturated thickness ranges from approximately 30 to 45 feet (ft) beneath OU1, and is underlain by a fine-grained unit of a paleochannel, which is a remnant of a former river or stream channels that has likely eroded the Yorktown and Pungo River confining units and deposited younger-aged sediments. As a result, the uppermost aquifers may be in direct hydraulic communication with each other at locations where a paleochannel truncates the confining units that normally separate the aquifers physically and hydraulically (USGS, 1994, 1996, and 2004). Recharge is by the infiltration of precipitation. No groundwater production from the surficial aquifer occurs in the area.

The surficial aquifer has been evaluated as two different groundwater zones due to minor differences in aquifer properties and in order to more precisely delineate the vertical distribution of contamination: the upper and lower surficial aquifers. The upper surficial aquifer is defined as the upper 10 to 15 ft of saturated thickness, and is generally monitored by wells installed just below or across the water table. The lower surficial aquifer is defined as the lower 20 to 30 ft of the aquifer and is monitored by wells installed just above the fine-grained unit of the paleochannel below it. The upper surficial aquifer generally contains finer-grained materials than the lower surficial aquifer. However, the upper and lower surficial aquifers are in direct hydraulic communication.

2.2.2 Aquifer Properties

Aquifer properties were estimated by conducting single-well aquifer hydraulic conductivity (“slug”) testing at various monitoring wells within the upper and lower surficial aquifers. The hydraulic conductivity is estimated at approximately 3.2 ft per day (ft/day) (16GW35) for the upper surficial aquifer within the proposed pilot study area. For the lower surficial aquifer, no slug testing data are available for the pilot study area; however, the hydraulic conductivity is estimated to range from 1.9 to 78.9 ft/day within OU1, with a geometric mean of 21.9 ft/day (CH2M HILL, 2009). The wider range of hydraulic conductivity values of the lower surficial aquifer is consistent with the heterogeneous nature of the aquifer. Hydraulic conductivity data from the 2009 RI Addendum is shown on **Figure 2-8**. Additional slug testing will be conducted on four to eight of the pilot study monitoring wells to provide further characterization of the pilot study area.

2.2.3 Groundwater Flow

Across OU1, groundwater flows generally westward in the upper and lower surficial aquifers toward East Prong Slocum Creek and Sandy Branch (**Figures 2-9** and **2-10**), with an average horizontal hydraulic gradient of approximately 0.003 foot per foot (ft/ft) (CH2M HILL, 2009). Groundwater flow appears to have minimal discharge to Sandy Branch Tributaries 1 and 2 and follows along their same general direction. Assuming an effective porosity of 30 percent, the geometric mean for hydraulic conductivity and corresponding average linear horizontal groundwater velocity is approximately 4.5 and 0.1 ft/day for the upper surficial aquifer and 18.3 and 0.2 ft/day for the lower surficial aquifer (CH2M HILL, 2009).

2.2.4 Nature and Extent of Impacts

The sampling activities conducted during the RIs for OU1 included soil, groundwater, sediment, and surface water sampling as part of the 2002 RI (TetraTech NUS, 2002), soil and groundwater sampling as part of the 2009 RI Addendum (CH2M HILL, 2009), and groundwater sampling as part of the 2009 additional investigation activities (Appendix A of the FS [CH2M HILL, 2011]). The following discussion focuses on the nature and extent of groundwater impacts within the pilot study area (**Figure 2-11).**

VOCs

The most prevalent VOCs detected above regulatory standards within the Central Groundwater Plume (in order based on the greatest frequency of exceedances) included TCE, 1,2-DCE, VC, 1,1-dichloroethane (1,1-DCA), and 1,1-DCE. These chemicals generally exceeded the regulatory standards at a frequency of greater than 10 percent. Other VOCs related to chlorinated solvents detected above regulatory standards, but less frequently, included tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1,2,2-tetrachloroethane (1,1,2,2-PCA), and 1,2-DCA.

The most-elevated TCE concentrations (**Figures 2-2** and **2-3**) occurred beneath Building 133, at concentrations that may be indicative of the presence of dense non-aqueous phase liquid (DNAPL) (CH2M HILL, 2009). The TCE plume extends laterally from the western portion of Building 133 more than 3,000 ft in a southwesterly direction to Site 16 and East Prong Slocum Creek and Sandy Branch. The Central Groundwater Plume also extends vertically from the upper surficial aquifer at Building 133 into the lower surficial aquifer at locations downgradient of Building 133, and is present in both upper and lower surficial aquifers in the pilot study area. The maximum concentrations of TCE observed in the pilot study area were 190 micrograms per liter (μg/L) at 16GW04 in the upper surficial aquifer (**Figure 2-12**) and 38 μg/L at 16GW34 in the lower surficial aquifer (**Figure 2-13**), both exceedances of North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2L Groundwater Quality Standards (NCGWQS). TCE was not detected on the western side of the creeks west of the pilot study area.

Similar to TCE, detections of 1,2-DCE and VC extend vertically from the upper surficial aquifer beneath Building 133 to the lower surficial aquifer downgradient of the building, and laterally to the pilot study area and East Prong Slocum Creek and Sandy Branch. At the pilot study area, 1,2-DCE exceeded NCGWQS at only one location in the upper surficial aquifer, with a concentration of 210 μg/L at 16GW04 (**Figure 2-14**), and was as high as 190 μg/L at 16GW28 in the lower surficial aquifer (**Figure 2-15**). VC exceeded NCGWQS at only two locations in the upper surficial aquifer, with concentrations of 8.8 μg/L at 16GW40 and 60 μg/L at 16GW04 (**Figure 2-16**), and was as high as 32 μg/L at 16GW42 in the lower surficial aquifer (**Figure 2-17**).

2.3 Remedial Action Objectives

The remedial action objectives (RAOs) were developed for the OU1 Central Groundwater Plume in the FS. The RAOs consist of medium-specific goals for protecting human health and the environment. The RAOs reflect the COCs, exposure routes and receptors, and acceptable contaminant concentrations (or range of acceptable contaminant concentrations) for each medium of concern at OU1.

The RAOs for the OU1 Central Groundwater Plume are as follows:

- Restore groundwater quality at OU1 to the NCGWQS and the maximum contaminant level (MCL), based on the classification of the aquifer as a potential source of drinking water (Class GA or Class GSA) under 15A NCAC 02L.0201.
- Prevent human exposure to groundwater above levels that would cause unacceptable risks.
- 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.

2.4 Feasibility Study Results

The 2011 FS identified a ZVI PRB as a potentially viable treatment for TCE and its daughter products in groundwater within the downgradient portion of the Central Groundwater Plume at OU1 (CH2M HILL, 2011). The primary objective of the ZVI PRB is to intercept the plume and prevent the discharge of groundwater with VOC concentrations exceeding North Carolina Administrative Code Title 15A, Subchapter 2B, Surface Water and Wetland Standards (NC 2B standards) to East Prong Slocum Creek and Sandy Branch. For the downgradient portion of the OU1 Central Groundwater Plume, other technologies considered in the FS include installing an in-situ enhanced bioremediation biobarrier and an air sparge curtain.

The proposed full-scale ZVI PRB remedy in the OU1 FS consists of two sections: the first to intercept the southern lobe of the plume between East Prong Slocum Creek and Sandy Branch, and a second barrier to intercept the northern lobe of the plume, near Roosevelt Boulevard (**Figure 2-3**). The first PRB would be constructed using a continuous trencher to 35 to 40 ft below ground surface (bgs). This technique was used effectively at nearby Marine Corps Base Camp Lejeune to depth of 25 ft bgs (AGVIQ/CH2M HILL, 2008).

In the FS, it is assumed the second (shorter) PRB would consist of a series of closely spaced (25 ft apart) soil borings, with micro-scale ZVI injected at 3.5-ft vertical intervals from 20 to 45 ft bgs. The FS indicated that this second PRB would have to be installed to a depth of approximately 45 ft bgs in the northern lobe to prevent cVOCs from discharging to Sandy Branch. Although a continuous trencher was concluded to be more cost-effective to install and maintain, the PRB consisting of multiple vertical soil borings was necessitated at the time because of depth limitations on the trencher.

Since the FS was prepared, DeWind Dewatering has indicated that they now have trenching equipment that can achieve the design depths for the second PRB. As such, the Partnering Team agreed in May 2011 to conduct the ZVI PRB pilot study to assess the feasibility of installing the ZVI PRB using the DeWind One-Pass Trench System to a depth of 45 ft bgs and to evaluate the overall effectiveness of the ZVI PRB approach for containing the plume. The objectives of the pilot study include the following:

- Determine if a PRB can be installed to a depth of 45 ft bgs at OU1 using the DeWind One-Pass Trench System; and
- Evaluate the ability of the PRB to achieve 90 percent reduction of TCE and 75 percent reduction of overall VOCs over a 2-year time period in the monitoring wells immediately downgradient of the PRB, although attaining specific percentages of these magnitudes are not critical in achieving protection of Slocum Creek.

Additional details about the technology and the pilot study are provided in the subsequent sections.

TABLE 2-1

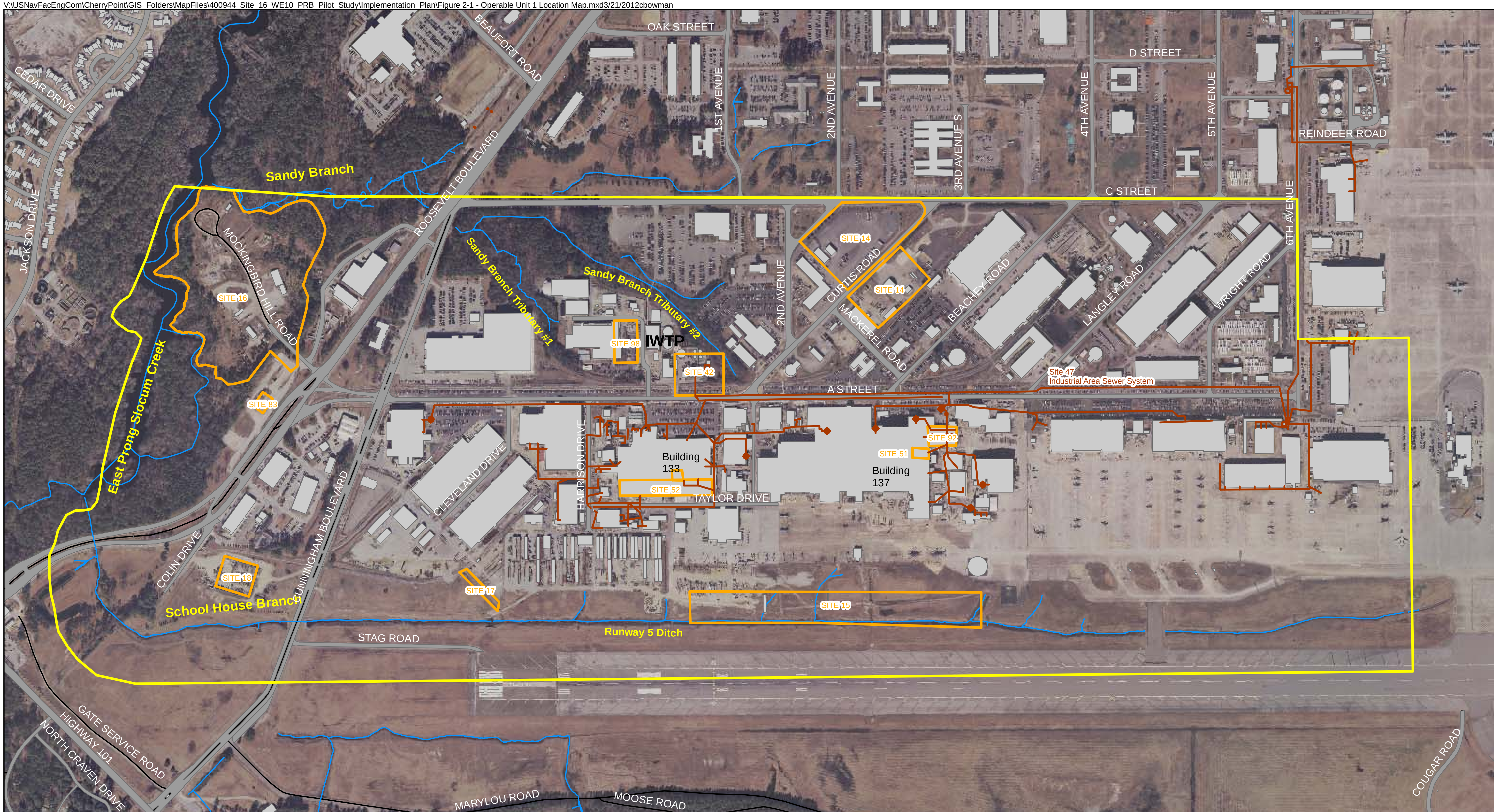
Summary of Potential Source Areas

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Site	Description
Site 42: Industrial Wastewater Treatment Plant (IWTP)	Originally constructed in 1957 to treat wastes from industrial sources such as metal plating, painting, aircraft maintenance, vehicle maintenance, and stormwater. A groundwater extraction and treatment system operated at the site from 1998-2005 to remediate the groundwater VOC plume in the vicinity of FRCE.
Site 47: Industrial Area Sewer System	Construction began in 1942 and was expanded over time for a system of underground pipes and aboveground drains to transfer industrial wastewater from various parts of FRCE and OU1 to the IWTP from processes such as metal plating, metal finishing, solvent degreasing, paint stripping, painting, fuel storage, fueling, aircraft washing, and general maintenance. Site 47 only includes the industrial sewers within OU1 that currently discharge to the IWTP. Concentrated wastes are now containerized and transported to the IWTP. Leaks were detected at several locations within the sewer system in the past and have been repaired. Inspections and repairs are conducted as part of the facility's ongoing maintenance process.
Site 51: Building 137 Former Plating Shop	Former Plating Shop that operated from 1942 to 1990, was located within Building 137, and consisted of approximately 4,000 square feet (ft^2) that included a 3-foot-deep sump for containment of spillage and tank overflows. The wastes generated in the plating shop consisted of plating solution overflow and rinse water containing zinc and chromium that were discharged to the sump. The sump discharged to the industrial sewer system (Site 47) until 1987, when the sump was plugged and the plating shop converted to a closed-loop system. From then until the Plating Shop was moved in 1990, wastes were transported to the IWTP (Site 42) in containers for batch treatment.
Site 52: Building 133 Former Plating Shop and Ditch	Former Plating Shop that operated from 1942 to 1990, was located in Building 133, and consisted of approximately 2,000 ft^2 that included a 2.5-ft-deep sump for containment of spillage and tank overflows. Former employees indicated that a ditch was formerly present behind Building 133 that received stormwater and industrial wastewater discharge from the Plating Shop and other areas within Building 133. This former ditch was covered in the 1970s by an addition to Building 133. The plating shop area was cleaned and renovated in 1996 and is currently used to process and store non-hazardous parts and supplies. The wastes generated in the plating shop consisted of plating solution overflow and rinse water that discharged to the sump. The sump wastes likely discharged to the former ditch behind Building 133 prior to the installation of the industrial sewer system (Site 47). An addition constructed on the southeastern side of the building subsequently covered this ditch. The sump then discharged to the industrial sewer system (Site 47) until 1987, when the sump was plugged and the plating shop converted to a closed-loop system. From then until the plating shop was moved in 1990, wastes were transported to the IWTP (Site 42) in containers for batch treatment.
Site 92: VOCs in Groundwater near the Stripper Barn	Site 92 is a plume of VOC-contaminated groundwater near the Stripper Barn portion of Building 137, where paint is removed from aircraft. The area around the site is covered with buildings and concrete, and portions of the industrial sewer system (Site 47) are located beneath and around the Stripper Barn. In the past, large quantities of solvent were used to remove paint; during the paint removal process, spent solvent flowed into the industrial sewer system. The current paint removal method requires approximately 90 percent less solvent, and spent solvent is captured for proper disposal. Any historical spills that occurred outside the building may have flowed toward storm drains located northeast of the Stripper Barn.
Site 98: VOCs in Groundwater near Building 4032	Site 98 is a plume of VOC-contaminated groundwater near Building 4032, located southeast of the IWTP in the central portion of OU1. Site 98 was discovered by MCAS Cherry Point during an investigation of underground storage tanks (USTs) at Building 4032 in 1994, and was identified as a new site in 1999.

V:\USNavFacEngCom\CherryPoint\GIS_Folders\MapFiles\400944_Site_16_WE10_PRB_Pilot_Study\Implementation_Plan\Figure 2-1 - Operable Unit 1 Location Map.mxd3/21/2012cbowman



Legend

- OU1 Boundary
- Industrial Area Sewer System
- Site Boundary
- Existing Buildings
- Surface Water

IWTP - Industrial Wastewater Treatment Plant

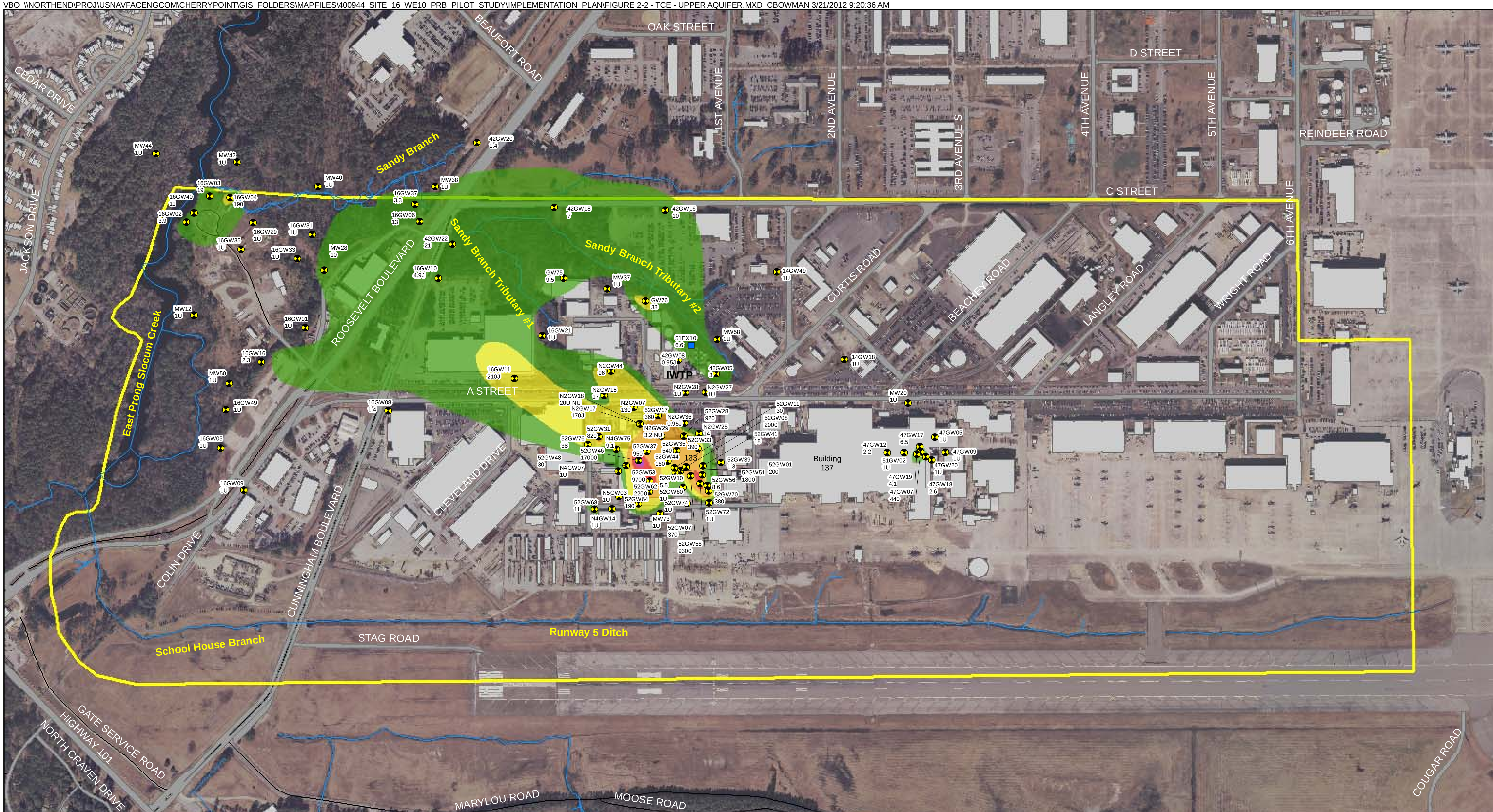
W N S E

0 600 1,200 Feet

Figure 2-1
Sites Within OU1
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-2 - TCE - UPPER AQUIFER.MXD CBOWMAN 3/21/2012 9:20:36 AM



Legend

- Extraction Well
- Monitoring Well - Upper Aquifer
- Surface Water
- OU1 Boundary
- Existing Buildings
- 3 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L
- 3,000 - 11,000 µg/L
- > 11,000 µg/L

IWTP - Industrial Wastewater Treatment Plant

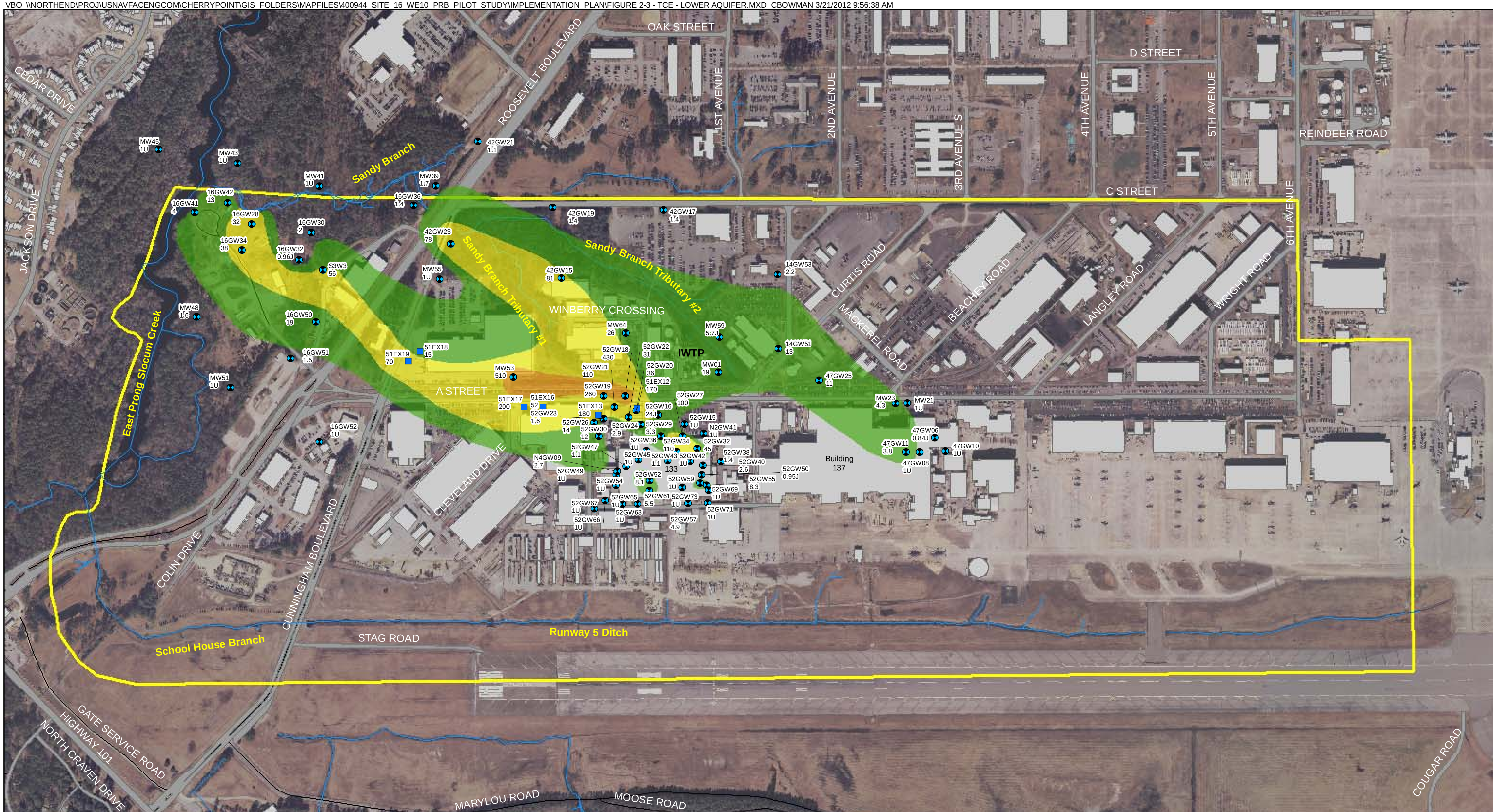
Notes:
NC2L - North Carolina Groundwater Standard
NC2L = 3 µg/L (Jan 2010)
NU = Not Used
Concentrations are from the Spring 2009 sampling event
µg/L = micrograms per liter
U - analyte not detected above detection limit
J - concentration is estimated

0 600 1,200 Feet

Figure 2-2
TCE Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-3 - TCE - LOWER AQUIFER.MXD CBOWMAN 3/21/2012 9:56:38 AM



Legend

- Extraction Well
- Monitoring Well - Lower Aquifer
- Surface Water
- OU1 Boundary
- Existing Buildings
- 3 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L

Notes:
NC2L - North Carolina Groundwater Standard
NC2L = 3 µg/L (Jan 2010)
NU = Not Used
Concentrations are from Spring 2009 sampling event
µg/L = micrograms per liter
U - analyte not detected above detection limit
J - concentration is estimated

IWTP - Industrial Wastewater Treatment Plant

Figure 2-3
TCE Isoconcentration Map
Lower Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

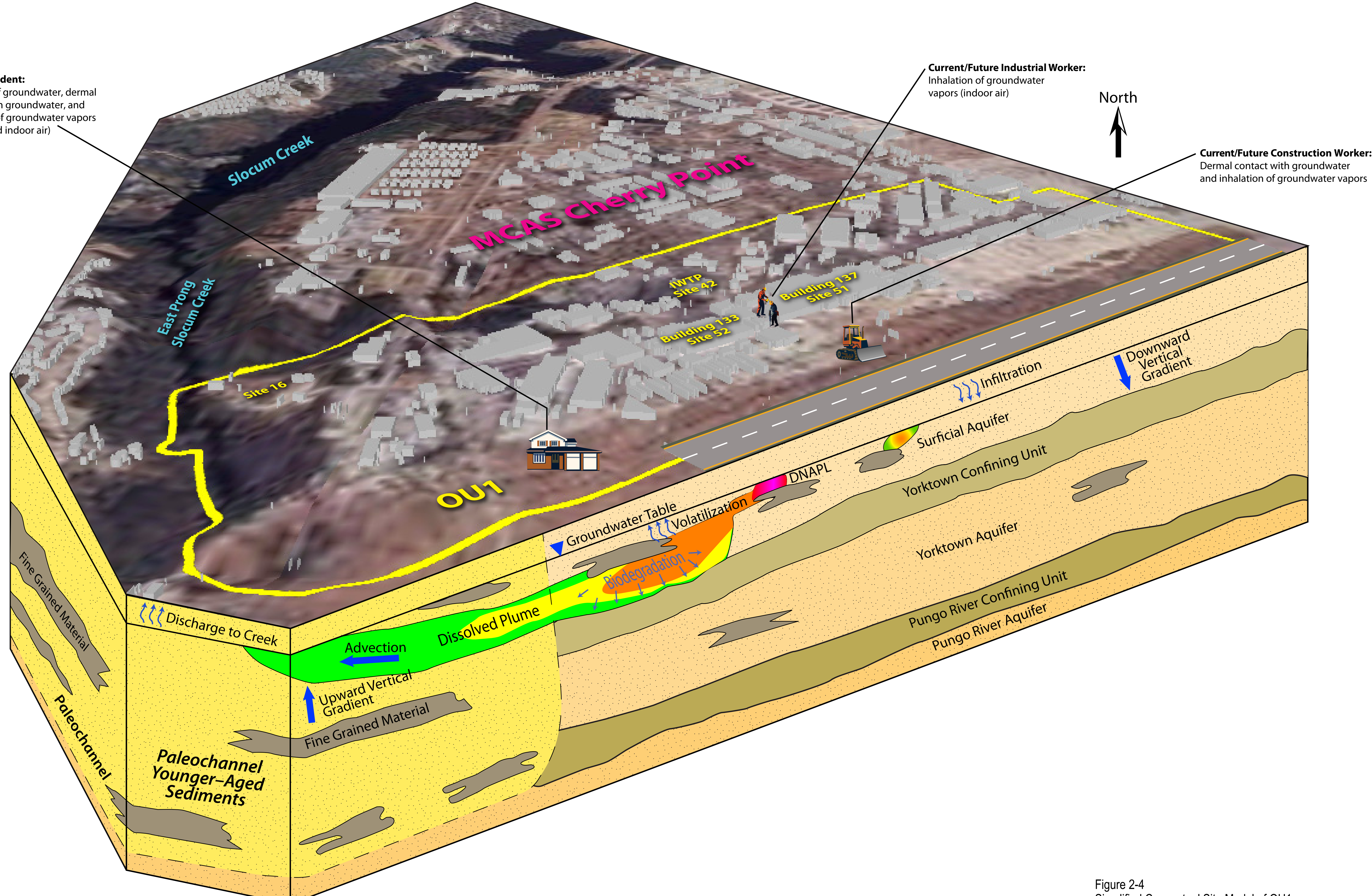
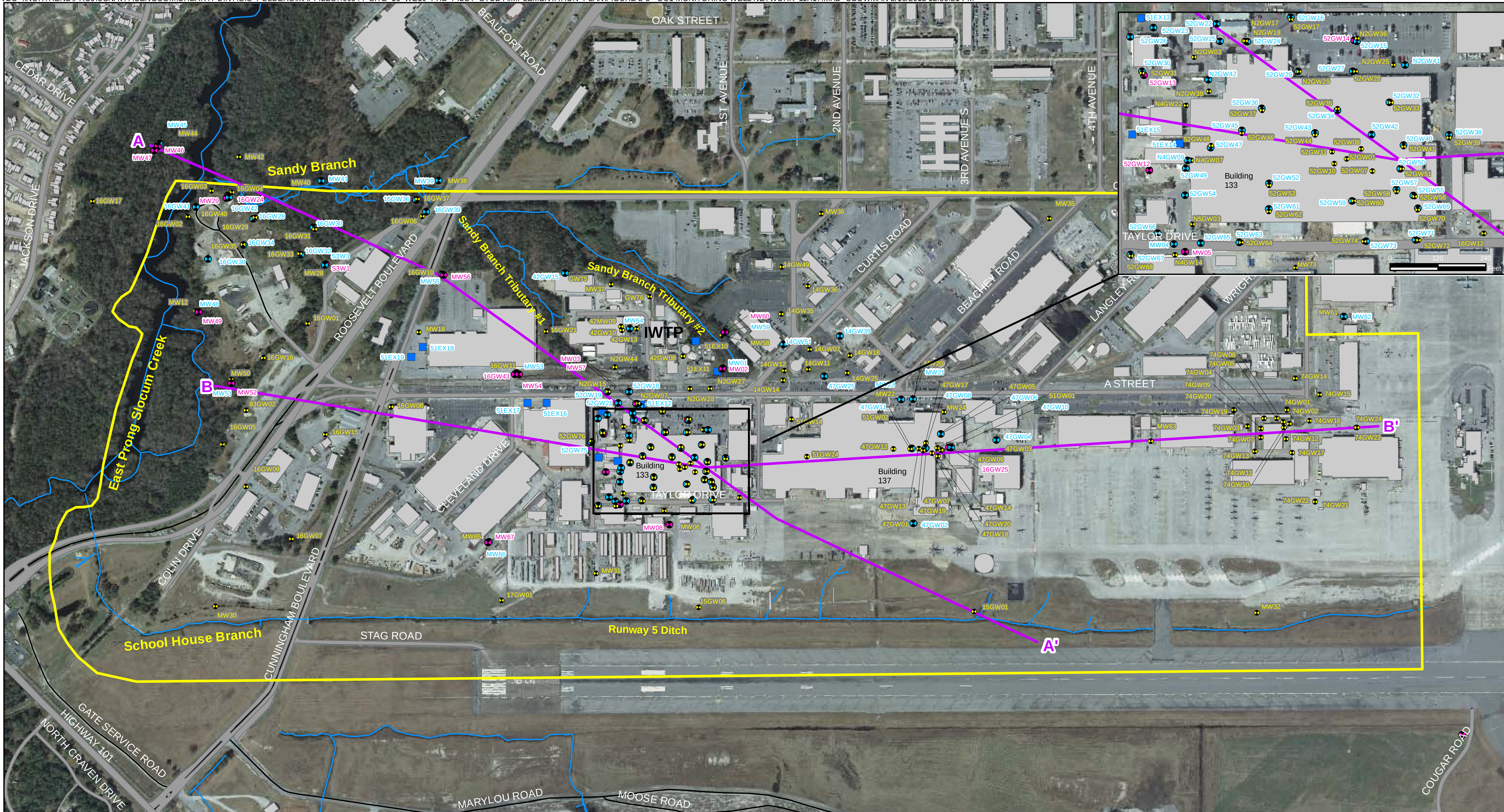


Figure 2-4
Simplified Conceptual Site Model of OU1
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-5 - OU1 MONITORING WELL NETWORK_11X17.MXD CBOWMAN 2/16/2012 12:50:21 PM



Legend

- Extraction Well
- Upper Surficial Monitoring Well
- Lower Surficial Monitoring Well
- Yorktown Monitoring Well
- Cross Section Transects
- Surface Water
- OU1 Boundary
- Existing Buildings

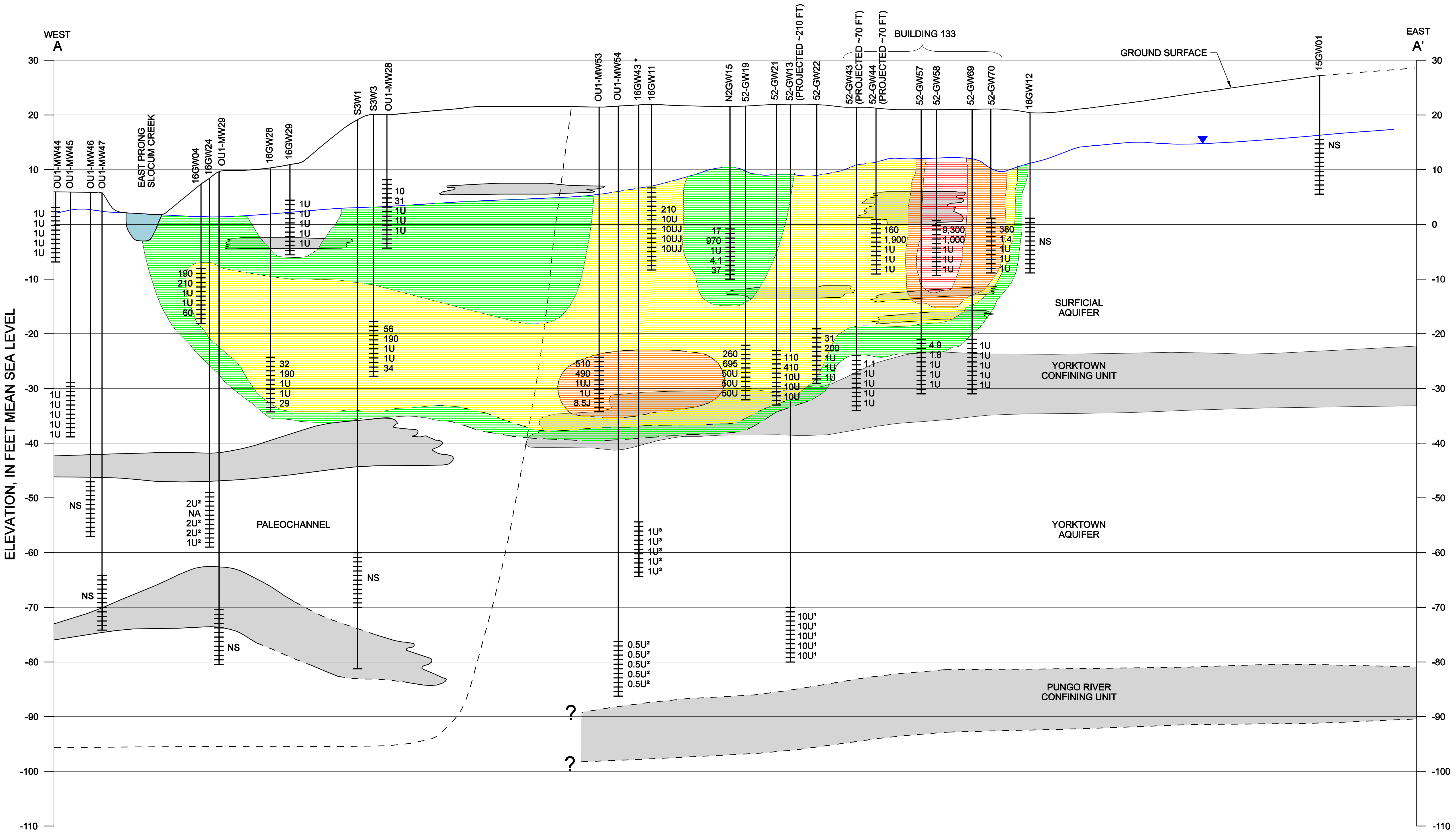
IWTP - Industrial Wastewater Treatment Plant

W N S E

0 600 1,200 Feet

Figure 2-5
OU1 Monitoring Well Network and
Location of Hydrogeologic Cross-Sections
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.



LEGEND

WELL SCREEN INTERVAL

LINE OF APPROXIMATELY EQUAL TCE ISOCONCENTRATION IN µg/L

PREDOMINANTLY COARSE-GRAINED MATERIAL

PREDOMINANTLY FINE-GRAINED MATERIAL

TCE ISOCONCENTRATION CONTOURS

3 – 30 µg/L

30 – 300 µg/L

300 – 3,000 µg/L

3,000 – 11,000 µg/L

>11,000 µg/L

NOTES

ALL ANALYTICAL DATA IS FROM THE SPRING 2009 SAMPLING EVENT UNLESS OTHERWISE NOTED.

1. ANALYTICAL DATA IS FROM THE APRIL AND MAY 2006 SAMPLING EVENT.
2. ANALYTICAL DATA IS FROM EITHER MARCH AND MAY 2005 SAMPLING EVENT.
3. ANALYTICAL DATA IS FROM THE AUGUST 2008 SAMPLING EVENT.

? - PUNGO RIVER CONFINING UNIT NOT DELINEATED IN THE WESTERN PORTION OF THE SITE.

CONCENTRATIONS ARE PRESENTED IN THE FOLLOWING ORDER:

TRICHLOROETHENE (TCE)
1,2 - DICHLOROETHENE (1,2 -DCE)
1,1,1 - TRICHLOROETHANE (1,1,1 -TCA)
1,1 - DICHLOROETHENE (1,1 - DCE)
VINYL CHLORIDE

ALL CONCENTRATIONS ARE IN µg/L

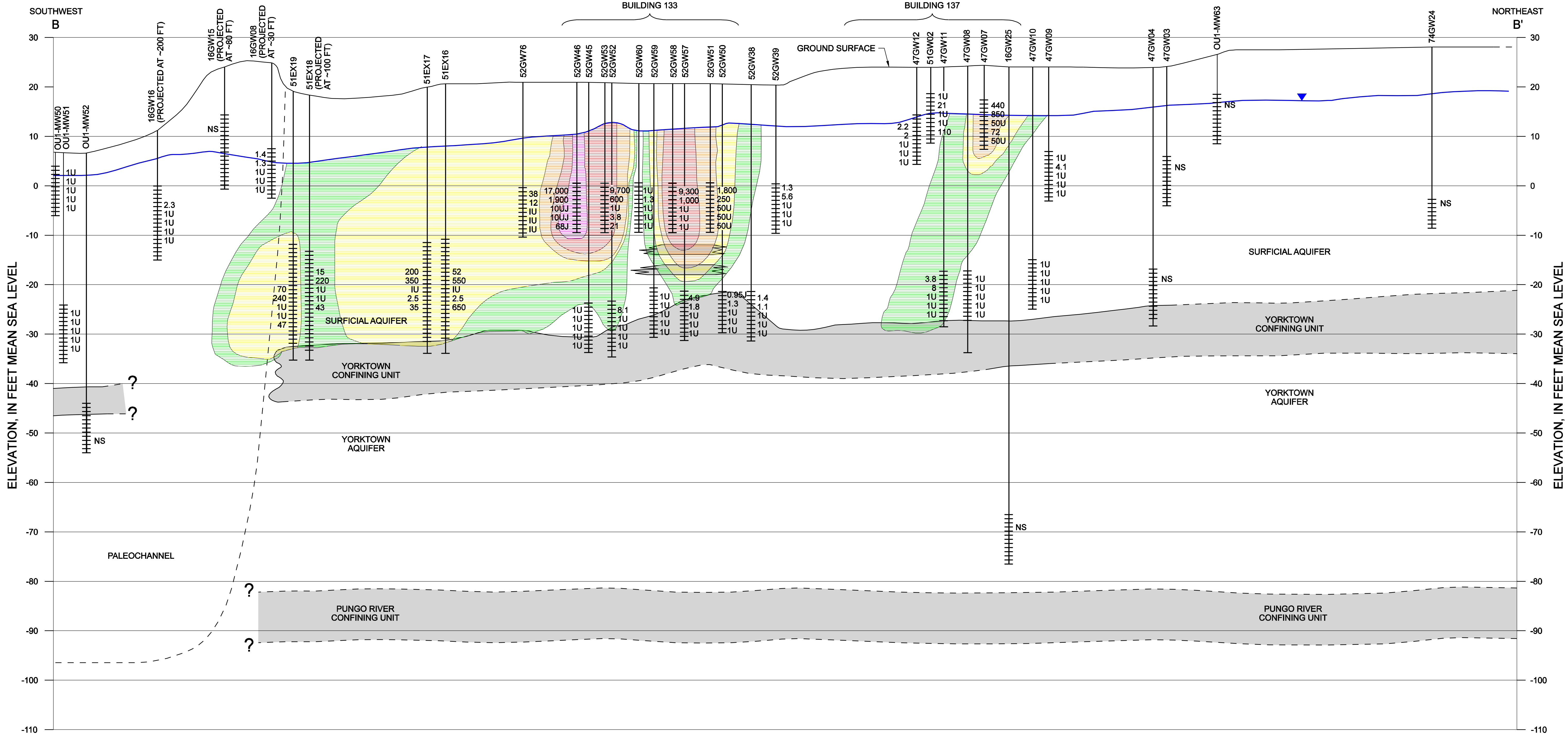
NA = NOT ANALYZED
µg/L = MICROGRAMS PER LITER
NS = NOT SAMPLED
J = ESTIMATED VALUE
NC2L FOR TCE = 3 µg/L (Jan 2010)

VERTICAL SCALE 10 0 300
APPROXIMATE HORIZONTAL SCALE (SCALE IN FEET)
VERTICAL EXAGGERATION = 30

Figure 2-6
VOC Isoconcentrations Cross Section A-A'
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

FILENAME: fn01g004_358454.dgn PLOT DATE: 12/28/2009

CH2MHILL



LEGEND

WELL SCREEN INTERVAL

LINE OF APPROXIMATELY EQUAL TCE ISOCONCENTRATION IN µg/L

PREDOMINANTLY COARSE-GRAINED MATERIAL

PREDOMINANTLY FINE-GRAINED MATERIAL

TCE ISOCONCENTRATION CONTOURS

3 – 30 µg/L

30 – 300 µg/L

300 – 3,000 µg/L

3,000 – 11,000 µg/L

>11,000 µg/L

ALL ANALYTICAL DATA IS FROM THE APRIL AND MAY 2006 SAMPLING EVENT UNLESS OTHERWISE NOTED.

1. ANALYTICAL DATA IS FROM THE MAY 2005 SAMPLING EVENT.
2. ANALYTICAL DATA IS FROM THE NOVEMBER 2005 SAMPLING EVENT.
3. ANALYTICAL DATA IS FROM THE MARCH 2000 SAMPLING EVENT.

CONCENTRATIONS ARE PRESENTED IN THE FOLLOWING ORDER:
TRICHLOROETHENE (TCE)
1,2 - DICHLOROETHENE (1,2 -DCE)
1,1,1 - TRICHLOROETHANE (1,1,1 -TCA)
1,1 - DICHLOROETHENE (1,1 - DCE)
VINYL CHLORIDE

ALL CONCENTRATIONS ARE IN µg/L

NA = NOT ANALYZED
µg/L = MICROGRAMS PER LITER
NS = NOT SAMPLED
J = ESTIMATED VALUE
NC2L FOR TCE = 3 µg/L (Jan 2010)

? - PUNGO RIVER CONFINING UNIT NOT DELINEATED IN THE WESTERN PORTION OF THE SITE.

VERTICAL SCALE 10, 0; 300

APPROXIMATE HORIZONTAL SCALE (SCALE IN FEET)

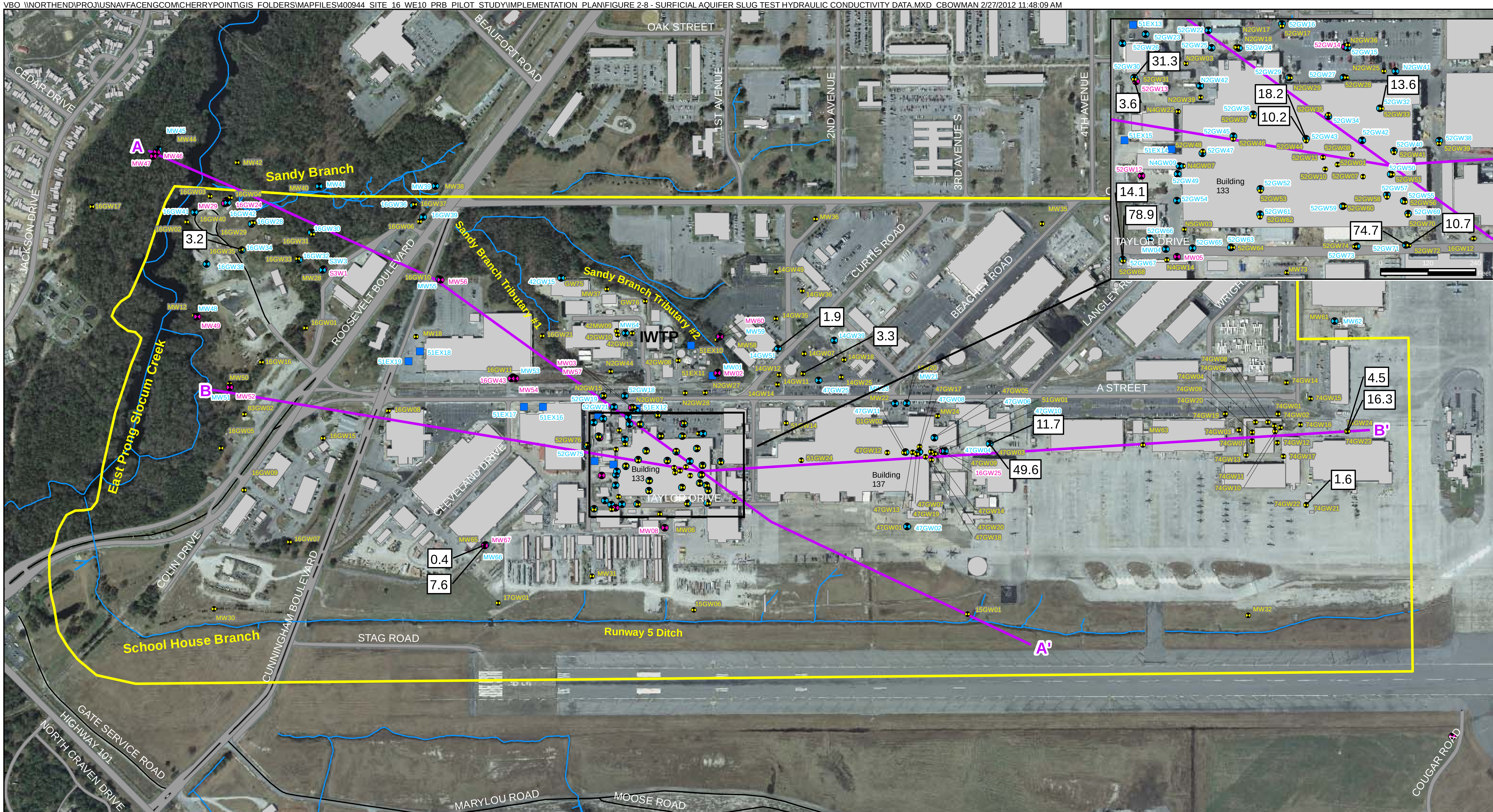
VERTICAL EXAGGERATION = 30

Figure 2-7
VOC Isoconcentrations Cross Section B-B'
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

FILENAME: fn01g005_358454.dgn PLOT DATE: 12/28/2009

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-8 - SURFICIAL AQUIFER SLUG TEST HYDRAULIC CONDUCTIVITY DATA.MXD CBOWMAN 2/27/2012 11:48:09 AM



Legend
- Extraction Well
- Upper Surficial Monitoring Well
- Lower Surficial Monitoring Well
- Yorktown Monitoring Well
- Cross Section Transects
- Surface Water
- OU1 Boundary
- Existing Buildings

Note:
- Hydraulic conductivity data in feet per day.
- Data from 2009 RI Addendum

0 600 1,200 Feet

IWTP - Industrial Wastewater Treatment Plant

Figure 2-8
Surficial Aquifer Slug Test Hydraulic Conductivity Data
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-9 - UPPER SURFICIAL AQUIFER POTENTIOMETRIC SURFACE CONTOUR MAP.MXD CBOWMAN 3/21/2012 11:08:57 AM

Legend

- Monitoring Well
- Site 16 Boundary
- Groundwater Flow Direction
- Groundwater Elevation Contour

1.14 - Groundwater Elevation Measurement

Notes:
All groundwater elevation measurements are in feet mean sea level

N W E S

0 70 140 Feet

Figure 2-9
Upper Surficial Aquifer Potentiometric Surface Contour Map
September 2011
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL®

Legend

- Monitoring Well
- Site 16 Boundary
- Groundwater Flow Direction
- Groundwater Elevation Contour

1.55 - Groundwater Elevation Measurement

Notes:
All groundwater elevation measurements are in feet mean sea level

N W E S

0 70 140 Feet

Figure 2-10
Lower Surficial Aquifer Potentiometric Surface Contour Map
September 2011
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-11 - PILOT STUDY LOCATION MAP.MXD CBOWMAN 3/21/2012 11:16:45 AM

Legend

- Upper Surficial Aquifer Monitoring Well
- Lower Surficial Aquifer Monitoring Well
- Upper Yorktown Aquifer Monitoring Well
- Proposed ZVI/Sand PRB
- Site 16 Boundary

N W E S

0 70 140 Feet

Figure 2-11
Pilot Study Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

Legend

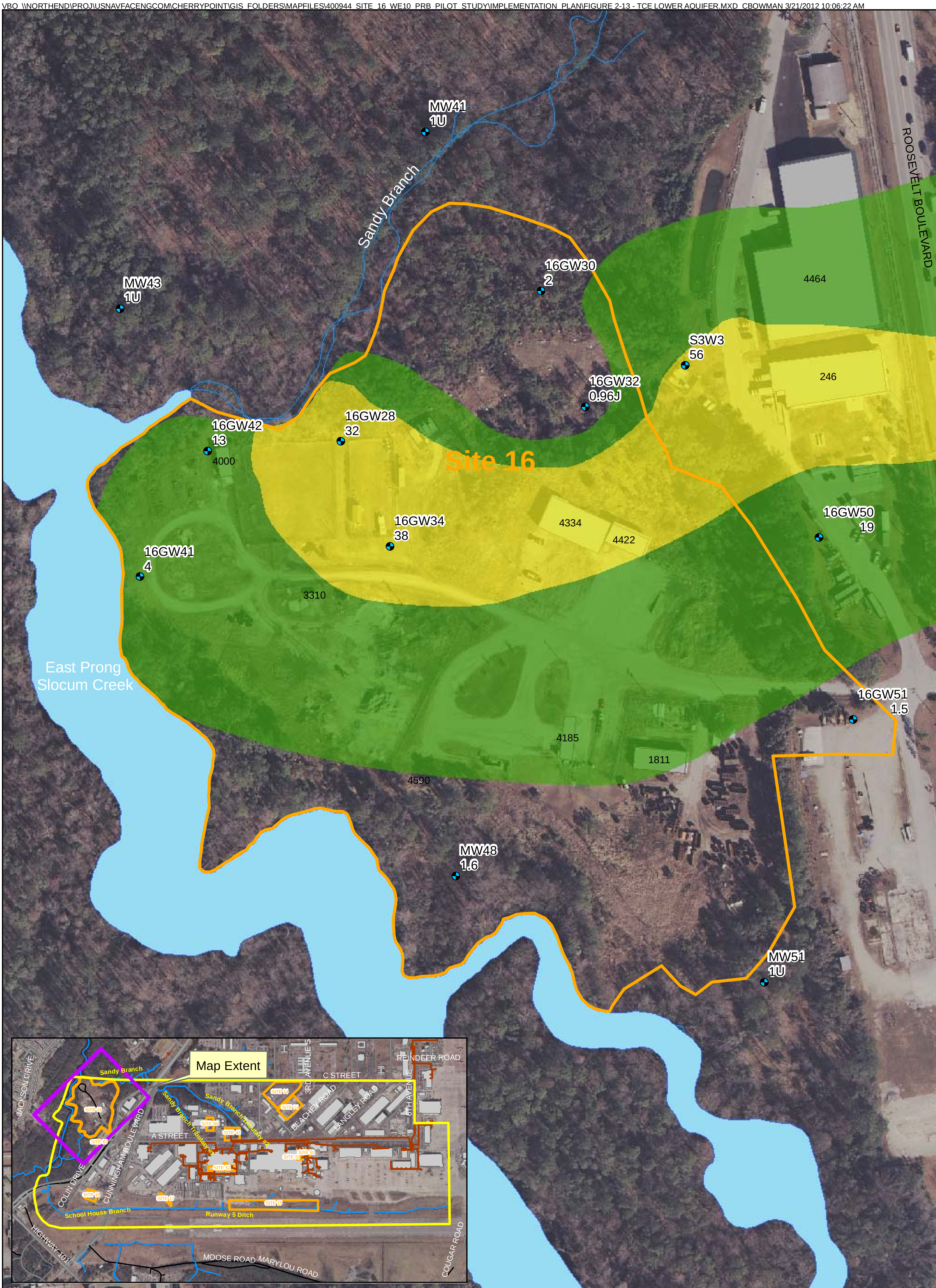
- Monitoring Well
- Site 16 Boundary
- Buildings
- 3 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L
- 3,000 - 11,000 µg/L
- > 11,000 µg/L

N W E S

0 70 140 Feet

Figure 2-12
TCE Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL



Legend

- Monitoring Well
- Site 16 Boundary
- Buildings
- 3 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L

N W E S

0 70 140 Feet

Figure 2-13
TCE Isoconcentration Map
Lower Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-14 - 1_2_DCE UPPER AQUIFER.MXD CBOWMAN 3/21/2012 10:07:00 AM

Figure 2-14
1,2 DCE Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-15 - 1_2_DCE LOWER AQUIFER.MXD CBOWMAN 3/21/2012 11:37:09 AM

Legend

- Monitoring Well
- Site 16 Boundary
- Buildings
- 70 - 700 µg/L
- 700 - 7,000 µg/L

N W E S

0 70 140 Feet

Figure 2-15
1,2 DCE Isoconcentration Map
Lower Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-16 - VC UPPER AQUIFER.MXD CBOWMAN 3/21/2012 10:08:12 AM

Legend

- Monitoring Well
- Site 16 Boundary
- Buildings
- 0.03 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L

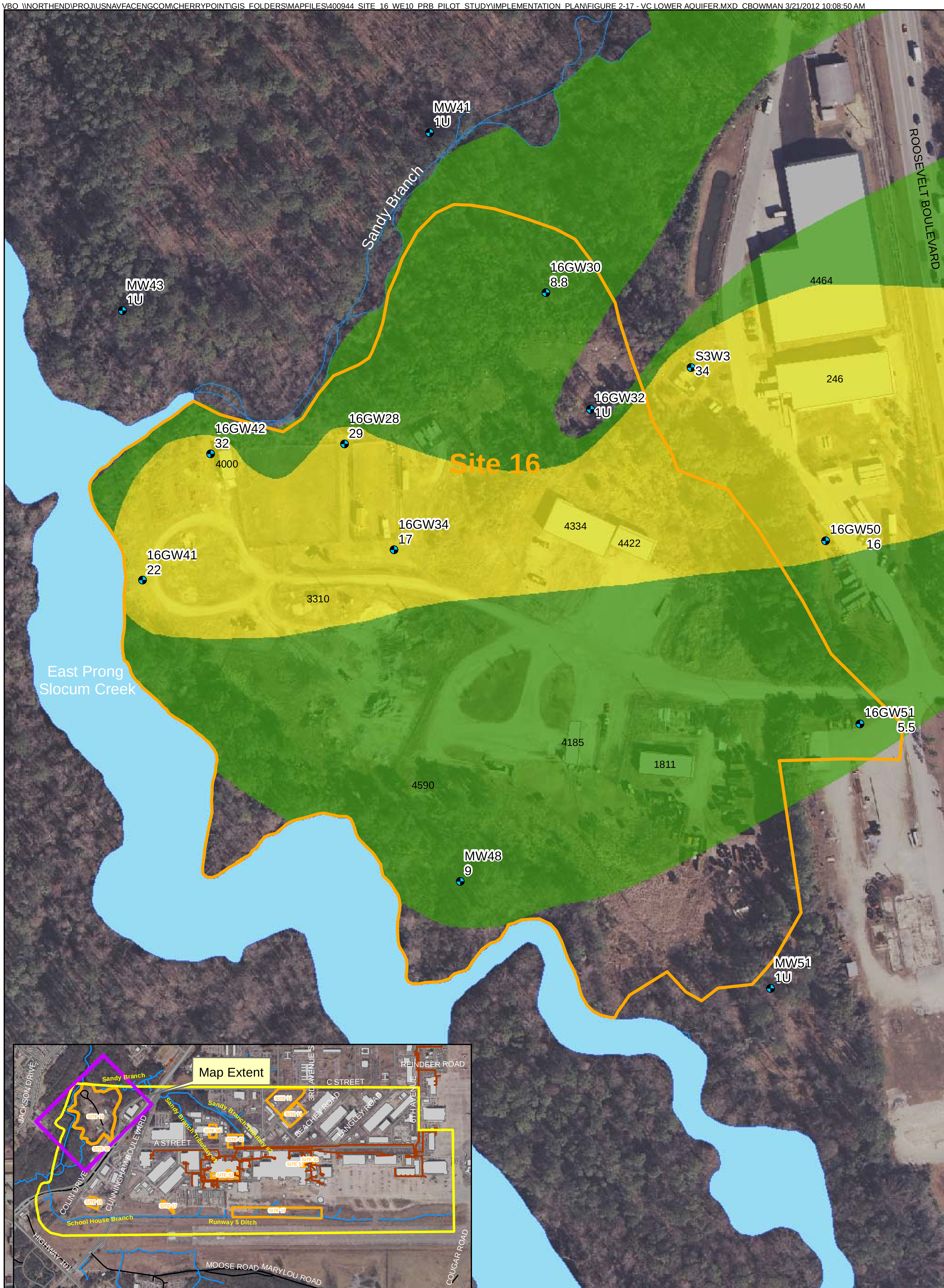
N
W E
S

0 70 140 Feet

Figure 2-16
VC Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 2-17 - VC LOWER AQUIFER.MXD CBOWMAN 3/21/2012 10:08:50 AM



Legend

- Monitoring Well
- Site 16 Boundary
- Buildings
- 0.03 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L

N
W E
S

0 70 140
Feet

Figure 2-17
VC Isoconcentration Map
Lower Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL®

SECTION 3

Pilot Study ZVI PRB Design Basis

This section presents an overview of the ZVI PRB technology and basis of design for the system. The specific implementation plan for the pilot study is presented in Section 4.

3.1 Technology Description

This section presents a brief technical overview of the technology, as well as the design parameters, assumptions, and methodology selected for implementation.

3.1.1 Permeable Reactive Barriers

PRBs are passive groundwater treatment systems that create a subsurface (in-situ) zone to treat contaminants dissolved in groundwater as they flow through. The PRB technology relies on natural hydraulic gradients to bring contaminants into the reactive treatment medium; thus, the ideal PRB is oriented perpendicular to groundwater flow.

For the pilot study, the reactive medium chosen was ZVI, to promote the in-situ chemical reduction (ISCR) of cVOCs. ZVI and ISCR are discussed further below. The ZVI PRB is expected to rapidly degrade chloroethenes to nontoxic end products as groundwater flows through the permeable reactive zone.

3.1.2 Zero Valent Iron

ZVI is commonly used as a reactive agent for PRBs. ZVI degrades chloroethenes using an abiotic reductive dechlorination process which occurs on the surface of the iron. Oxidation of the ZVI under anaerobic conditions yields hydrogen, which is used during the reductive dechlorination process. If DO is present in the groundwater as it enters the PRB, DO concentrations are quickly reduced along with the ORP. Once DO is depleted, the anaerobic and highly reducing conditions enhance abiotic reductive dechlorination, in which ethene and chloride are the primary nontoxic end products (Gavaskar et al., 2000).

If properly designed and installed, ZVI PRBs have been shown to be effective in reducing a wide range of dissolved chlorinated solvents in groundwater for up to 20 years or longer, without generation of toxic daughter products. Removal efficiencies of 90 percent or more are common.

3.2 Basis of Design

In addition to plume geometry and site hydrogeology, the ZVI PRB design was based on the results of a bench-scale ZVI column study and grain size analysis. These elements are discussed below.

3.2.1 PRB Alignment and Depth

The ZVI PRB will be installed in the western portion of OU1, approximately 250 ft east of the East Prong of Slocum Creek and approximately 125 ft southeast of Sandy Branch (**Figure 2-11**). The PRB will be installed to a target depth of 45 ft bgs, but if this depth cannot be reached due to equipment limitations, the PRB will be installed to a depth of 35 to 40 ft bgs, which is still expected to be protective of East Prong Slocum Creek for this portion of the plume. In this case, the second PRB would likely be installed using the method prescribed in the FS, injection of micro-scale iron into multiple vertical borings.

The PRB will be installed with a central curve (turn radius of approximately 100 ft), shaped to maintain a perpendicular orientation to the natural flow of groundwater in the OU1 Central Groundwater Plume across the 600-ft length of the PRB. The PRB is to be located close to the creek with room for downgradient monitoring, with easy site access.

3.2.2 Bench-Scale ZVI Column Study

In October and November of 2011, 4 gallons of groundwater were sampled from each of two monitoring wells within the PRB pilot study area (16GW34 [upper surficial] and 16GW35 [lower surficial]) and sent to Adventus in

Ontario, Canada for the purpose of conducting two ZVI bench-scale column studies using commercial granular iron material (-8 to +50 U.S. Standard Mesh Size [CC -1004] from Connelly GPM of Chicago, Illinois). The column studies were performed to estimate the site-specific degradation rates of VOCs in OU1 groundwater under flowing conditions in both the upper and lower surficial aquifers. These rates were then used to determine the required residence time in the ZVI PRB and the necessary thickness of the treatment zone. During the study, VOC concentrations were monitored at the inlet, outlet, and sampling ports of the column to determine when steady state was reached.

The study also monitored inorganic parameters (major cations, anions, and alkalinity) in the column influent and effluent to provide information about potential mineral precipitation in the reactive material caused by changing redox potential (Eh) and pH conditions.

The full bench-scale ZVI column study report is included as **Appendix A**, and the results are summarized below:

- Connelly iron (-8/+50 U.S. Mesh Size) degraded cVOCs present in the site groundwater.
- Based on the field anticipated half-lives at the 18 degrees Celsius field groundwater temperature and the cVOC concentrations tested, a residence time of 5 to 7 hours would be required in a ZVI PRB to achieve NCGWQS.
- Slow, but perceptible ZVI passivation was observed in one of the ZVI columns within the test period and was attributed to the formation of carbonate and iron oxyhydroxides precipitation on iron grains. Therefore, it is recommended that an engineering safety factor be included in ZVI volume design calculations for the PRB to promote long-term efficacy. A minimum of 0.08-ft ZVI thickness is recommended to accommodate this precipitation effect for every 10 years of expected operation.

Based on the positive results of the bench-scale column study, it is recommended that Connelly iron (-8/+50 U.S. Mesh Size), or iron of equivalent size and quality, be used for the ZVI PRB.

Although nitrate was not detected above method detection limits in the influent for the bench-scale ZVI column study, nitrate was detected in samples collected from monitoring wells in the area during the 2009 additional investigation activities, and ranged from non-detect to 1.3 mg/L. The average of nitrate detections was used as a conservative estimate of nitrate concentrations in groundwater in the pilot study area, approximately 0.46 mg/L. Additionally, based on an average nitrate reduction capacity of 1.3 mg nitrate/g iron for Connelly GPM (Envirometals Technologies, Inc., 2007), an effective porosity of 30 percent, and a seepage velocity of 0.2 ft/day, it is estimated that 0.039 inches per year of ZVI passivation may occur. Calculations for iron passivation due to both carbonate and nitrate are shown on **Table 3-1**.

Impact on Design

For a conservative 0.2 ft/day average linear horizontal groundwater velocity, 0.7-inches of ZVI would be required to provide a 7-hour residence time (**Table 3-1**). During early stages of the design, a 2-ft wide ZVI PRB with a loading factor of 20 percent by volume was incorporated to provide an adequate safety factor for long-term operation of the PRB. However, it was determined that an 18-inch wide ZVI PRB would provide the same treatment and would reduce costs. Therefore, the ZVI loading factor was modified to 26.7 percent by volume to maintain a constant ZVI tonnage (720 tons) for reduction of the PRB width from 2-ft to 1.5-ft (**Table 3-1**). This scenario provides adequate residence time to meet remedial goals while also providing a safety factor of approximately 7 in case field degradation rates do not reach those achieved during the column study and to account for potential passivation (**Table 3-1**).

3.2.3 Grain Size Analysis

In December 2011, 10 soil samples were collected and analyzed for grain size distribution from five locations shown on **Figure 4-1**. Utility location was conducted by East Carolina Locating Services within a 20-ft radius of each location in order to identify potential subsurface utilities and obstructions.

The samples were collected using direct-push technology (DPT) drilling techniques. At each of the 5 sampling locations, 1 soil sample was collected from 15 to 20 ft bgs (upper surficial aquifer) and another from 35 to 40 ft bgs (lower surficial aquifer). For each soil boring, cores were logged for lithological characterization (**Appendix B)**. These logs also show that no subsurface obstructions were encountered during DPT drilling.

The objective of the grain size sampling was to determine the optimal sand size to be used in the sand/ZVI mixture. Results of the grain size analysis sampling are summarized in Table B-1 of **Appendix B** and all laboratory results are also included in **Appendix B**. The results generally show that sands within the surficial aquifer generally range between 0.15 and 0.6 millimeters (mm) with a higher percentage of grain sizes less than 0.075 mm observed in the upper surficial sands.

Impact on Design

The range of grain size distribution in the formation sands is finer than the ZVI used in the bench-scale column study (-8 to +50 mesh) (Table B-1 and Figure B-1 of **Appendix B**), which will allow for appropriate transmissivity of groundwater across the PRB. The results on Figure B-1 were also compared to several commercially-available sand mixtures, which generally matched the grain size distribution of the ZVI. This range of grain size distribution (0.3 to 1.18 mm) is therefore recommended for use in the sand/ZVI mixture. Based on data from multiple sand vendors (**Appendix B**), it is recommended that an even blend of sands similar to the concrete and Ricci OON sands be used to best match the ZVI grain size distribution.

3.2.4 Construction Method

The PRB will be constructed using the DeWind One-Pass Trench System (continuous trenching), which has successfully been used at nearby Marine Corps Base Camp Lejeune. Continuous-trenching machines allow simultaneous excavation and backfilling without an open trench. Excavation is performed by a cutting chain immediately in front of a trench box (boot) that extends the width and depth of the treatment zone. Both the cutting chain and boot are attached to the trenching machine. As the trencher moves forward, reactive material or a material/sand mixture is added to the boot, creating a continuous treatment zone.

3.3 ZVI PRB Design Summary

The PRB will be installed perpendicular to the flow path of the downgradient portion of the OU1 Central Groundwater Plume, producing a treatment zone that allows the passage of water while treating site COCs. The PRB will be installed with a central curve with a 100-ft turn radius, shaped to maintain a perpendicular orientation to the natural flow of groundwater across the 600-ft length of the PRB.

The PRB is to be constructed using the DeWind one-pass trench system to a target depth of 45 ft, with a thickness of 18-inches and a total length of 600 ft. The PRB includes a target iron loading of 26.7 percent, or 355 cubic yards (720 tons) of granular ZVI. The remainder of backfill material will consist of clean sand, trucked in from an offsite source. Based on data from multiple sand vendors (**Appendix B**), it is recommended that a blend of sands similar to the concrete and Ricci OON sands be used to best match the ZVI grain size distribution. The ZVI/sand mixture will be placed in the bottom 40 ft of the trench. The top 5-ft will be backfilled using native soils. A summary of the ZVI PRB is included in **Table 3-2**.

TABLE 3-1

PRB Design Calculations

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Design Parameter Summary

Target PRB Depth:	45	ft bgs
Total PRB Thickness:	40	ft
Total PRB Width:	1.5	ft
Total PRB Length:	600	ft
ZVI Loading Factor:	26.65%	% by volume
Sand Loading Factor:	73.35%	% by volume
ZVI Bulk Density	2.405	g/cm^3
Sand Bulk Density	1.758	g/cm^3
Total ZVI	**355**	**cubic yards**
	720	**tons**
Total Sand	**978**	**cubic yards**
	1448	**tons**

Design Parameter Justification

<u>From Bench-Scale Column Study[1]</u>

Seepage Velocity:	0.2	ft/day			
Residence Time:	7	hours			
PRB Thickness:	0.058	ft	or	0.7	inches
20-yr Carbonate Passivation[2]:	0.160	ft	or	1.92	inches
20-yr Nitrate Passivation[3]:	0.065	ft	or	0.77	inches
TOTAL PRB Thickness:	0.283	ft	or	3.39	inches

Comments	PRB Thickness (ft)	ZVI Loading Factor[4]	ZVI (Cubic Yards)	ZVI (tons)	Sand Loading Factor	Sand (Cubic Yards)	Sand (tons)	Total Cubic Yards	Safety Factor (without Passivation thickness)[5]	Overall Safety Factor (Average 20-year Passivation thickness)[6]
ZVI Optimization	2.0	0.20	355.6	720.0	0.80	1,422	2,105	1,778	6.86	1.41
	1.5	**0.2665**	355.3	719.6	0.7335	978	1,448	1,333	6.85	1.41

[1]Most conservative values used in ranges from Adventus Bench-Scale Treatability Study TM (**Appendix B**)

[2]From Adventus Iron Passivation TM - 0.08 ft iron passivation due to carbonate precipitation over 10-year operational period (**Appendix B**)

[3]Based on average (0.46 mg/L) of nitrate detections in groundwater near pilot study area during 2009 additional investigation activities and 1.3 mg nitrate/g iron for Connelly GPM (Envirometals Technologies, Inc., 2007)

[4]ZVI Loading Factor modified to maintain constant ZVI tonnage to change from a 2-ft wide PRB at a 20 percent loading factor to a 1.5-ft wide PRB.

[5]Calculation does NOT include any safety factor due to iron passivation.

[6]Calculation INCLUDES 0.16 ft recommended by Adventus for passivation due to carbonate and 0.065 ft for passivation due to average nitrate concentration, **<u>for a 20-year operational period</u>**

ZVI Passivation Prediction for Nitrate

Nitrate Influent Concentration (mg/L)[1]	Seepage Velocity (ft/day)	Aquifer Porosity (%)	Nitrate Mass Flux (mg/day per cm^2)	Nitrate Reduction Capacity (mg NO_3-N/g Fe)[2]	Field Bulk Density (g/cm^3)	Nitrate Front Migration Rate (inch/year)	Nitrate Passivation in 10 years (ft)	Nitrate Passivation in 20 years (ft)
0.46	0.2	30	0.0008	1.3	2.4	0.039	0.032	0.065

Notes:

[1]Based on 0.46 mg/L average nitrate concentrations in groundwater near pilot study area during 2009 additional investigation activities.

[2]Envirometals Technologies, Inc. 2007. *Nitrate Reduction on Granular Iron and the Effects on Chlorinated Volatile Organic Compound Degradation* . Technical Note 2.08.

cm - centimeter
L - Liter
NO_3-N- nitrate nitrogen
Fe - iron
mg - milligrams

TABLE 3-2

Zero-Valent Iron Permeable Reactive Barrier Design Summary

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Parameter	Value
Groundwater velocity	0.2 ft/ day (73 ft per year)
Minimum ZVI thickness	0.7 inches
Design ZVI thickness	4.8 inches
Total PRB thickness	18 inches
ZVI Design Loading Factor	26.7 percent by volume
Total PRB Residence time	7.5 days
Length	600 feet
Top of PRB	5 ft bgs
Bottom of PRB	45 ft bgs
Saturated thickness (PRB height)	40 ft
ZVI volume	355 cubic yards
ZVI weight	720 tons (2.405 g/cubic centimeter)

Note:
Based on site geochemistry and the results of the bench-scale column study, the PRB is expected to be effective for approximately 20 years.

SECTION 4

Pilot Study Implementation

This section presents the implementation plan for the OU1 Central Groundwater Plume ZVI PRB pilot study.

Key tasks associated with the pilot study are summarized below:

- Installation of a 600-ft long, 18-inch wide, curved PRB to 45 ft bgs.
- Installation, development, and hydraulic testing of 15 new monitoring wells.
- Collection of samples at baseline, 3 months, 6 months, 9 months, 12 months, and 24 months for the 15 new monitoring wells and 4 existing wells. Analytical parameters will include select VOCs. In addition, field parameters will be analyzed during sampling events.

4.1 Site Preparation

Prior to trenching operations, site preparation activities will be conducted as described below.

4.1.1 Fence Removal

In preparation for PRB installation, two fenced areas in the pilot study area (**Figure 4-1**) will be temporarily disassembled. Fencing materials will be placed out of the way of construction activities as to prevent damage so they can be reassembled following PRB installation. Fence removal activities will be conducted by MCAS Cherry Point.

4.1.2 Overhead Power Line Removal

Following fence removal, electricity in the vicinity of the pilot study area outdoor lights will be turned off and power lines temporarily taken down for PRB trenching activities. Overhead power line removal activities will be conducted by MCAS Cherry Point.

4.1.3 Vegetation Clearance

Vegetation, including brush and trees, will be cleared in an area approximately 50 ft long and 40 ft wide in the northern portion of the PRB area. The vegetation will be removed to within 6 inches of the ground surface. Stumps and root-balls greater than 10 inches in diameter will be fully removed. All felled brush and trees will be mulched and left in place. Mulch will be spread evenly in the area from which the vegetation was cut. Downed trees or vegetation cannot be left inside the cleared areas and must be placed in such a manner that tripping hazards are not created.

4.1.4 Water Line Disconnection

A water line extending through the southern portion of the ZVI PRB (**Figure 4-1**) will be removed from service or re-routed in preparation for construction activities. CH2M HILL will work in coordination with MCAS Cherry Point to oversee this activity so that no Base operations are disrupted.

4.1.5 Soil Staging Area Construction

A soil staging area will be established near the central portion of the PRB area, north of Mockingbird Hill Road (**Figure 4-1**). It is estimated that an area approximately 90 ft by 140 ft will be required to stage the estimated 2,800 cubic yards of native soils that may be removed during trenching activities. The staging area will be graded such that water flows to a small sump, installed approximately 2-ft below grade.

A berm will be created around the staging area using hay bales or clean soils. The ground surface and berm material will be covered with 10-mil plastic and secured with sandbags. A mesh material, similar to that used for the silt fence, will be placed above the sump to allow water to flow through. The collected water will then be pumped to a container or tank for transportation to the MCAS Cherry Point IWTP, as discussed in Section 5.

4.1.6 Silt Fence Construction

A silt fence will be constructed between the entire construction area and the creek to ensure that no materials flow over the berm from the stockpile staging area, and that no other materials from ZVI/sand mixing enter Slocum Creek, as shown in **Figure 4-1**.

Silt fence will be a woven geotextile produced by the manufacturer specifically for this use. The fabric will have a minimum height of 3 ft. Filter fabric may be fastened in place by stake or other accepted means. Posts will be placed a maximum of 6 ft apart. The bottom of the fabric will be entrenched in the ground at least 4 inches.

4.1.7 Work Platform Construction

The one-pass trenching equipment requires a stable and level work platform. Grading activities will be conducted upon completion of vegetation clearance. Any areas with steep grades (anticipated in the area of vegetation removal) will be filled to bring the area level with the surrounding soils. For stability during construction, the top of the work platform will be at least 6 ft above the water table.

4.1.8 PRB Corridor Survey

A survey for the vertical and horizontal coordinates for points along the centerline of the PRB will be conducted (**Figure 4-2**) by a North Carolina licensed Professional Land Surveyor. Stakes will be placed every 25 ft along the 600-ft PRB. At each stake location, vertical coordinates of the ground surface relative to mean sea level will be collected.

4.1.9 Utility Location

Utility locating will consist of marking the lateral extent (i.e., footprint) of potential subsurface utilities and obstructions within an approximately 12,000-square-foot (20-ft by 600-ft) corridor centered on the PRB wall to depths of 10 ft. CH2M HILL will coordinate with Base personnel and a third party professional utilities locating subcontractor to identify subsurface structures that could be impacted by drilling and PRB installation activities. In addition, the North Carolina One Call Center (ULOCO) will be called to mark-out utilities. A record of each utility mark-out ticket will be retained to document that ULOCO was contacted.

Geophysical Locating

- Geophysical locating will be conducted to identify potential subsurface obstructions possibly associated with construction debris to depths of 10 ft bgs within the PRB wall corridor.
- The geophysical locating will consist of electromagnetic locating using the Geonics EM61-MK2 time domain electromagnetic (TDEM) instrument and ground-penetrating radar (GPR). The investigation area (**Figure 4-2**) will initially be surveyed utilizing the EM61-MK2 to identify the footprint of potential subsurface obstructions. Positioning will be maintained using a global positioning system (GPS).
- Anomalies identified with the EM61-MK2 potentially indicative of subsurface utilities or obstructions will be further characterized using GPR. GPR will also be used to identify potential non-metallic obstructions.

Identified Utilities

Identified utilities which cannot be avoided during PRB installation will be re-located or temporarily removed and re-installed upon coordination with MCAS Cherry Point. Suspected utilities identified using the Base GIS layers include a water line and low voltage power line. In addition, overhead power lines are present in the area and will be temporarily disconnected during PRB construction.

4.2 PRB Installation

As detailed below, the PRB installation process will include the following components: sand/ZVI mixing, trenching, medium placement, and residuals management (discussed in Section 5). The PRB will be constructed in accordance with specific quality assurance/quality control (QA/QC) measures, which are detailed and included in **Appendix C**, the Construction Quality Management Plan (CQMP).

4.2.1 Sand/ZVI Mixing

ZVI will be delivered to the site in super sacks and sand will be delivered in dump trucks. The ZVI and sand will be stored in the staging area and covered with plastic to keep the materials dry. ZVI and sand will be mixed into a homogenous blend in batches using an Elkin mixer on a volumetric basis. Water will be added, as necessary, to make the ZVI and sand mixture flow, and to ease mixing and placement. The uniformity of the mixture will be assessed with a magnetic iron separation test, discussed below. The ZVI and sand will be blended until results of magnetic separation tests show that the mixture meets or exceeds the minimum specified ZVI-to-sand ratio. The size of each batch will be determined by the selected subcontractor based on the size of the mixer and handling equipment available. The ZVI/sand mixture will be moved via front-end loader to the hopper for placement in the PRB after an acceptable mix ratio is achieved. The area where sand and ZVI will be staged and mixed is shown on **Figure 4-1**.

Quality Assurance and Quality Control

During sand/ZVI mixing, field testing will be conducted for QA/QC purposes. Periodically during the mixing process, samples will be collected to ensure thorough mixing. Testing will be conducted on a minimum of every 50 cubic yards of material.

CH2M HILL will use several methods, as listed below, to verify that the mixture conforms to the design mix recipe:

- The quantities of materials will be confirmed by verifying the manufacturer tags on the ZVI super sacks.
- Mixed samples will be collected and analyzed in the field using the magnetic separation testing (as described in this section). Samples of the mixture will be collected to test the iron content in the field to ensure that adequate mixing and a minimum percent ZVI by mass are achieved. The minimum ZVI percent by mass is 26.7 percent. The separation method below will be used in the field to obtain results within a short timeframe (results should be available within 20 minutes). If the results indicate that thorough mixing throughout the treatment area has not been achieved (does not meet or exceeds the minimum specified ZVI-to-sand ratio), the mixing process will be adjusted accordingly and the number of samples collected during mixing will be increased.
- At the end of each day, CH2M HILL will compare recorded results and quantities with the subcontractor's records. Any discrepancies will be resolved. If resolution is not possible, discrepancies will be noted, and the CH2M HILL Project Manager (PM) will be notified. A copy of the daily log and QA/QC sampling log is contained in **Appendix C**.

Magnetic Separation Testing

The magnetic testing procedure is outlined below.

1. Weigh the empty sample collection containers.
2. Collect samples (about 250 to 1,000 grams) of the iron-sand mixture from the discharge of the mixing device.
3. Weigh the sample container and the sample and record the weight of each. Determine the net weight of the sample by subtracting the empty sample container weight. A suitable weighing device that can be calibrated must be used. Calibration of weighing device will be checked daily.
4. Dry the sample. If it cements together during drying, lightly break up the sample, weigh, and record the net weight.
5. Spread the sample out in a suitable container (e.g., bowl, pan, or cardboard box).

6. Cover the magnet (using a plastic bag or similar material) to allow the magnetic particles to be easily separated from the magnet.
7. Pass the magnet over the sample to remove the magnetic fraction. Care must be taken to minimize the trapping of sand particles within the iron grains. Remove the magnetic fraction from the magnet and place in a container.
8. Continue passing the magnet over the material until no more magnetic material is removed. Mixing of the non-magnetic fraction between passes may be required to obtain all the magnetic particles.
9. The magnetic fraction might contain some non-magnetic (sand) particles. Repeat Steps 5 to 8 at least three more times to ensure that the magnetic and non-magnetic fractions are completely separated. After each separation, the non-magnetic fraction should be added to the non-magnetic fraction from the previous separation.
10. Weigh the magnetic and non-magnetic fractions and record the weights. The total net weight of the magnetic and non-magnetic fractions should be the same as the total weight prior to separation.
11. Determine the dry iron net weight and percentage.

4.2.2 Trenching and Medium Placement

Excavation of the trench and placement of the reactive media will be conducted using the DeWind One-Pass Trenching System. This specialized equipment will simultaneously excavate and backfill the PRB trench to limit the risk of sidewall failure and groundwater accumulation during construction.

Once the DeWind One-Pass Trenching System has cut through the formation and reaches the target depth, the ZVI and sand mixture will be loaded into the system hopper via front-end loader. Formation sands will be removed and simultaneously replaced with the ZVI/sand fill mixture. The ZVI/sand mixture will be added to 5 ft bgs. A geotextile will then be placed above the ZVI-sand mixture and the remaining excavation depth (approximately 5 ft) will be backfilled with clean sand or site soils will be placed over it, to prevent the clean backfill material from settling into the ZVI-sand mix.

4.2.3 Residuals Management

During construction, accumulated soils will be moved to the soil staging area using a lined dump truck to be dewatered and sampled. The excavated material will be characterized and either re-used or properly disposed in accordance with Section 5 of this Implementation Plan.

4.2.4 Site Restoration

The surface area disturbed by PRB construction will be restored by patching the area to match the adjacent ground surfaces. Upon completion of the trenching, the trench will be filled to grade using soils from the staging area and compacted using excavation equipment. Restoration activities also include replacement of removed roadways, grading, and re-vegetation. These activities are discussed below.

Roadway

Roadway areas will be restored with crusher run gravel. Crusher run gravel will be separated from the backfill using a geotextile. The minimum gravel thickness will be 6-inches.

Grading

Final grade will match with the surrounding grade and ensure proper area drainage. The slope will be designed to maintain the soil stability and prevent erosion, and will be consistent across the area to prevent water impoundment.

Re-vegetated Areas

Areas disturbed by the excavation and other project activities that are not under pavement will be re-vegetated. The areas will be vegetated with an acceptable mix of grass mix to match the surrounding areas.

4.2.5 As-Built Survey

Following PRB installation, the final location of the ZVI PRB will be surveyed in by a Professional Land Surveyor licensed in the state of North Carolina.

4.2.6 Demobilization

Following completion of all field activities, all personnel, equipment, temporary facilities, utilities, and subcontractors will be demobilized from the site. In addition, any remaining debris or other wastes generated during the work will be removed and properly disposed. Prior to demobilization, a site inspection will be conducted with the Navy or Base representative. Any deficiencies noted on the inspection will be corrected prior to demobilization.

4.3 Monitoring Well Installation

Immediately following trench installation, 15 monitoring wells will be installed using rotosonic drilling techniques within the study area (16GW53 to 16GW67) to monitor the effectiveness of the PRB (**Figure 4-1)**. Utility locating will be conducted at a total of 15 monitoring well locations within a 20-ft radius of each location to identify potential subsurface utilities and obstructions prior to planned drilling activities. Proposed well construction details and the rationale for each of their locations, also detailed in the UFP-SAP (CH2M HILL, 2012), are provided in **Table 4-1**.

Each monitoring well will be installed using a 10-ft section of 2-inch ID 0.010-inch slot polyvinyl chloride (PVC) screen. Monitoring well installation procedures are provided in the UFP-SAP (CH2M HILL, 2012). **Table 4-1** includes the screened intervals of each monitoring. Each monitoring well will be completed approximately 3 ft above ground surface with a lockable, steel protective stickup cover and 2-ft x 2-ft x 4-inch concrete pad. Four painted bollards (3.5 ft tall and 4-inch diameter) will be placed at each corner of the concrete pad, and each will be painted bright yellow.

For the installation of each monitoring well, cores will be logged for lithological characterization on a boring log and final well installation information will be indicated on a well construction diagram. Monitoring wells will be installed and developed immediately following installation of the PRB (rather than prior to PRB installation) to prevent damage of the newly installed monitoring wells during PRB trenching activities and to maintain the distances of monitoring wells from the PRB itself in case placement of the PRB is modified due to previously unidentified subsurface obstructions. Additional details are provided in the UFP-SAP (CH2M HILL, 2012).

4.3.1 Well Development

Following monitoring well installation, the fifteen newly installed wells will be developed by surging (with a surge block) and over-pumping. All development activity must be coordinated and observed by a CH2M HILL Geologist. Well development will be considered complete when visible sediment is removed or one hour of active development has been completed, whichever is shorter. CH2M HILL will monitor field parameters (conductivity, temperature, pH, dissolved oxygen, redox potential, and turbidity) during development. Development pumping and surging will not start until the last pumped grout in the well has had at least 24 hours to cure. Development water will be disposed of at the IWTP in accordance with procedures discussed in Section 5.

4.4 Groundwater Monitoring

4.4.1 Baseline Groundwater Sampling

New and existing monitoring wells within the pilot study area will be gauged and sampled following their installation and development once the PRB is completed to begin the PRB performance monitoring. The resulting laboratory and analytical data and field geochemical data will be used to establish baseline conditions in the area. Subsequent data will be compared to baseline conditions to evaluate performance during the pilot study.

Following installation, each monitoring well will be opened and screened at the well head for VOCs and recorded in log books. After all wells are opened, the water levels will be given time to equilibrate before being gauged. Once wells are adequately equilibrated, all newly installed monitoring wells will be gauged for depth to groundwater and depth to bottom and results will be recorded in log books. Existing wells 16GW28, 16GW29, 16GW34, and 16GW35 will also be screened and gauged (**Figure 4-1**, **Table 4-1**).

Groundwater samples will be collected for the baseline groundwater sampling event from the 15 newly installed monitoring wells and the 4 existing monitoring wells, as listed in **Table 4-1**. The groundwater sample analyses parameters that will be measured during each sampling event are listed in **Table 4-2**. All sample handling and analysis will be conducted in accordance with the Master Quality Assurance Plan (AGVIQ/CH2M HILL, 2004b).

The samples will be analyzed for the following VOCs, which were identified as COCs during the RI:

- 1,1,1-TCA
- 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)
- 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)
- 1,1,2-TCA
- 1,1-DCA
- 1,1-DCE
- 1,2-DCA
- cis-1,2-DCE
- Trans-1,2-dichloroethene (trans-1,2-DCE)
- Bromodichloromethane
- Bromoform
- Chloromethane
- Dichlorodifluoromethane (Freon-12)
- Methylene chloride
- PCE
- TCE
- VC

Additionally, the following water quality parameters will be measured using field tests during the groundwater monitoring events:

- pH
- DO
- ORP
- Nitrate
- Sulfate
- Ferrous iron
- Manganese
- Temperature
- Specific conductance
- Turbidity

Purge water will be disposed of at the IWTP in accordance with procedures discussed in Section 5.

4.4.2 Slug-Testing

To further characterize the surficial aquifer at Site 16, rising head slug tests will be performed on 4 to 8 of the 15 newly installed monitoring wells (16GW53 to 16GW67). The slug testing will consist of submerging a poly bailer or solid cylinder (PVC or stainless steel) of known volume (slug) in a test well, allowing the static water level time to equilibrate, rapidly removing the slug, and recording the changes in head over time. The test will be allowed to continue until the water level returns to within 10 percent of the original static water level.

Slug test equipment and decontamination procedures will be used in accordance with CLEAN Standard Operating Procedures (SOPs) and MCAS Cherry Point MFSPs (AGVIQ/CH2M HILL, 2004a) and will include a data logger and pressure transducer, a nylon rope, and a bailer or solid PVC or stainless steel slug.

4.4.3 Post-PRB Installation Monitoring

Groundwater samples will be collected from the ZVI PRB pilot study area to monitor the effectiveness of the PRB. In addition to the baseline sampling performed shortly after PRB installation, groundwater monitoring will be conducted after 3, 6, 9, 12, and 24 months following PRB installation. Groundwater sampling will be conducted in accordance with the UFP-SAP, which is being issued under separate cover.

Post-PRB installation groundwater samples will be collected from the 15 newly installed monitoring wells (16GW53 to 16GW67) and 4 existing monitoring wells (16GW28, 16GW29, 16GW34, and 16GW35), as shown on **Figure 4-1.** The groundwater analyses and parameters that will be measured in the field are listed in **Table 4-2**. All sample handling and analysis will be conducted in accordance with the Master Quality Assurance Plan (AGVIQ/CH2M HILL, 2004b).

4.5 Monitoring Well Survey

Following installation of the PRB, the vertical and horizontal coordinates, for both top-of-casing and ground level elevations for fifteen (15) newly installed monitoring well locations within the OU1 PRB Pilot Study Area will be surveyed (**Figure 4-1**). The survey will be conducted by a North Carolina licensed Land Surveyor.

TABLE 4-1

Well Construction Details

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Pilot Study	Well ID	Surficial Aquifer Zone	Total Well Depth (ft bgs)	Screen[a] Length (ft)	Screen Interval (ft bgs)	Installation Rationale
Proposed Monitoring Wells	16GW53	Upper Surficial	26	10	15 - 25	Located northeast of PRB to evaluate the COC concentrations in the low-concentration portion of the upper surficial aquifer plume that is not intercepted by the PRB to the northeast.
	16GW54	Lower Surficial	46	10	35 - 45	Located northeast of PRB to evaluate the COC concentrations in the low-concentration portion of the lower surficial aquifer plume that is not intercepted by the PRB to the northeast.
	16GW55	Upper Surficial	26	10	15 - 25	Located upgradient of the northeastern portion of the PRB to evaluate COC concentrations in the upper surficial aquifer entering the PRB in the northeastern portion (will be compared to downgradient well 16GW29).
	16GW56	Lower Surficial	46	10	35 - 45	Located upgradient of the northeastern portion of the PRB to evaluate COC concentrations in the lower surficial aquifer entering the PRB in the northeastern portion (will be compared to downgradient well 16GW28).
	16GW57	Upper Surficial	26	10	15 - 25	Located upgradient of the central portion of the PRB to evaluate COC concentrations in the upper surficial aquifer entering the PRB at the curve.
	16GW58	Lower Surficial	46	10	35 - 45	Located upgradient of the central portion of the PRB to evaluate COC concentrations in the lower surficial aquifer entering the PRB at the curve.
	16GW59	Upper Surficial	26	10	15 - 25	Located downgradient of the central portion of the PRB to evaluate COC concentrations in the upper surficial aquifer flowing out of the PRB at the curve (will be compared to upgradient well 16GW57).
	16GW60	Lower Surficial	46	10	35 - 45	Located downgradient of the central portion of the PRB to evaluate COC concentrations in the lower surficial aquifer flowing out of the PRB at the curve (will be compared to upgradient well 16GW58).
	16GW61	Lower Surficial (Deeper portion)	56	10	45 - 55	Located downgradient of the central portion of the PRB to evaluate whether impacted groundwater is flowing under the PRB.
	16GW62	Upper Surficial	26	10	15 - 25	Located upgradient of the southern portion of the PRB to evaluate COC concentrations in the upper surficial aquifer entering the PRB in the southern portion.
	16GW63	Lower Surficial	46	10	35 - 45	Located upgradient of the southern portion of the PRB to evaluate COC concentrations in the lower surficial aquifer entering the PRB in the southern portion.
	16GW64	Upper Surficial	26	10	15 - 25	Located downgradient of the southern portion of the PRB to evaluate COC concentrations in the upper surficial aquifer flowing out of the PRB in the southern portion (will be compared to upgradient well 16GW62).
	16GW65	Lower Surficial	46	10	35 - 45	Located downgradient of the southern portion of the PRB to evaluate COC concentrations in the lower surficial aquifer flowing out of the PRB in the southern portion (will be compared to upgradient well 16GW63).
	16GW66	Upper Surficial	26	10	15 - 25	Located south of the PRB to evaluate the COC concentrations in the low-concentration portion of the upper surficial aquifer plume that is not intercepted by the PRB to the south.
	16GW67	Lower Surficial	46	10	35 - 45	Located south of the PRB to evaluate the COC concentrations in the low-concentration portion of the lower surficial aquifer plume that is not intercepted by the PRB to the south.
Existing Monitoring Wells	16GW28	Lower Surficial	45.5	10	35.5 - 45.5	Located downgradient of the northeastern portion of the PRB to evaluate COC concentrations in the lower surficial aquifer leaving the PRB in the northeastern portion (will be compared to upgradient well 16GW56).
	16GW29	Upper Surficial	15	10	5 - 15	Located downgradient of the northeastern portion of the PRB to evaluate COC concentrations in the upper surficial aquifer leaving the PRB in the northeastern portion (will be compared to upgradient well 16GW55).
	16GW34	Lower Surficial	46.5	10	36.5 - 46.5	Located upgradient of the central portion of the PRB.
	16GW35	Upper Surficial	15	10	5 - 15	Located upgradient of the central portion of the PRB.

Notes:

[a] 2-inch diameter 0.010-inch machine slot Sch. 40 PVC screen for monitoring wells

ft - feet

ft bgs - feet below ground surface

TABLE 4-2
Sample Summary
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

Navy CLEAN 8012 CTO-WE10 Cherry Point OU1 Site 16						Analysis Group	VOC	GRAINSIZE
						Preparation and Analytical Method	SW-846 8260B	ASTM D422
						Analytical Laboratory / Analytical SOP Reference	APPL / ANA8260B	Cooper Testing Labs / N/A
						Data Package Turnaround Time (TAT)	Standard 28 Calendar-day TAT	Standard 28 Calendar-day TAT
						Container Type / Volume Required	Three of 40mL VOA vials; no headspace	One of 8oz Jar; Fill Completely
						Preservative	HCl to pH < 2; Cool to 4°C	None (OK to cool)
						Holding Time (Preparation/Analysis)	14 days to Analyze when properly preserved	N/A
Site	**Matrix**	**Station ID**	**Sample ID**	**Coordinates**		**Depth / Sampling Interval**		
				X	**Y**			
OU1 / Site 16	GW	16GW28	OU1-16GW28-MMYY	421876.93	2627325.49	Screened Interval	1	
OU1 / Site 16	GW	16GW29	OU1-16GW29-MMYY	421888.35	2627326.37	Screened Interval	1	
OU1 / Site 16	GW	16GW34	OU1-16GW34-MMYY	421717.5	2627400.13	Screened Interval	1	
OU1 / Site 16	GW	16GW35	OU1-16GW35-MMYY	421716.09	2627392.88	Screened Interval	1	
OU1 / Site 16	GW	16GW53	OU1-16GW53-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW54	OU1-16GW54-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW55	OU1-16GW55-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW56	OU1-16GW56-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW57	OU1-16GW57-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW58	OU1-16GW58-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW59	OU1-16GW59-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW60	OU1-16GW60-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW61	OU1-16GW61-MMYY	TBD	TBD	~50' bgs	1	
OU1 / Site 16	GW	16GW62	OU1-16GW62-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW63	OU1-16GW63-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW64	OU1-16GW64-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW65	OU1-16GW65-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	GW	16GW66	OU1-16GW66-MMYY	TBD	TBD	~20' bgs	1	
OU1 / Site 16	GW	16GW67	OU1-16GW67-MMYY	TBD	TBD	~40' bgs	1	
OU1 / Site 16	SB	OU1-16SB01	OU1-16SB01-1520-MMYY	TBD	TBD	15-20' bgs		1
			OU1-16SB01-3540-MMYY	TBD	TBD	35-40' bgs		1
OU1 / Site 16	SB	OU1-16SB02	OU1-16SB02-1520-MMYY	TBD	TBD	15-20' bgs		1
			OU1-16SB02-3540-MMYY	TBD	TBD	35-40' bgs		1
OU1 / Site 16	SB	OU1-16SB03	OU1-16SB03-1520-MMYY	TBD	TBD	15-20' bgs		1
			OU1-16SB03-3540-MMYY	TBD	TBD	35-40' bgs		1
OU1 / Site 16	SB	OU1-16SB04	OU1-16SB04-1520-MMYY	TBD	TBD	15-20' bgs		1
			OU1-16SB04-3540-MMYY	TBD	TBD	35-40' bgs		1
OU1 / Site 16	SB	OU1-16SB05	OU1-16SB05-1520-MMYY	TBD	TBD	15-20' bgs		1
			OU1-16SB05-3540-MMYY	TBD	TBD	35-40' bgs		1

TABLE 4-2

Sample Summary

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Navy CLEAN 8012 CTO-WE10 Cherry Point OU1 Site 16						Analysis Group	VOC	GRAINSIZE
						Preparation and Analytical Method	SW-846 8260B	ASTM D422
						Analytical Laboratory / Analytical SOP Reference	APPL / ANA8260B	Cooper Testing Labs / N/A
						Data Package Turnaround Time (TAT)	Standard 28 Calendar-day TAT	Standard 28 Calendar-day TAT
						Container Type / Volume Required	Three of 40mL VOA vials; no headspace	One of 8oz Jar; Fill Completely
						Preservative	HCl to pH < 2; Cool to 4°C	None (OK to cool)
						Holding Time (Preparation/Analysis)	14 days to Analyze when properly preserved	N/A
Field QC Samples[2]								
OU1 / Site 16	GW	TBD (Field Duplicate)	OU1-16GWXXP-MMYY	TBD	TBD	TBD	1	
OU1 / Site 16	GW	TBD (Field Duplicate)	OU1-16GWXXP-MMYY	TBD	TBD	TBD	1	
OU1 / Site 16	GW	TBD (Matrix Spike)	OU1-16GWXX-MMYY-MS	TBD	TBD	TBD	1	
OU1 / Site 16	GW	TBD (Spike Duplicate)	OU1-16GWXX-MMYY-SD	TBD	TBD	TBD	1	
OU1 / Site 16	AQ	OU1-QC (Equipment Blank)	OU1-EB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Equipment Blank)	OU1-EB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Equipment Blank)	OU1-EB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Equipment Blank)	OU1-EB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Equipment Blank)	OU1-EB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Trip Blank)	OU1-TB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Trip Blank)	OU1-TB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Trip Blank)	OU1-TB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Trip Blank)	OU1-TB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Trip Blank)	OU1-TB01-MMDDYY	N/A	N/A	N/A	1	
OU1 / Site 16	AQ	OU1-QC (Field Blank)	OU1-FB01-MMDDYY	N/A	N/A	N/A	1	
						Total Number of Samples to the Laboratory:	**34**	**10**

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 4-1 - PILOT STUDY MAP.MXD CBOWMAN 4/18/2012 1:19:51 PM

Legend

- Proposed Grain Size Analysis Location
- Proposed Upper Surficial Aquifer Monitoring Well
- Proposed Lower Surficial Aquifer Monitoring Well
- Proposed Upper Yorktown Aquifer Monitoring Well
- Upper Surficial Aquifer Monitoring Well
- Lower Surficial Aquifer Monitoring Well
- Upper Yorktown Aquifer Monitoring Well
- Fire Hydrant
- Proposed ZVI/Sand PRB
- Site 16 Boundary
- Soil Pending Analysis Staging Area
- Soil Staging Area
- ZVI/Sand Mixing Area
- ZVI/Sand Staging Area
- Vegetation Clearance Area
- Water Line Removal Area
- Water Line
- Wastewater Line
- Storm Sewer Line
- Heating and Cooling Line
- Electrical Cable Line
- Silt Fence

N W E S

0 60 120 Feet

Figure 4-1
Pilot Study Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

VBO \\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_SITE_16_WE10_PRB_PILOT_STUDY\IMPLEMENTATION_PLAN\FIGURE 4-2 - UTILITY LOCATION MAP.MXD CBOWMAN 3/21/2012 10:18:39 AM

Legend

- Proposed Grain Size Analysis Location
- Proposed Upper Surficial Aquifer Monitoring Well
- Proposed Lower Surficial Aquifer Monitoring Well
- Proposed Upper Yorktown Aquifer Monitoring Well
- Upper Surficial Aquifer Monitoring Well
- Lower Surficial Aquifer Monitoring Well
- Upper Yorktown Aquifer Monitoring Well
- Proposed ZVI/Sand PRB
- Site 16 Boundary
- Utility Locate Corridor
- Water Line
- Wastewater Line
- Storm Sewer Line
- Heating and Cooling Line
- Electrical Cable Line

N W E S

0 40 80 Feet

Figure 4-2
Utility Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

SECTION 5

Health and Safety and Residuals Management

5.1 Health and Safety

A HSP has been prepared in accordance with 29CFR1910 and 29CFR1926, and is included in **Appendix D**. The HSP will address the potential hazards associated with the field activities and pilot studies. Subcontractors are responsible for H&S procedures specific to their particular work components and are required to develop and submit an Activity Hazard Analysis to CH2M HILL for review prior to the start of field work. Subcontractors must comply with the established HSP, and CH2M HILL will monitor and enforce compliance.

5.2 General Safety

All personnel involved with the PRB construction will undergo training on proper handling and operation of the mixing equipment. The training will also cover personal protective equipment (PPE) and ZVI PRB installation protocols. Only trained personnel will be allowed to oversee PRB trenching/installation activities.

5.3 Residuals Management

Wastes generated during construction are classified as IDW and will be managed to protect the public and the environment. The MFSP provides general information for the characterization, handling, and disposal of contaminated wastes expected to be encountered or generated during this work (AGVIQ/CH2M HILL, 2004a). A site-specific Environmental Protection Plan (EPP) is included in **Appendix E**.

5.3.1 Waste Streams

The waste streams associated with this project may include:

- Soil cuttings from the installation of monitoring wells
- Native soils from the installation of the PRB
- Equipment and personnel decontamination fluid
- Development/purge water from the monitoring wells
- PPE
- Used sampling supplies
- Uncontaminated general debris

5.3.2 Waste Management

IDW management actions will be documented in the field notes. Specific waste management procedures are documented in the MFSP (AGVIQ/CH2M HILL, 2004a). The Field Team Leader (FTL) will coordinate and oversee placement of IDW.

Soil Cuttings

Soil cuttings from PRB installation and drilling will be stockpiled, as discussed below:

- Stockpiles of soil cuttings will be staged in the soil staging area (**Figure 4-1**).
- Stockpiles will be provided with liners, covers, and perimeter berms to prevent release or infiltration of liquids.
  - Minimum 10-mil polyethylene sheeting will be used for liners and covers.
  - A perimeter berm will be constructed of clean materials (e.g., hay bales under the liner, clean soils).
  - A small sump will be excavated (to 2 ft bgs) to allow for collection of any free liquids draining from the stockpile.

  - Accumulated free liquids will be pumped to a container or tank. Covers and perimeter berms will be secured in-place for each stockpile when not in use and at the end of each workday, or as necessary to prevent wind dispersion or runoff from major precipitation events.

- Construction materials used for the stockpiles that contact contaminated soil will be disposed of as contaminated debris.
- Accumulation start dates will be recorded on a log or a sign located at the stockpile.

A soil sample will be collected every 100 cubic yards and analyzed for VOCs. Analytical data will be compared to the USEPA Adjusted Residential Soil RSLs and USEPA Adjusted Industrial Soil RSLs. These are risk-based levels adjusted by one-tenth for noncarcinogenic contaminants for the evaluation of analytical results from surface or subsurface soil for residential receptors. Soil data will also be compared to the North Carolina Soil Screening Levels. If VOC concentrations are below these regulatory criteria, the soils will then be used as trench backfill and elsewhere within OU1, specifically to re-grade the slope at Site 83 under a separate project.

Should soil IDW not be acceptable for reuse or be characterized as hazardous, then soil will be disposed in accordance with applicable regulatory requirements. Depending on the type and amount of soil IDW requiring offsite disposal, roll-offs or drums may be utilized. Hazardous wastes will be segregated from non-hazardous wastes. Additionally, incompatible wastes (e.g., flammable and corrosive wastes) will be segregated. Wastes of the same matrix, contamination, and source may be aggregated to facilitate storage and disposal. Drums containing hazardous soils will be marked with pre-printed hazardous waste labels that include the following information: accumulation start date, generator name, USEPA identification number, applicable waste codes, and the manifest number. The IDW will be moved by a licensed waste transporter. Within 90 days from the accumulation start date, the soil will be transported offsite for disposal at a properly permitted Resource Conservation and Recovery Act (RCRA) Subtitle C treatment, storage, or disposal (TSD) facility.

Fluids

Decontamination fluids, development water from the monitoring wells, and free liquids drained from the soil cuttings stockpile will be collected in bulk containers for subsequent disposal at the IWTP. The IWTP is located near the center of OU1, north of A Street. The FTL will coordinate the transportation of all IDW fluids to the IWTP for disposal. A CH2M HILL representative will provide oversight when transferring IDW fluids to the IWTP. Adequate time will be allotted to allow for any significant solids to settle from the fluids prior to discharging to the wet well at the IWTP and will be managed as soils.

PPE, Used Sampling Supplies, and General Debris

PPE and used sampling supplies associated with the generation of non-hazardous wastes and general debris will be collected in black, non-translucent trash bags and disposed of in an ordinary refuse dumpster aboard MCAS Cherry Point.

5.3.3 Container Labels

Labels will include the type of waste, location where the waste was generated, and accumulation start date. Labels will be legible at all times. Faded labels will be rewritten or replaced. One of the following labels will be affixed to each container:

- “Analysis Pending” - Temporary or handwritten label used until analytical results are received and reviewed. If handwritten, a paint pen will be used. This label will include the following:
  - Accumulation Start Date: The date that waste first entered the container
  - Type of waste (e.g., IDW soil)
  - Site
  - The words “CERCLA-derived, Analysis Pending”
  - Generator Name: Mr. Will Potter, MCAS Cherry Point [Environmental Affairs Department (EAD) field office]

- "Hazardous Waste" - Pre-printed hazardous waste labels with the following information:
  - Accumulation start date: The date that waste first entered the container
  - Generator Name: Mr. Will Potter, MCAS Cherry Point [Environmental Affairs Department (EAD) field office]
  - Hazardous Waste Generator Number (NC 1170027261)
  - Waste codes
  - Prior to transport, the manifest number must be added (for containers of less than 110-gallon capacity)
- "Non-Hazardous Waste" - Preprinted labels (if handwritten paint pen is required) with the following information:
  - Accumulation start date: The date that waste first entered the container
  - Generator name: Mr. Will Potter, MCAS Cherry Point EAD field office
  - The words "CERCLA-derived"
  - Waste-specific information (e.g., IDW soil)

Where applicable, the major hazards (e.g., flammable, oxidizer, and carcinogen) will be included on the label. It is expected that the required labels will be the "Analysis Pending" and/or the "Non-Hazardous Waste" label.

SECTION 6
Reporting

A ZVI PRB pilot study completion report will be prepared following installation of the PRB and new monitoring wells and after baseline groundwater sampling activities are completed. Pre-mobilization activities and field activities will be summarized, and boring logs, well construction details, PRB installation records, official survey data, and an overview of baseline sampling activities will be presented. The report will also provide insight on the constructability of the deep ZVI PRB.

A baseline sampling results report will be prepared once analytical data from the procured lab are returned and validated. Quarterly groundwater monitoring results will be presented in four quarterly reports to evaluate the ongoing progress of the pilot study at 3, 6, 9, and 12 months following completion of the PRB installation. A final groundwater sampling event will be conducted to evaluate the long-term effectiveness of the pilot study and the results will be presented in a pilot study summary report after 24 months. After a comment period for each draft report, any comments received will be addressed in the respective final report.

The results of the pilot study will then be used for potential optimization of full-scale implementation during remedial design.

SECTION 7

Project Management

7.1 Project Schedule

The proposed schedule for implementing the ZVI PRB pilot study at OU1 is presented on **Figure 7-1**. The tasks shown on the schedule correspond to the tasks identified in this Implementation Plan.

7.2 Project Organization

The project organization is presented on **Figure 7-2**. The Partnering Team includes representatives from CH2M HILL, NAVFAC, MCAS Cherry Point, NCDENR, and USEPA Region 4.

Ms. Keri Hallberg, P.E., will serve as the PM for the pilot study. The PM is responsible for overall project management and the overall QA/QC of project deliverables.

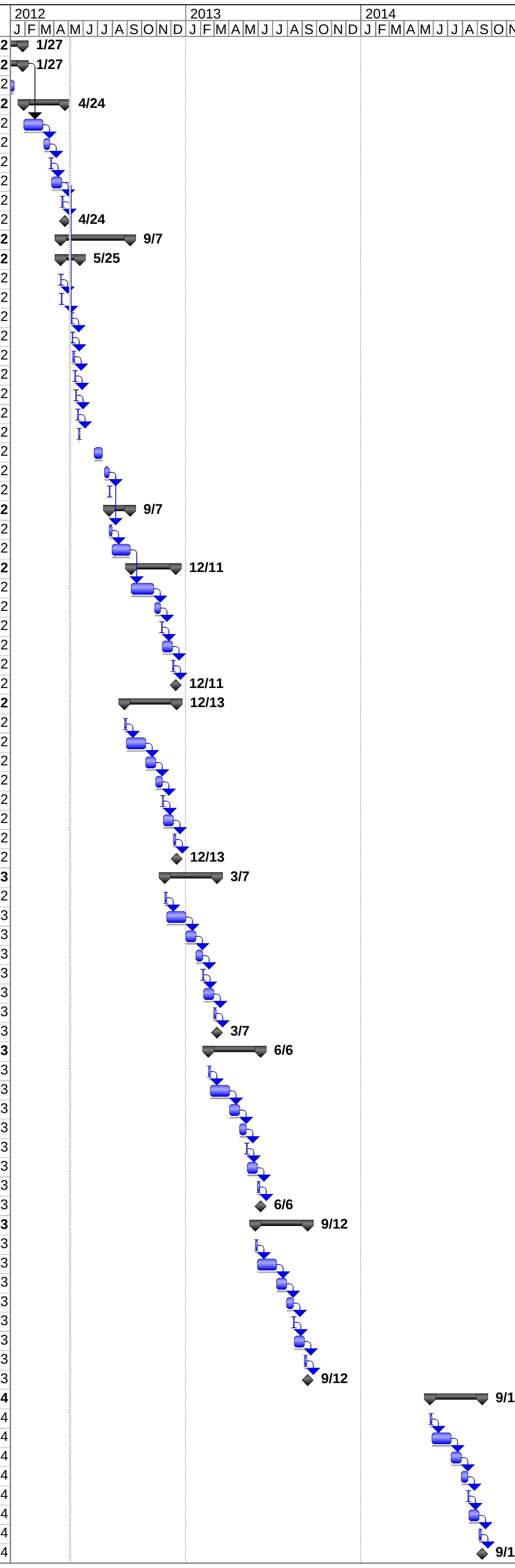
Mr. Dean Williamson, P.E. will serve as the Technical Consultant for the pilot study. He will work with the PM to ensure the quality of project execution and will review the technical aspects of the work from project scoping to project completion.

The construction quality organization is included in the CQMP in **Appendix C**. Other members of the project team include:

- Project Engineer/Hydrogeologist
- FTL
- Field support staff
- Technical project staff

All field and subcontractor activity will be under the direction of the FTL.

ID	Task Name	Duration	Start	Finish
1	**ZVI PRB Pilot Study Preparation Activities**	**65 days**	**Mon 10/31/11**	**Fri 1/27/12**
2	ZVI Bench Scale Column Study	**65 days**	**Mon 10/31/11**	**Fri 1/27/12**
5	Grain Size Sampling and Analysis	10 days	Tue 12/27/11	Mon 1/9/12
6	**ZVI PRB Pilot Study Implementation Plan**	**62 days**	**Mon 1/30/12**	**Tue 4/24/12**
7	Draft ZVI PRB Pilot Study Implementation Plan and UFP-SAI	30 days	Mon 1/30/12	Fri 3/9/12
8	Navy/Base Review	10 days	Mon 3/12/12	Fri 3/23/12
9	Incorporate Comments	2 days	Mon 3/26/12	Tue 3/27/12
10	Partnering Team Review	15 days	Wed 3/28/12	Tue 4/17/12
11	Response to Comments	3 days	Wed 4/18/12	Fri 4/20/12
12	Final ZVI PRB Pilot Study Implementation Plan	2 days	Mon 4/23/12	Tue 4/24/12
13	**ZVI PRB Pilot Study Implementation**	**105 days**	**Mon 4/16/12**	**Fri 9/7/12**
14	**Site Preparation Activities**	**30 days**	**Mon 4/16/12**	**Fri 5/25/12**
15	PRB Corridor Survey	1 day	Mon 4/16/12	Mon 4/16/12
16	Utility Location	2 days	Tue 4/17/12	Wed 4/18/12
17	Fence Removal	2 days	Tue 5/8/12	Wed 5/9/12
18	Overhead Power Line Removal	1 day	Thu 5/10/12	Thu 5/10/12
19	Vegetation Clearance	2 days	Fri 5/11/12	Mon 5/14/12
20	Water Line Disconnection	2 days	Tue 5/15/12	Wed 5/16/12
21	Soil Staging Area Construction	2 days	Thu 5/17/12	Fri 5/18/12
22	Silt Fence Construction	2 days	Mon 5/21/12	Tue 5/22/12
23	Work Platform Construction	3 days	Wed 5/23/12	Fri 5/25/12
24	PRB Installation	13 days	Mon 6/25/12	Wed 7/11/12
25	Monitoring Well Installation and Development	8 days	Mon 7/16/12	Wed 7/25/12
26	As-Built Survey	2 days	Thu 7/26/12	Fri 7/27/12
27	**Baseline Groundwater Sampling Event**	**32 days**	**Thu 7/26/12**	**Fri 9/7/12**
28	Field Work	4 days	Thu 7/26/12	Tue 7/31/12
29	Data Analysis	28 days	Wed 8/1/12	Fri 9/7/12
30	**ZVI PRB Pilot Study Completion Report**	**67 days**	**Mon 9/10/12**	**Tue 12/11/12**
31	Draft ZVI PRB Pilot Study Completion Report	35 days	Mon 9/10/12	Fri 10/26/12
32	Navy/Base Review	10 days	Mon 10/29/12	Fri 11/9/12
33	Incorporate Comments	2 days	Mon 11/12/12	Tue 11/13/12
34	Partnering Team Review	15 days	Wed 11/14/12	Tue 12/4/12
35	Response to Comments	3 days	Wed 12/5/12	Fri 12/7/12
36	Final ZVI PRB Pilot Study Completion Report	2 days	Mon 12/10/12	Tue 12/11/12
37	**3-Month Sampling Event**	**79 days**	**Mon 8/27/12**	**Thu 12/13/12**
38	Field Work	4 days	Mon 8/27/12	Thu 8/30/12
39	Data Analysis	28 days	Fri 8/31/12	Tue 10/9/12
40	Draft 3-Month TM	15 days	Wed 10/10/12	Tue 10/30/12
41	Navy/Base Review	10 days	Wed 10/31/12	Tue 11/13/12
42	Incorporate Comments	2 days	Wed 11/14/12	Thu 11/15/12
43	Partnering Team Review	15 days	Fri 11/16/12	Thu 12/6/12
44	Response to Comments	3 days	Fri 12/7/12	Tue 12/11/12
45	Final 3-Month TM	2 days	Wed 12/12/12	Thu 12/13/12
46	**6-Month Sampling Event**	**79 days**	**Mon 11/19/12**	**Thu 3/7/13**
47	Field Work	4 days	Mon 11/19/12	Thu 11/22/12
48	Data Analysis	28 days	Fri 11/23/12	Tue 1/1/13
49	Draft 6-Month TM	15 days	Wed 1/2/13	Tue 1/22/13
50	Navy/Base Review	10 days	Wed 1/23/13	Tue 2/5/13
51	Incorporate Comments	2 days	Wed 2/6/13	Thu 2/7/13
52	Partnering Team Review	15 days	Fri 2/8/13	Thu 2/28/13
53	Response to Comments	3 days	Fri 3/1/13	Tue 3/5/13
54	Final 6-Month TM	2 days	Wed 3/6/13	Thu 3/7/13
55	**9-Month Sampling Event**	**79 days**	**Mon 2/18/13**	**Thu 6/6/13**
56	Field Work	4 days	Mon 2/18/13	Thu 2/21/13
57	Data Analysis	28 days	Fri 2/22/13	Tue 4/2/13
58	Draft 9-Month TM	15 days	Wed 4/3/13	Tue 4/23/13
59	Navy/Base Review	10 days	Wed 4/24/13	Tue 5/7/13
60	Incorporate Comments	2 days	Wed 5/8/13	Thu 5/9/13
61	Partnering Team Review	15 days	Fri 5/10/13	Thu 5/30/13
62	Response to Comments	3 days	Fri 5/31/13	Tue 6/4/13
63	Final 9-Month TM	2 days	Wed 6/5/13	Thu 6/6/13
64	**12-Month Sampling Event**	**79 days**	**Mon 5/27/13**	**Thu 9/12/13**
65	Field Work	4 days	Mon 5/27/13	Thu 5/30/13
66	Data Analysis	28 days	Fri 5/31/13	Tue 7/9/13
67	Draft 12-Month TM	15 days	Wed 7/10/13	Tue 7/30/13
68	Navy/Base Review	10 days	Wed 7/31/13	Tue 8/13/13
69	Incorporate Comments	2 days	Wed 8/14/13	Thu 8/15/13
70	Partnering Team Review	15 days	Fri 8/16/13	Thu 9/5/13
71	Response to Comments	3 days	Fri 9/6/13	Tue 9/10/13
72	Final 12-Month TM	2 days	Wed 9/11/13	Thu 9/12/13
73	**24-Month Sampling Event**	**79 days**	**Mon 5/26/14**	**Thu 9/11/14**
74	Field Work	4 days	Mon 5/26/14	Thu 5/29/14
75	Data Analysis	28 days	Fri 5/30/14	Tue 7/8/14
76	Draft 24-Month TM	15 days	Wed 7/9/14	Tue 7/29/14
77	Navy/Base Review	10 days	Wed 7/30/14	Tue 8/12/14
78	Incorporate Comments	2 days	Wed 8/13/14	Thu 8/14/14
79	Partnering Team Review	15 days	Fri 8/15/14	Thu 9/4/14
80	Response to Comments	3 days	Fri 9/5/14	Tue 9/9/14
81	Final 24-Month TM	2 days	Wed 9/10/14	Thu 9/11/14



Project: WE10_CP_OU1_PRB_Sched
Date: Fri 5/4/12

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	

Figure 7-1
ZVI PRB Pilot Study Project Schedule
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

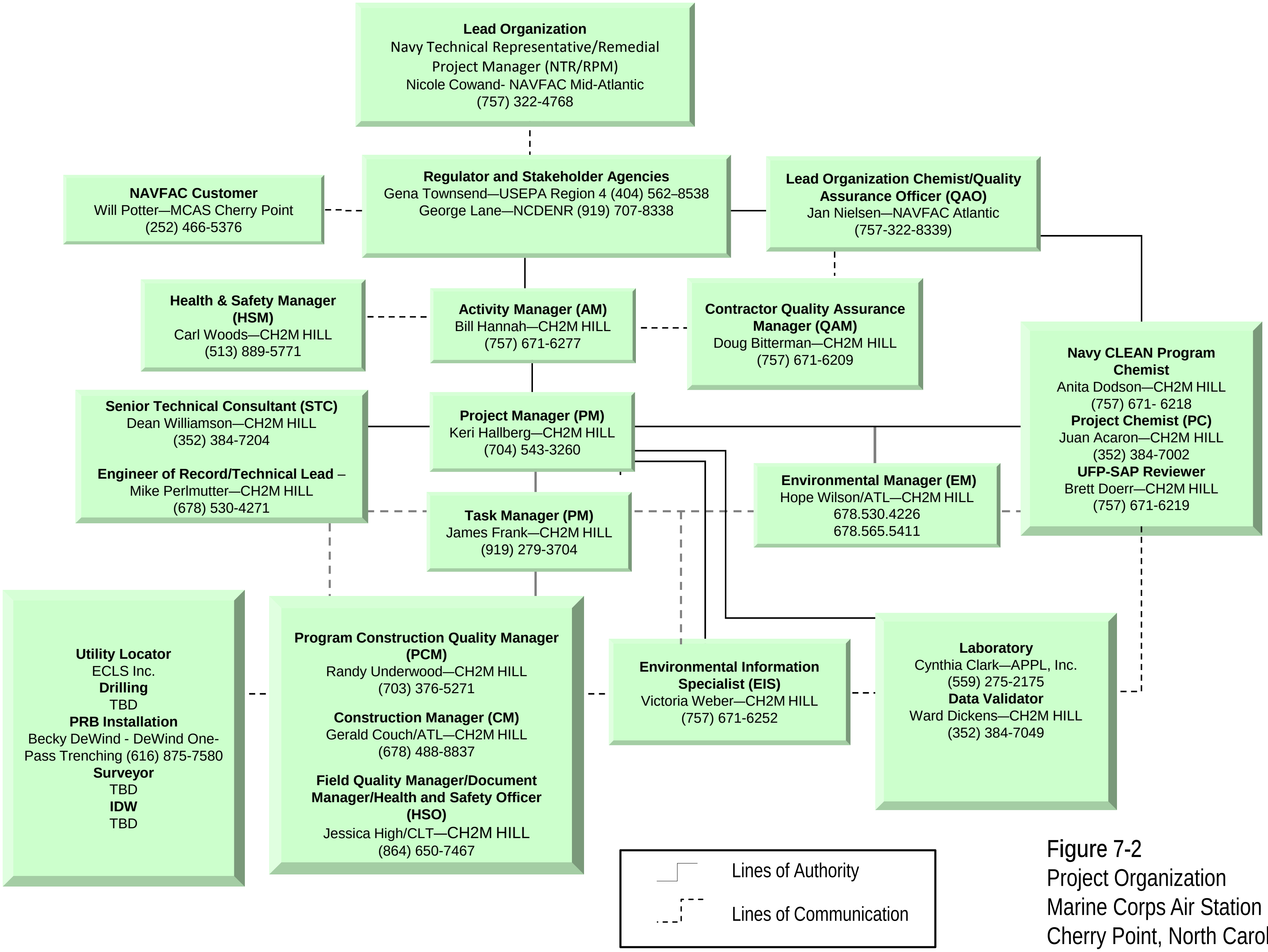


Figure 7-2
Project Organization
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

SECTION 8

References

AGVIQ/CH2M HILL Joint Venture (JV) 1. 2004a. *Master Field Sampling Plan*, *Marine Corps Air Station Cherry Point, Cherry Point, North Carolina*. November.

AGVIQ/CH2M HILL JV 1. 2004b. *Master Quality Assurance Plan*, *Marine Corps Air Station Cherry Point, Cherry Point, North Carolina*. November.

AGVIQ/CH2M HILL JV 1. 2008. *Treatability Studies Report Site 89, Operable Unit 16 Marine Corps Base Camp Lejeune, North Carolina.* February.

CH2M HILL. 2009. *OU1 Remedial Investigation Addendum*, *Marine Corps Air Station Cherry Point, Cherry Point, North Carolina*. April.

CH2M HILL. 2011. *Operable Unit 1 Central Groundwater Plume Feasibility Study*, Marine Corps Air Station, Cherry Point, North Carolina. August.

CH2M HILL. 2012. *Tier II Sampling and Analysis Plan, Groundwater Treatment Zero-Valent Iron, Permeable Reactive Barrier Pilot Study, Operable Unit 1*. January.

Envirometals Technologies, Inc. 2007. *Nitrate Reduction on Granular Iron and the Effects on Chlorinated Volatile Organic Compound Degradation*. Technical Note 2.08.

Gavaskar, Arun, Neeraj Gupta, Bruce Sass, Robert Janosy, and James Hicks. 2000. *Final Design Guidance for Application of Permeable Reactive Barriers for Groundwater Remediation*. BATTELLE, Columbus, Ohio. March.

Naval Facilities Engineering Command (NAVFAC). 2005. *United States Environmental Protection Agency Region 4, State of North Carolina, and the United States Department of the Navy, Marine Corps Air Station, Cherry Point, North Carolina, Federal Facility Agreement Under CERCLA Section 120 Administrative Docket Number: CERCLA-04-2005-3766*. May.

TetraTech NUS, Inc. 2002. *Final Remedial Investigation Report for Operable Unit 1 (OU 1)*. Marine Corps Air Station, Cherry Point, North Carolina. November.

USGS. 1994. *Hydrogeology and Simulation of Ground-Water Flow at U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1987-90*. Water-Resources Investigations Report 94-4186.

USGS. 1996. *Application of Geophysical Methods for the Delineation of Paleochannels and Missing Confining Units Above the Castle Hayne Aquifer at U.S. Marine Corps Air Station, Cherry Point, North Carolina*. Water-Resources Investigation Report 94-4186.

USGS. 2004. *Data from Stratigraphic Test Holes Drilled at the U.S. Marine Corps Air Station, Cherry Point, North Carolina, 1994-2001, and Periodic Water Levels, 2000-2003*. U.S. Geological Survey Open-File Report 2004-1434.

Appendix A
Bench-Scale ZVI Column Study Report

Bench-Scale Treatability Report in Support of a ZVI Permeable Reactive Barrier Installation at Operable Unit 1 (OU1) in MCAS Cherry Point, Havelock, North Carolina

DRAFT

Prepared For:

CH2M HILL
11301 Carmel Commons Boulevard
Suite 304
Charlotte, NC 28226

Prepared By:

Adventus
2871 W. Forest Road, Suite 2
Freeport, IL 61032

Reference: AAI11-640

January 2012

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION AND BACKGROUND

This bench-scale treatability report was prepared for CH2M HILL to support the design of a granular zero valent iron (ZVI) permeable reactive barrier (PRB) for treatment of dissolved chlorinated volatile organic compounds (cVOCs), present in groundwater at Operable Unit 1 (OU1) in MCAS Cherry Point, Havelock, NC (the “site”). The column treatability study was conducted in Adventus’ laboratory near Toronto, Ontario, Canada.

1.1 Background Information on the ZVI Technology

Numerous *in-situ* PRBs have been successfully implemented for groundwater remediation (RTDF 2004; O’Hannesin and Gillham, 1998). *In-situ* PRB technology involves the construction of a permeable wall or barrier, containing appropriate reactive materials, across the path of a contaminant plume. As the contaminated groundwater passes through the wall, the contaminants are removed through chemical or physical processes. Various configurations of *in-situ* treatment systems have been implemented, based on site-specific conditions. Advantages of *in-situ* PRBs include:

- low maintenance costs;
- no operating costs;
- long-term passive treatment;
- absence of waste materials requiring treatment or disposal;
- absence of invasive surface structures and equipment; and
- conservation of groundwater resources.

Several types of materials have been suggested for use in PRBs. The most advanced stage of application has been achieved with systems using ZVI to degrade chlorinated organic compounds. Under highly reducing conditions and in the presence of metallic surfaces, certain dissolved chlorinated organic compounds in groundwater degrade to non-toxic products such as ethene, ethane and chloride (Gillham and O’Hannesin, 1994). The process is abiotic reductive dehalogenation, with the metal serving to lower the solution redox potential (Eh) and as the electron source in the reaction. Using ZVI as the reactive metal, reaction half-lives (the time required to degrade one half of the original contaminant mass) are commonly several orders of magnitude lower than those measured under natural conditions. The technology is particularly attractive for the remediation of contaminated groundwater because of the high rates of degradation, the ZVI is relatively inexpensive, the process requires no external energy supply and because most compounds are degraded with production of few, if any, hazardous (chlorinated) organic by-products.

To date, ZVI PRBs have been installed at over 140 sites in the United States, Canada, Europe, Japan and Australia. These PRBs have been installed at Superfund sites; as part of brownfield site redevelopment; at various active manufacturing, DoD and DOE facilities; at former dry cleaning facilities; and landfills. The earliest commercial applications in California and Belfast, Ireland have been in operation for the past 15 years.

1.2 Approach to Technology Implementation at the Site

A ZVI PRB has been proposed as an *in-situ* treatment technology to degrade the trichloroethene (TCE), cis 1,2-dichloroethene (cDCE), trans 1,2-dichloroethene (tDCE), and vinyl chloride (VC) present in the groundwater at the site. When viewed in the context of previous successful applications, the site appears quite amenable to treatment using this technology:

i) all cVOCs present in the site groundwater have been successfully treated in numerous laboratory studies and field applications; and

ii) the main inorganic constituents of the plume appeared to pose no significant impediment to technology application.

Several design parameters need to be addressed and quantified in order to apply the ZVI technology in the field. This bench-scale test was initiated to provide design parameters (cVOC degradation rates) for the anticipated maximum concentrations entering the PRB. Specifically, the following factors need to be investigated to facilitate field implementation of a treatment system at the site:

i) The degradation rates of cVOC present in the site groundwater. These rates allow the calculation of the iron thickness required to achieve cVOC concentrations below the regulatory limits.

ii) The production and subsequent degradation rates of chlorinated compounds produced from the cVOCs originally present in the site groundwater [e.g., vinyl chloride (VC)]. These can also affect the dimensions of the treatment system.

iii) The residence time in ZVI required. This values is based on the concentrations of cVOCs present in groundwater entering the treatment zone and potential breakdown products and the degradation rates.

iv) The effects of the process on the inorganic chemistry of the groundwater, in particular, the potential for mineral precipitation. Mineral precipitates could affect the long-term maintenance requirements of the treatment system.

1.3 Bench-Scale Test Report Organization

The remainder of this report is organized as follows:

- Section 2.0 presents the detailed objectives and methods for the bench-scale test.
- Section 3.0 presents the organic and inorganic results from the bench-scale test.
- Section 4.0 discusses the calculated residence time required for cVOC treatment to meet the target levels.
- Section 5.0 summarizes the results.

2.0 BENCH-SCALE TEST OBJECTIVES AND METHODS

2.1 Bench-Scale Test Objectives

The primary objective of the bench-scale test was to provide the data necessary to determine the residence time in ZVI to degrade the cVOCs present at the site, and their chlorinated breakdown products, to below their regulatory criteria. Samples collected during the laboratory column test were used to evaluate the following specific objectives:

- determine degradation rates of cVOCs using groundwater from the site;
- characterization of chlorinated breakdown products, and evaluation of the rates of degradation of these products; and
- changes in inorganic geochemistry as a result of the pH, Eh and alkalinity changes, including possible mineral precipitation.

2.2 Bench-Scale Test Methods

The bench-scale testing included two columns containing 100% granular ZVI obtained from Connelly GPM of Chicago, IL (CC-1004, 0.25 to 2.0 mm) tested using two different site groundwater samples. A hydraulic conductivity of 5×10^{-2} cm/sec (142 ft/day) was obtained for Connelly ZVI using a falling head permeameter test (**Table 1**). The specific surface area of the ZVI was 1.4 m^2/g, which was determined by the BET method (Brunauer et al., 1938) on a Micromeretic Gemini 2375 surface analyzer.

The columns were constructed of Plexiglas™ with a length of 1.64 ft (50 cm) and an internal diameter of 1.5 in (3.8 cm) (**Figures 1 and 2**). Seven sampling ports were positioned along the length at distances of 0.08, 0.16, 0.33, 0.50, 0.66, 1.0, and 1.3 ft (2.5, 5, 10, 15, 20, 30, and 40 cm) from the inlet end. The columns also allowed for the collection of samples from the influent (0 ft, 0 cm) and effluent lines (1.6 ft, 50 cm). Each sampling port consisted of a nylon Swagelok fitting (0.063 in, 0.16 cm) tapped into the side of the column, with a syringe needle (16G) secured by the fitting. Glass wool was placed in the needle to exclude the iron particles. The sampling ports allowed samples to be collected along the central axis of the column. Each sample port was fitted with a Luer-Lok™ fitting, such that a glass syringe could be attached to the port to collect a sample. When not in operation the ports were sealed by Luer-Lok™ plugs.

The ZVI, as received from the vendor, was packed in the columns. To assure a homogeneous mixture, aliquots of iron were packed vertically in lift sections within the column. Values of bulk density, porosity, and pore volume (PV) were determined by weight (**Table 1**). The column experiment was performed at a temperature of approximately 23°C.

A low flow peristaltic pump was used to feed the site water from a collapsible Teflon® bag to the influent end of the column. The pump tubing consisted of Viton®, and all the other tubing was Teflon® [0.125 in (0.32 cm) OD × 0.063 in (0.16 cm) ID]. A flow velocity was about 1.6 ft/day (50 cm/day).

2.2.1 Groundwater Shipment and Storage

The groundwater samples were provided by CH2M HILL from two site wells, 16GW34 and 16GW35. The initial concentrations of cVOCs detected in the groundwater samples after arrival in the laboratory are shown in **Table 2**.

The baseline cVOC results did not represent historic data from the sampled wells. Therefore, in consultation with CH2M HILL, the two site waters were homogenized separately and spiked using laboratory grade compounds to achieve a more representative cVOC composition in the waters used in the test (**Table 3**).

The site waters were stored at 4°C until required at which time they were siphoned from the field sample bottles into collapsible Teflon® bags. As noted in **Appendix A** by reservoir number [RN], the influent reservoir was filled three times [a-c] over the course of the test.

2.2.2 Sampling and Analysis

The column was sampled for cVOCs every 6 to 10 PVs for about 50 pore volumes of flow, resulting in a total of 7 complete cVOC column profiles. After removing the stagnant water from the sampling needle, 4.0 mL samples were collected from the sampling ports using glass on glass syringes, transferred to glass sample bottles, and analyzed immediately (no holding time). Samples for organic analyses, redox potential (Eh), pH, nitrate, chloride and sulphate were collected from each port as well as from the influent solution and the effluent overflow bottles (**Appendix A**).

Additional samples for complete inorganic analyses (**Appendix B**) were obtained from the influent solution and the effluent overflow bottles towards the end of the test.

2.3 Analytical Methods

2.3.1 Organic Analyses

The less volatile halogenated organics such as tetrachloroethene (PCE) and trichloroethene (TCE) were extracted from the water sample within the glass sample bottle using pentane with an internal standard of 1,2-dibromoethane, at a water to pentane ratio of 2.0 to 2.0 mL. The sample bottles are placed on a rotary shaker for 15 minutes to allow equilibration between the water and the pentane phases, then the pentane phase is transferred to an autosampler bottle. Using an Agilent 7683 autosampler, a 1.0 μL aliquot of pentane with internal standard was automatically injected directly into a Agilent 6890N gas chromatograph. The chromatograph was equipped with a Ni^{63} electron capture detector (ECD) and DB-624 megabore capillary column (30 m x 0.538 mm ID, film thickness 3 μm). The gas chromatograph had an initial temperature of 40°C, with a temperature time program of 10°C/minute reaching a final temperature of 150°C. The detector temperature was 300°C. The carrier gas was helium and makeup gas was 5% methane and 95% argon, with a flow rate of 30 mL/min.

For the more volatile compounds such as cis 1,2-dichloroethene (cDCE), trans 1,2-dichloroethene (tDCE), 1,1-dichloroethene (11DCE) and vinyl chloride (VC), 4.0 mL samples were collected in glass on glass syringes and placed in 10 mL Telfon® faced speta crimp cap vials, creating a headspace with a ratio of 6.0 mL headspace to 4.0 mL aqueous sample. The samples are placed on a rotary shaker for 15 minutes to allow equilibration between the water and gas phase. Using an Agilent G1888 headspace auto sampler, a 1 mL stainless steel sample loop injects the samples directly onto an Agilent 6890N gas chromatograph. The chromatograph was equipped with a HNU photoionization detector (PID) with a bulb ionization potential of 10.2 eV. The gas chromatograph was fitted with a fused silica capillary NSW-PLOT column (15 m x 0.53 mm ID). The samples are placed in the analyzer oven for 2 minutes at 75°C, and subsequently injected onto the gas chromatograph. The temperature program was initially set at 50°C, then increased at 20°C/min to 200°C and held for 7 minutes. The injector and detector temperatures are 200°C and 150°C, respectively. The carrier gas is helium with a flow rate of 14 mL/min. Data is collected with a HP Pentium XP computer using GC-Chemstation Version B.01.03.

Method detection limits (MDL) were determined for each compound as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDLs were determined from analysis of samples from a solution matrix containing the analytes of interest. Although MDLs are reported, these values are not subtracted from any reported cVOC concentrations (**Appendix A**). The reason for this is that it indicates that the organic concentrations are approaching or advancing within the column, and is helpful when determining degradation rates. Detection limits for all compounds, as given in **Table 4**, were determined using the EPA procedure for MDL (US EPA, 1982).

2.3.2 Inorganic Analyses

Eh was determined using a combination Ag/AgCl reference electrode with a platinum button and a Oakton™ Model meter. The electrode was standardized with an ORP standard (ThermElectron Corporation). Millivolt (mV) readings were converted to Eh, using the electrode reading and the standard potential of the Ag/AgCl electrode at a given temperature. The pH measurements were made using a combination pH/reference electrode and a Oakton™ Model meter, standardized with the pH buffer 7 and the appropriate buffer of either 4 or 10. A 2.0 mL sample was collected with a glass on glass syringe and analyzed immediately for Eh and then pH.

Two complete column profiles were collected from each column for nitrate (as N), sulphate and chloride by collecting a 0.5 mL sample in autosampler plastic vials (**Appendix A**). These samples were sent to SGS Canada Inc. for analysis using ion chromatography. At the end of the test, two water samples were collected from the influent and effluent of each column and sent to Maxxam Analytics Inc. for cation and anion analyses. Cation analyses, included Fe, Na, Mg, Ca, K, Mn, etc. were performed using inductively coupled plasma (ICP). All cation samples were unfiltered and acidified to a pH of 2 with nitric acid. Anion analyses, including Cl, NO_3, SO_4, etc. were performed using ion chromatography. In addition, alkalinity, ammonia (as N), total organic carbon (TOC) and dissolved organic carbon (DOC) analyses are determined by colorimetry and were sampled from the column influent and effluent. The TOC and DOC samples were unfiltered and acidified to a pH of 2 with sulphuric acid. Detection limits for the inorganic parameters are included in **Table 4**.

3.0 BENCH-SCALE TEST RESULTS

3.1 Degradation of Volatile Organic Compounds

Samples for measurement of cVOC concentrations along the length of the column were taken approximately every 6 to 10 PVs (**Appendix A**). Using the distance for each sampling port and flow velocity, the residence time was calculated for each port. The results were plotted as cVOC concentration (μg/L) versus residence time within the column (hrs). At a flow velocity of about 1.6 ft/day, one PV corresponded to a residence time of 25 hrs within the two columns (**Table 1**). A total of about 50 PVs of water were passed through the columns.

The cVOC degradation profiles obtained in the last sampling event are shown in **Figures 3 and 4**. The influent concentrations of major compounds, TCE, cDCE and VC were degraded to non-detectable levels within a residence time of 2.5 hrs or less in both columns. The obtained cVOC concentration profiles were used to calculate the degradation rates, as described in Section 3.2.

3.2 Determination of cVOC Degradation Parameters

The cVOC degradation trends observed in groundwater in contact with ZVI are typically described using first-order kinetics:

$$C = C_o e^{-kt} \qquad (1)$$

or

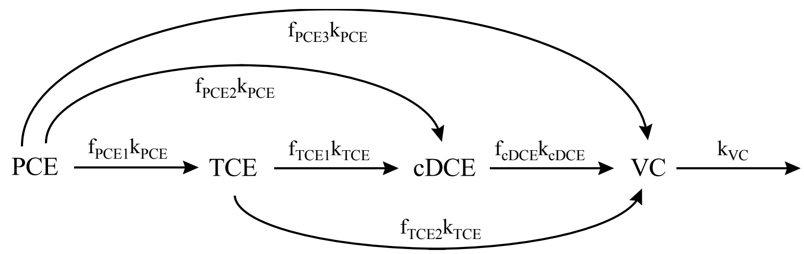
$$\ln\left(\frac{C}{C_o}\right) = -kt \qquad (2)$$

where: C = cVOC concentration in solution at time t,
C_o = cVOC concentration of the influent solution,
k = first-order rate constant, and
t = time.

The time at which the initial concentration declines by one-half, (C/C_o = 0.5), is the half-life.

ETI has developed a first-order kinetic model to simulate the degradation of cVOCs with ZVI. In the model, potential breakdown products are concurrently produced and degraded as described by first-order kinetic equations. The model is an expression of the chemistry that is observed in the solution phase. For example, for the chlorinated ethenes (PCE, TCE, cDCE and VC) the production of chlorinated acetylene via a β-elimination pathway is considered to be the dominant degradation pathway (Eykholt, 1998; Arnold and Roberts, 1999). However, since chlorinated acetylenes are unstable, short-lived, intermediates that are rapidly reduced to ethene (Roberts et al., 1996; Sivavec et al., 1997), these compounds are not typically detected in the solution phase and are therefore not explicitly contained in the degradation model.

The equations contained in the model were developed by ETI to describe the first-order kinetic degradation process occurring in a ZVI groundwater treatment zone. For example, PCE, TCE, cDCE and VC the model takes the form:



where: f = mole fraction (or percent molar conversions)
k = first-order rate constant

In order to determine the cVOC concentrations at a given time the following first-order equations are used:

$$dPCE / dt = -k_{PCE}PCE \quad (3)$$
$$dTCE / dt = f_{PCE1}k_{PCE}PCE - k_{TCE}TCE \quad (4)$$
$$dcDCE / dt = f_{PCE2}k_{PCE}PCE + f_{TCE1}k_{TCE}TCE - k_{cDCE}cDCE \quad (5)$$
$$dVC / dt = f_{PCE3}k_{PCE}PCE + f_{TCE2}k_{TCE}TCE + f_{cDCE}k_{cDCE}cDCE - k_{VC}VC \quad (6)$$

These equations were adapted for the computer program Scientist® for Windows® Version 2.0 (1995). The Scientist® program can be used to fit the first-order equations to experimental data using the least squares best-fit method. Least squares fitting is performed using a modified Powell algorithm to find a local minimum of the sum of squared deviations between observed data and model calculations. The degradation rate and molar conversion are determined for each compound sequentially starting with the most chlorinated compound.

The results from the model include half-lives for all cVOCs selected and statistical fit data including coefficient of determination (r^2) values. The r^2 values indicate how well the degradation model represents the experimental data. The half-lives determined from the cVOC profiles are shown in **Table 5**, along with the corresponding r^2 values. Degradation parameters for the last three cVOC profiles are shown in **Appendix A**.

The degradation model provided good fits to the cVOC concentration profiles with r^2 values of more than 0.999 for the cVOCs (**Table 5)**. The obtained degradation half-lives values detected at the end of the test ranged from 0.22 hrs for VC to 0.42 for cDCE in the GW34 column and from 0.15 hrs for TCE and to 0.24 hrs for the DCE isomers in the GW35 column. Those half-lives values are considered very low (i.e.; representing an extremely high reactivity). In comparison, the average half-lives based on over 50 results from column tests at room temperature for various commercial ZVIs were 1.3 hrs (SD=0.9 hrs) for TCE, 3.4 hrs (SD=2.2 hrs) for cDCE and 3.2 hrs (SD=2.9 hrs) for VC (Gillham et al., 2010).

The half-life data were used to develop residence time requirements for a field scale PRB in Section 4.1. As indicated in **Appendix A**, a quantifiable, gradual increase the degradation half-lives was observed with time in the GW34 columns. Those trends are indicative of some loss in reactivity due to exposure of increasing volumes of groundwater resulting in inorganic precipitation on ZVI grains, as described below.

3.3 Inorganic Results

Two influent and effluent samples were collected from the columns as steady state approached (**Appendix B**). Changes in inorganic chemical constituents observed in the influent and effluent groundwater are summarized in **Table 6**. **Appendix B** contains the inorganic analytical data.

When iron is exposed to water, several reactions occur as a result of iron corrosion:

$$Fe^\circ \rightarrow Fe^{2+} + 2e^- \qquad (5)$$

This iron corrosion drives the geochemical changes that occur as groundwater flows through the PRB. When groundwater first contacts the ZVI, any dissolved oxygen present is consumed via iron corrosion:

$$4Fe^\circ + 3O_{2(aq)} + 12H^+ \rightarrow 4Fe^{3+} + 6H_2O \qquad (6)$$

After the initial, rapid depletion of any dissolved oxygen, the water corrosion of iron dominates to produce hydrogen and hydroxide resulting in an increase in pH and decline in Eh:

$$Fe^\circ + 2H_2O \rightarrow Fe^{2+} + H_{2(aq)} + 2OH^- \qquad (7)$$

Figure 5 and 6 show the Eh and pH profiles observed in the test columns. At the end of the test, the redox potential (Eh) in both columns declined from an initial value of +550 mV to minimum values of less than -500 mV (**Figures 5 and 6**). Values of pH increased in both columns from about 6.4 in the column influent to a maximum value of about 9 (**Figures 5 and 6**). The observed pH and Eh trends in the columns are representative of water chemistry strongly influenced by ZVI corrosion.

The influent calcium concentrations of 63 mg/L and 78 mg/L decreased to 14 and 32 mg/L in the effluents of the GW-34 and GW-35 columns, respectively (**Table 6**). The carbonate alkalinity value in the columns decreased from initial values of about 161 and 132 mg/L to 29 mg/L and 5 mg/L within the GW-34 and GW-35 columns, respectively. Based on the stoichiometry of calcium carbonate formation (eq. 9), the observed losses in alkalinity were higher than those expected from the formation of calcium carbonate. Therefore, iron carbonate (siderite) was likely also formed (eq. 10).

Aragonite/Calcite: $Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(s)}$ (9)

Siderite: $Fe^{2+} + CO_3^{2-} \rightarrow FeCO_{3(s)}$ (10)

In analyses of iron obtained from previous laboratory studies and field sites, siderite ($FeCO_3$) as well as both calcite and aragonite, which are forms of calcium carbonate, have been identified.

Potassium and sodium behave as conservative tracers in iron systems and as expected their concentrations remained essentially unchanged within the columns (**Table 6**). A significant increase in chloride concentration due the dissolved chloride created by the cVOC dechlorination was not expected considering relatively low influent cVOC concentrations in the columns. Decreases in concentrations of silicon, DOC and TOC observed in the columns were expected in response to geochemical conditions created by ZVI.

The concentrations of sulfate detected at 14 and 67 mg/L in the influent of the GW-34 and GW-35 columns, respectively remained unchanged along the column lengths within the test period. However, declines in sulfate concentrations have been observed at a number of field sites as groundwater passes through the iron treatment zones and microbial sulfate reducing activity develops with time.

These results are consistent with the inorganic trends typically observed in other ZVI applications and indicate no significant impediment to application of the technology. However, the temporal degradation trends in cVOC degradation, especially in the GW34 column, indicated that although ZVI reactivity was extremely high, this reactivity will diminish gradually with operation time. Therefore, the PRB design based on the degradation data from this test should include a reasonable safety factor to account for this phenomenon. To evaluate the safety factor needed the mass fluxes of DO and carbonate alkalinity in the field PRB should be considered in relation to the conditions simulated in this flow through column test.

4.0 FIELD-SCALE TREATMENT SYSTEM DESIGN CONSIDERATIONS

4.1 Required Residence Time for cVOCs

The laboratory half-lives were obtained at a temperature of 23°C. Based on site information provided by CH2M HILL, the minimum field groundwater temperature is *ca.* 18°C. Based on previous research, cVOC degradation half-lives increase by 100% per every 5°C to 8°C temperature decrease within a temperature range of 5 to 25°C (O'Hannesin et al., 2004). Therefore, the laboratory half-life values were increased by a factor of 2 to obtain the anticipated field values (**Table 7**).

Preliminary residence time calculations for a field application were performed assuming the cVOC concentration values in the waters used for the bench scale test (**Table 7**). The Scientist® program described in Section 3.2 was used to simulate the change in cVOC concentrations over time using the first-order kinetic equations. In simulation mode, the model calculates the cVOC concentrations over time, from which the time required for the cVOCs to degrade to their regulatory criteria can be determined.

Based on those simulations, the residences time required to achieve NCGWQS (2L) standards in a Connelly ZVI PRB at the site are 7 and 5 hrs for treatment by cVOC levels using data from the GW-34 and GW-35 columns, respectively (**Table 7**). The required ZVI thickness can be obtained by multiplying the residence time required by the groundwater flow rate anticipated in the location of the proposed PRB. Note that at previous sites where the required ZVI iron thickness is relatively small, ZVI-sand mixes have been used as PRB backfill. At those applications, a minimum ZVI content of 10% to 20% has been recommended to account for potential segregation during mixing and backfill and to assure direct contact between the aqueous phase contaminants and ZVI particles within the PRB.

4.2 Possible Mineral Precipitates

While there is little doubt that inorganic (mostly carbonates and iron oxy-hydroxides) precipitates will form over time in a PRB installed at the site, their impact may not be significant, depending on the groundwater velocity and the resulting mass flux of those constituents. In other words, it is anticipated that a ZVI PRB designed based on the cVOC degradation rates form this column test, including a reasonable safety factor, would be able to last for a long time without rehabilitation.

4.3 Iron Consumption

As discussed in Section 3.3, there are many processes such as water corrosion, cVOC degradation, dissolved oxygen consumption and sulfate reduction that may consume the iron. These processes are not independent of one another and are also influenced by site conditions such as groundwater flow velocity, inorganic aqueous concentrations, cVOC concentrations, biological activity and temperature. All of these factors make it difficult to gauge with exact certainty how long before all the iron in a PRB is consumed (e.g. completely corroded).

If water corrosion were to remain constant over time at a typical rate of 0.3 mmol/kg Fe/day, the iron is predicted to last for about 150 years. However, Reardon (1995) noted declining hydrogen production over time at room temperature. This decline in corrosion rate was likely due to mineral precipitate formation on the surface of the iron over long periods of time. Warner et al. (2005) found that the pH of the groundwater at the first commercial PRB in Sunnyvale, California continues to increase from a value of 7.5 in the upgradient aquifer to a value of about 11 in the PRB, and that dissolved hydrogen concentrations approach solubility. Clearly, water corrosion was still occurring at significant rates at this site after 12 years. Although there is some uncertainty in the conditions that may exist decades in the future, it seems reasonable to expect the iron in the PRB to last for many decades.

4.4 Potential for Biofouling of Reactive Material

There was no evidence of biofouling (sliming, etc.) observed during the bench-scale test. Field tests to date from other sites have not indicated significant biofouling. Based on this experience, there is no reason to believe that biofouling will be an issue in a PRB at the site.

5.0 SUMMARY

Bench-scale testing using groundwaters from OU1 in MCAS Cherry Point showed that:

i) Connelly iron degraded the cVOCs present in the site water. Degradation rates in the test were significantly better than those typically observed in previous tests for the same ZVI source and other groundwaters with comparable cVOC composition and concentrations.

ii) Based on the field anticipated half-lives at the 18^{o}C field groundwater temperature and the cVOC concentrations tested, a residence time of 5 to 7 hrs would be required in a ZVI PRB to achieve the NCGWQS (2L) target levels.

iii) Slow, but perceivable ZVI passivation was observed in one of the ZVI columns within the test period and it was attributed to the formation of carbonate and iron oxyhydroxides precipitation on iron grains. Therefore, it is recommended that an engineering safety factor be included in ZVI volume design calculations for the proposed PRB to assure long-term efficiency.

6.0 REFERENCES

Arnold, W.A. and Roberts, L.A., 1999. Pathways and Kinetics of Chlorinated Ethylene and Chlorinated Acetylene Reaction with Fe(0). American Chemical Society National Meeting, New Orleans, LA, Vol. 39, No. 2, pp. 158-159.

Eykholt, G.R., 1998. Analytical Solution for Networks of Irreversible First-Order Reactions. The Journal of the International Association on Water Quality, Vol. 33, No. 3, pp. 814-826.

Gillham, R.W. and O'Hannesin, S.F., 1994. Enhanced Degradation of Halogenated Aliphatics by Zero-Valent Iron. Ground Water, Vol. 32, No. 6, pp. 958-967.

Gillham, R.W., Vogan, J., Gui., L., Duchene, M., Son, J., 2010. Iron Barrier Walls for Chlorinated Solvent Remediation. In Situ Remediation of Chlorinated Solvent Plumes. Ed. Hans F. Stroo and C. Herb Ward. New York, NY: Springer Science+Business Media, 2010

MicroMath Scientist, 1995. Experimental data fitting. Microsoft Windows Version 2.0, Salt Lake City, Utah, 84121.

O'Hannesin, S.F. and Gillham, R.W., 1998. Long-Term Performance of an In-Situ "Iron Wall" for Remediation of cVOCs. Ground Water, Vol. 36, No. 1, pp. 164-170.

O'Hannesin, S.F., Przepiora, A. and Gillham, R.W., 2004. Effect of Temperature and Iron Content on Iron PRB Design. Presented at The Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, California, May 24-27.

Remediation Technologies Development Forum (RTDF), 2004. The Permeable Reactive Barriers Action Team Web Site [www.rtdf.org/public/permbarr/].

Roberts, A.L., Totten, L.A., Arnold, W.A., Burris, D.R. and Campbell, T.J., 1996. Reductive Elimination of Chlorinated Ethylenes by Zero-Valent Metals. Environ. Sci. & Technol., Vol. 30, pp. 2654-2659.

Sivavec, T.M., Mackenzie, P.D., Horney, D.P. and Baghel, S.S., 1997. Redox-Active Media for Permeable Reactive Barriers. Presented at the 1997 International Containment Conference and Exhibition, St. Petersburgh, FL. , February 9-12, pp. 753-759.

United States Environmental Protection Agency, 1982. Methods for Organic Chemical Analyses of Municipal and Industrial Wastewater. EPA-600/4-82-057. J.E. Longbottom and J.J. Lichtenberg (eds), Cincinnati, Ohio, Appendix A.

Table 1: Iron and Column Properties

Iron:		
Source	Connelly-GPM, Chicago, IL	
Grain Size	2.0 to 0.25 mm (-8 to +50 mesh)	
Surface Area	1.4 m^2/g	
Hydraulic Conductivity	5.0×10^{-2} cm/sec (142 ft/day)	
Column:	**GW34**	**GW35**
Flow Velocity	47.9 cm/day (1.57 ft/day)	47.8 cm/day (1.57 ft/day)
Residence Time	25.04 hr	25.14 hr
Pore Volume	362 mL	354 mL
Total Porosity	0.64	0.62
Bulk Density	2.687 g/cm^3	2.694 g/cm^3
Iron to Volume of Solution Ratio	4.2 g : 1 mL	4.3 g : 1 mL
Surface Area to Volume of Solution Ratio	5.6 m^2 : 1 mL	6.0 m^2 : 1 mL

Table 2: Initial cVOC composition in site waters provided for the test.

Sample		PCE	TCE	cDCE	tDCE	11DCE	VC	1,1-DCA
		(ug/L)						
16GW34	Cooler 4 Bottle 2	nd	21	47	4.8	nd	4.9	nd
	Cooler 5 Bottle 2	nd	21	46	4.6	nd	5.0	nd
	Cooler 6 Bottle 2	nd	21	41	4.5	nd	4.5	nd
	Cooler 6 Bottle 6	nd	14	45	4.0	nd	4.8	nd
	Avg.	**nd**	**19**	**45**	**4.5**	**nd**	**4.8**	**nd**
16GW35	Cooler 1 Bottle 1	nd	0.7	0.9	nd	nd	nd	nd
	Cooler 3 Bottle 1	nd	0.8	1.1	nd	nd	nd	nd
	Cooler 6 Bottle 8	nd	1.8	2.5	nd	nd	nd	nd
	Cooler 7 Bottle 3	nd	1.3	1.5	nd	nd	nd	nd
	Avg.	**nd**	**1.2**	**1.5**	**nd**	**nd**	**nd**	**nd**

Table 3: CVOC concentrations targeted in the spiked site waters used in the test.

Sample	VC	tDCE	cDCE	TCE
	(ug/L)			
16GW34	~50	~50	~500	~200
16GW35	0	0	~300	~240

Table 4: Method Detection Limits (MDL) and Reported Detection Limits (RDL)

Organic Compounds:	**MDL (µg/L)**
Tetrachloroethene (PCE)	0.3
Trichloroethene (TCE)	0.3
Cis 1,2-dichloroethene (cDCE)	0.7
Trans 1,2-dichloroethene (tDCE)	0.6
1,1-Dichloroethene (11DCE)	0.6
Vinyl chloride (VC)	0.9
Inorganic Compounds:	**RDL (mg/L)**
Barium (Ba)	0.002
Boron (B)	0.01
Calcium (Ca)	0.2
Iron (Fe)	0.1
Magnesium (Mg)	0.05
Manganese (Mn)	0.002
Potassium (K)	0.2
Silicon (Si)	0.05
Sodium (Na)	0.1
Strontium (Sr)	0.001
Chloride (Cl^-)	1
Nitrate (as N) (NO_3)	0.1
Sulfate (SO_4)	1
Alkalinity (mg $CaCO_3$/L)	1
Ammonia, Total (as N) (NH_3^+)	0.1
Dissolved Organic Carbon (DOC)	0.2
Total Organic Carbon (TOC)	0.2
Calculated Total Dissolved Solids (TDS)	1

Table 5: Bench-Scale Test Half-Life at the End of the Test (23°C).

Volatile Organic Compound	Influent Concentration (µg/L)	Half-Life at Temperature 23°C (hr)	Coefficient of Determination (r^2)	Molar Conversion [a] (%)	
GW-34					
TCE	179	0.36	1.000		
cDCE	510	0.42	1.000	TCE → cDCE	4%
tDCE	37	0.33	0.999	TCE → tDCE	0%
VC	48	0.22	0.998	cDCE → VC	5%
GW-35					
TCE	201	0.15	1.000		
cDCE	292	0.24	0.999	TCE → cDCE	4%
tDCE	4.6	0.24	1.000	TCE → tDCE	0%
VC	0	na	na	na	na

[a] Typical conversion rates from previous testing for Connelly ZVI

Table 6: Major Influent and Effluent Inorganic Chemistry at Steady State.

Constituent	Column GW-34		Column GW-35	
	Influent	Influent	Effluent	Effluent
Barium	0.035 0.034	0.057 0.073	0.034 0.034	0.210 0.160
Boron	0.029 0.023	0.42 0.26	0.038 0.036	0.46 0.38
Calcium	64 62	14 14	79 77	33 32
Iron	nd nd	nd nd	nd nd	nd nd
Magnesium	2.7 2.9	0.066 0.045	3.6 3.9	1.6 1.8
Manganese	0.60 0.57	nd nd	nd nd	0.008 0.010
Potassium	1.4 1.4	1.5 1.4	2.6 2.4	2.6 2.4
Silicon	8.3 8.3	0.36 0.31	3.2 3.4	0.18 0.11
Sodium	13 12	13 13	12 12	12 12
Strontium	0.37 0.38	0.12 0.11	0.27 0.28	0.14 0.14
Chloride	15 15	16 16	25 25	26 26
Nitrate (as N)	nd nd	nd nd	nd nd	nd nd
Sulfate	14 14	21 17	59 67	67 71
Alkalinity (mg $CaCO_3$/L)	162 161	20 29	134 131	6 5
Ammonia (as N)	nd nd	nd nd	nd nd	nd nd
Dissolved Organic Carbon (DOC)	6.0 6.4	4.9 4.7	5.7 4.7	1.2 0.9
Total Organic Carbon (TOC)	5.9 6.3	5.6 5.2	5.6 4.7	1.8 0.9
Total Dissolved Solids (TDS)	226 223	78 79	269 273	147 149

nd - not detected
Samples collected at 39 PVs and 42 PVs

Table 7: Residence Time Calculation for Connelly Iron.

cVOC	Anticipated Field Concentration [a] (µg/L)	Target Level [b] (µg/L)	Field Anticipated Half-Life [c] (hrs)	Field Residence Time (hr)
GW-34				
TCE	500	3	0.72	7
cDCE	200	70	0.84	
tDCE	50	100	0.66	
VC	50	0.03	0.44	
GW-35				
TCE	300	3	0.30	5
cDCE	240	70	0.48	
tDCE	0	100	0.48	
VC	0	0.03	na	

[a] Targeted spiked concentrations in waters used in the column test
[b] NCGWQS (2L)
[c] Laboratory half-lives obtained at the end of test and corrected by a factor of 2 to a temperature of 18°C

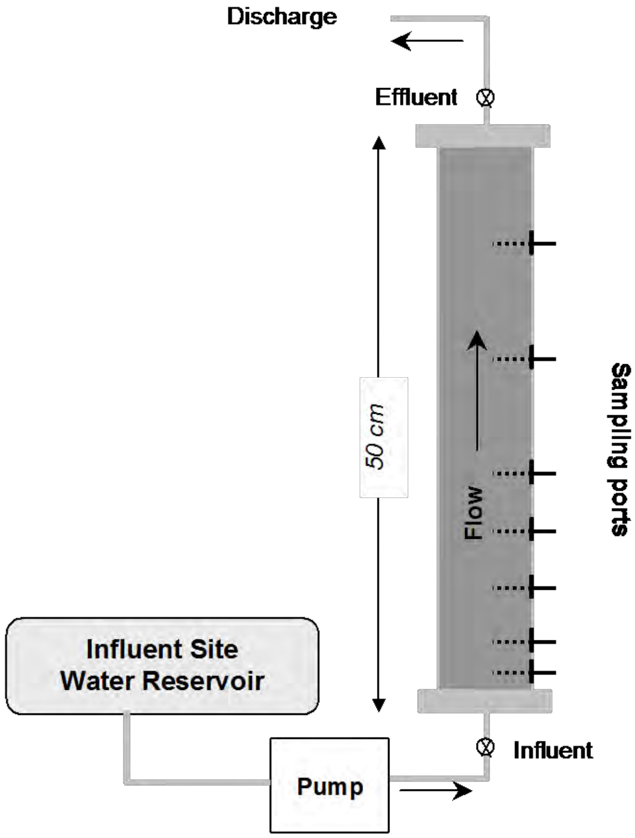


Figure 1: Schematic of Column Test Setup.

Figure 2: Photo of Column Test Setup

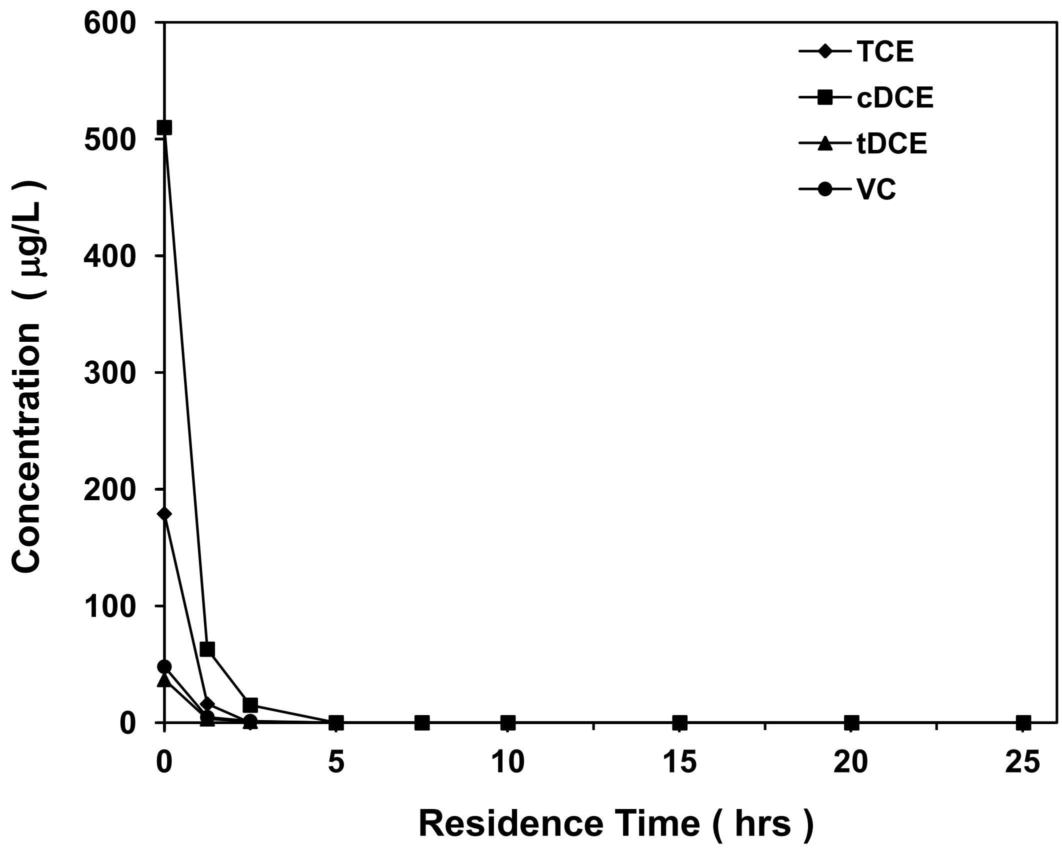


Figure 3: cVOC concentration profiles versus residence time in the GW34 ZVI column at the end of the test.

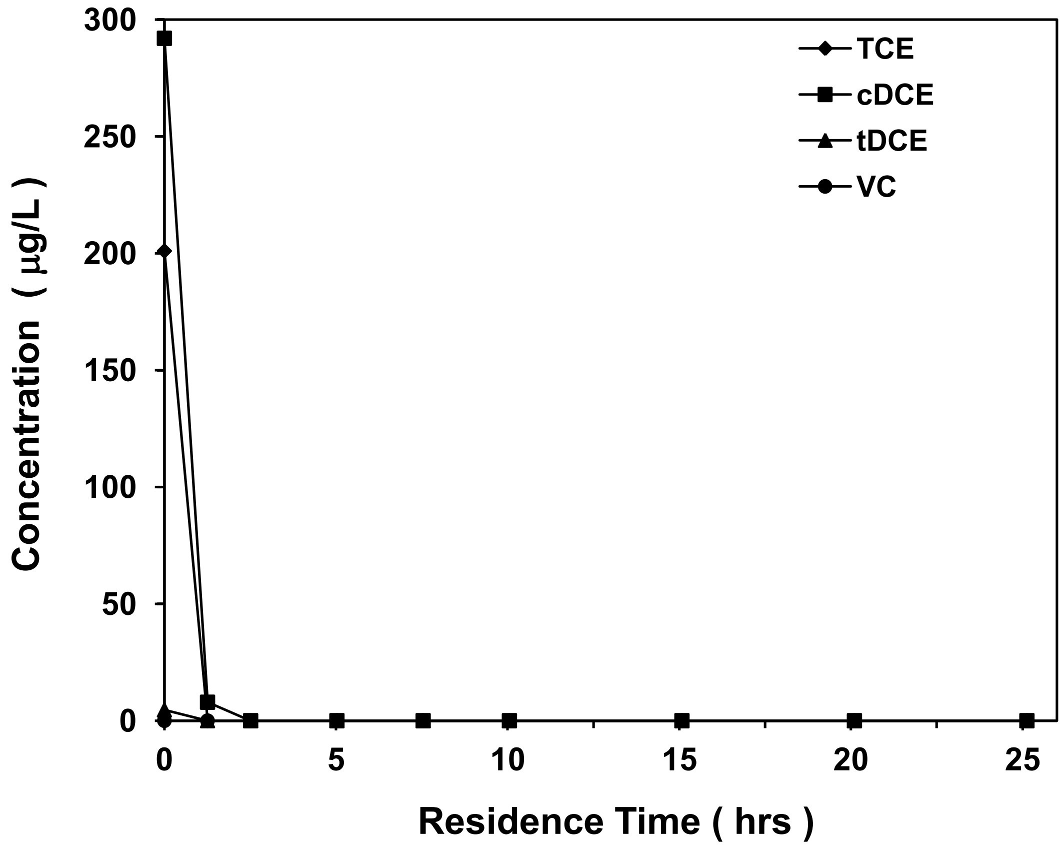


Figure 4: cVOC concentration profiles versus residence time in the GW35 ZVI column at the end of the test.

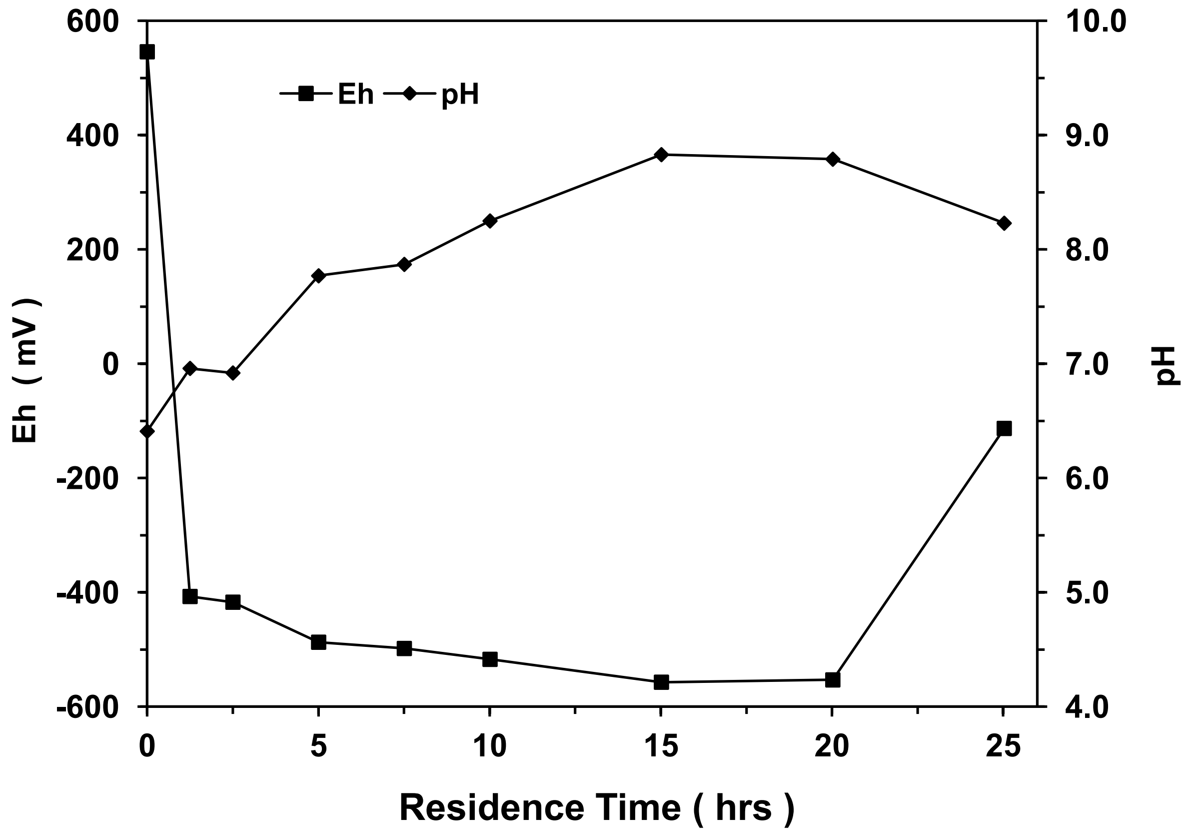


Figure 5: Redox potential (Eh) and pH profiles versus residence time along the GW34 ZVI column at the end of the test.

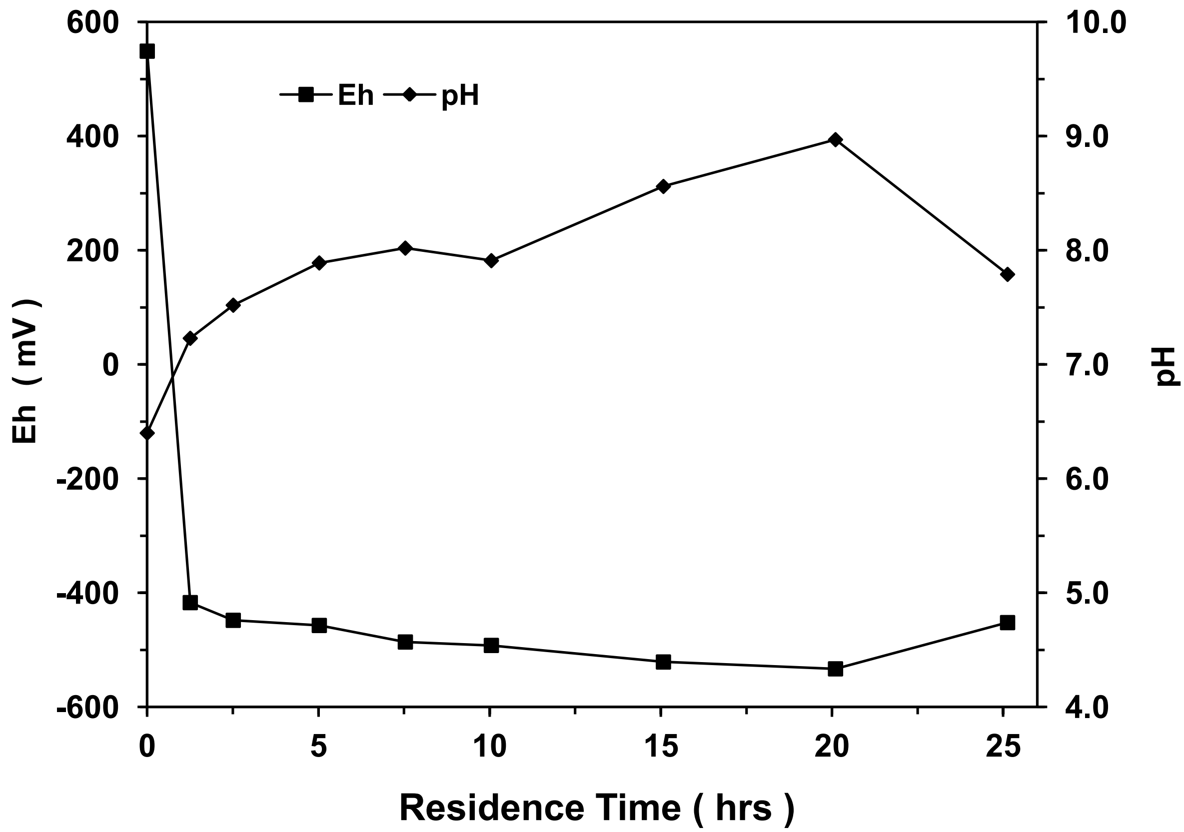


Figure 6: Redox potential (Eh) and pH profiles versus residence time along the GW35 ZVI column at the end of the test.

Appendix A

Laboratory Organic Analyses for Bench-Scale Testing Involving the ZVI Technology

Treatability Test	Column Identification:	ETI#1064
CH2M HILL AAI11-640	Column Composition:	100% Connelly CC1004
Nov-11	Site GW	16GW34
	Pore Volume (PV):	361.9
	Porosity:	0.638
	Column Length:	1.6 ft (50 cm)
	Column Diameter:	1.5 in (3.8 cm)
	Flow Velocity:	1.6 ft/day (50 cm/day)
	Test Temperature:	23°C

Column Distance (cm)			0.0	2.5	5	10	15	20	30	40	50		
Column Distance (ft)			0.0	0.08	0.16	0.33	0.50	0.66	1.0	1.3	1.6		
Residence Time (hr)			0.0	1.3	2.5	5.0	7.5	10.0	15.0	20.0	25.0		
	PV	RN	Influent	Organic Concentration (μg/L)							Effluent	HL	r2
TCE													
	7.4	a	179	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	165	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	197	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	169	nd	nd	nd	nd	nd	nd	nd	nd		
	33.8	b	143	nd	nd	nd	nd	nd	nd	nd	nd	0.17	1.000
	40.7	b	218	7.4	nd	nd	nd	nd	nd	nd	nd	0.26	1.000
	50.8	c	179	16	nd	nd	nd	nd	nd	nd	nd	0.36	1.000
cDCE													
	7.4	a	551	1.3	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	375	0.8	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	595	1.1	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	545	3.0	nd	nd	nd	nd	nd	nd	nd		
	33.8	b	525	2.0	nd	nd	nd	nd	nd	nd	nd	0.15	1.000
	40.7	b	440	24	2.7	nd	nd	nd	nd	nd	nd	0.29	0.999
	50.8	c	510	63	15	nd	nd	nd	nd	nd	nd	0.42	0.996
tDCE													
	7.4	a	50	1.5	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	35	1.0	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	47	0.7	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	38	1.1	nd	nd	nd	nd	nd	nd	nd		
	33.8	b	46	1.0	nd	nd	nd	nd	nd	nd	nd	0.22	1.000
	40.7	b	35	1.6	nd	nd	nd	nd	nd	nd	nd	0.26	1.000
	50.8	c	37	3.3	nd	nd	nd	nd	nd	nd	nd	0.33	0.999
1,1-DCE													
	7.4	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	33.8	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	40.7	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	50.8	c	nd	nd	nd	nd	nd	nd	nd	nd	nd		
VC													
	7.4	a	69	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	57	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	48	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	46	nd	nd	nd	nd	nd	nd	nd	nd		
	33.8	b	60	nd	nd	nd	nd	nd	nd	nd	nd	0.13	1.000
	40.7	b	43	1.9	nd	nd	nd	nd	nd	nd	nd	0.16	1.000
	50.8	c	48	4.7	1.3	nd	nd	nd	nd	nd	nd	0.22	0.998

Treatability Test	Column Identification:	ETI#1064
CH2M HILL AAI11-640	Column Composition:	100% Connelly CC1004
Nov-11	Site GW	16GW34
	Pore Volume (PV):	46.01
	Porosity:	47.927
	Column Length:	1.6 ft (50 cm)
	Column Diameter:	1.5 in (3.8 cm)
	Flow Velocity:	1.6 ft/day (50 cm/day)
	Test Temperature:	23°C

Column Distance (cm)		0.0	2.5	5	10	15	20	30	40	50
Column Distance (ft)		0.0	0.08	0.16	0.33	0.50	0.66	1.0	1.3	1.6
Residence Time (hr)		0.0	1.3	2.5	5.0	7.5	10.0	15.0	20.0	25.0
PV	RN	Influent				Organic Concentration (mg/L)				Effluent
Nitrate (as N) mg/L										
32.8	b	nd	nd	nd	nd	nd	nd	nd	nd	nd
38.5	b	nd	nd	nd	nd	nd	nd	nd	nd	nd
Chloride (mg/L)										
32.8	b	14	15	14	15	14	14	14	15	15
38.5	b	14	14	14	15	15	14	15	15	15
Sulphate (mg/L)										
32.8	b	16	16	16	16	16	16	16	18	24
38.5	b	17	16	16	16	16	16	16	18	20
pH Values										
5.6	a	6.1	7.0	7.0	7.5	6.3	6.5	6.2	6.5	6.1
12.4	a	6.4	6.9	7.3	7.7	8.2	8.4	7.8	7.7	7.8
19.4	a	6.8	6.9	7.5	7.9	8.2	8.6	9.0	8.5	8.3
26.1	a	6.8	6.8	7.3	8.0	8.3	8.4	8.4	8.6	8.3
32.8	b	6.5	7.2	7.5	8.2	8.5	8.6	8.7	8.5	9.0
38.5	b	6.9	7.0	7.3	8.0	8.3	8.5	8.8	9.3	9.4
45.3	c	6.4	7.0	6.9	7.8	7.9	8.3	8.8	8.8	8.2
Eh (mV)										
5.6	a	634	-412	-413	-310	-24	40	64	63	122
12.4	a	662	-412	-448	-476	-510	-500	-185	-122	80
19.4	a	621	-405	-444	-482	-503	-535	-559	-528	-38
26.1	a	386	-380	-447	-482	-509	-516	-527	-539	-519
32.8	b	608	-399	-448	-494	-507	-541	-532	-557	-3
38.5	b	603	-433	-464	-503	-522	-528	-551	-573	-55
45.3	c	546	-407	-417	-487	-498	-517	-557	-553	-113

PV = pore volume
RN = reservoir number
HL = half life (hours)
r2 = coefficient of determination
nd = not detected

Treatability Test
CH2M HILL AAI11-640
Nov-11

Column Identification: ETI#1065
Column Composition: 100% Connelly CC1004
Site GW 16GW35
Pore Volume (PV): 354
Porosity: 0.624
Column Length: 1.6 ft (50 cm)
Column Diameter: 1.5 in (3.8 cm)
Flow Velocity: 1.6 ft/day (50 cm/day)
Test Temperature: 23°C

Column Distance (cm)			0.0	2.5	5	10	15	20	30	40	50		
Column Distance (ft)			0.0	0.08	0.16	0.33	0.50	0.66	1.0	1.3	1.6		
Residence Time (hr)			0.0	1.2	2.4	4.8	7.2	9.6	14.4	19.2	24.0		
	PV	RN	Influent	Organic Concentration (µg/L)							Effluent	HL	r2
TCE													
	7.5	a	205	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	185	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	239	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	183	nd	nd	nd	nd	nd	nd	nd	nd		
	33.7	b	143	nd	nd	nd	nd	nd	nd	nd	nd	0.15	1.000
	40.4	b	211	6.4	nd	nd	nd	nd	nd	nd	nd	0.25	1.000
	50.6	c	201	nd	nd	nd	nd	nd	nd	nd	nd	0.15	1.000
cDCE													
	7.5	a	280	1.5	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	241	2.2	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	310	5.9	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	263	11	nd	nd	nd	nd	nd	nd	nd		
	33.7	b	270	3.4	nd	nd	nd	nd	nd	nd	nd	0.14	1.000
	40.4	b	345	23	nd	nd	nd	nd	nd	nd	nd	0.32	1.000
	50.6	c	292	7.9	nd	nd	nd	nd	nd	nd	nd	0.24	0.999
tDCE													
	7.5	a	3.7	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	2.9	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	4.1	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	2.8	nd	nd	nd	nd	nd	nd	nd	nd		
	33.7	b	3.6	nd	nd	nd	nd	nd	nd	nd	nd	0.26	1.000
	40.4	b	4.4	nd	nd	nd	nd	nd	nd	nd	nd	0.21	1.000
	50.6	c	4.6	nd	nd	nd	nd	nd	nd	nd	nd	0.24	1.000
1,1-DCE													
	7.5	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	nd	nd	0.9	nd	nd	nd	nd	nd	nd		
	20.2	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	33.7	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	40.4	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	50.6	c	nd	nd	nd	nd	nd	nd	nd	nd	nd		
VC													
	7.5	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	13.3	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	20.2	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	27.1	a	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	33.7	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	40.4	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	50.6	c	nd	nd	nd	nd	nd	nd	nd	nd	nd		

Treatability Test	Column Identification:	ETI#1065
CH2M HILL AAI11-640	Column Composition:	100% Connelly CC1004
Nov-11	Site GW	16GW35
	Pore Volume (PV):	46
	Porosity:	48.000
	Column Length:	1.6 ft (50 cm)
	Column Diameter:	1.5 in (3.8 cm)
	Flow Velocity:	1.6 ft/day (50 cm/day)
	Test Temperature:	23°C

Column Distance (cm)			0.0	2.5	5	10	15	20	30	40	50		
Column Distance (ft)			0.0	0.08	0.16	0.33	0.50	0.66	1.0	1.3	1.6		
Residence Time (hr)			0.0	1.2	2.4	4.8	7.2	9.6	14.4	19.2	24.0		
	PV	RN	Influent			Concentration (mg/L)					Effluent	HL	r2
Nitrate (as N) mg/L													
	32.9	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
	38.5	b	nd	nd	nd	nd	nd	nd	nd	nd	nd		
Chloride (mg/L)													
	32.9	b	24	25	25	25	25	25	25	27	26		
	38.5	b	25	25	25	25	25	26	26	27	26		
Sulphate (mg/L)													
	32.9	b	68	69	69	68	69	69	75	81	78		
	38.5	b	71	72	71	71	72	72	77	86	80		
pH Values													
	5.6	a	6.1	7.0	7.0	7.5	6.2	6.1	6.3	5.9	5.3		
	12.5	a	6.5	7.1	7.4	7.7	8.2	7.6	7.7	7.6	8.0		
	19.4	a	6.8	7.1	7.4	7.9	8.1	8.4	8.3	8.2	8.1		
	26.1	a	7.2	6.9	7.1	7.5	8.2	8.5	8.3	8.4	7.4		
	32.9	b	6.8	7.4	7.4	7.4	8.5	8.6	8.6	8.8	5.5		
	38.5	b	6.8	7.2	7.5	7.9	8.0	8.4	9.1	8.8	8.7		
	44.6	c	6.4	7.2	7.5	7.9	8.0	7.9	8.6	9.0	7.8		
Eh (mV)													
	5.6	a	638	-390	-395	-64	24	88	130	78	166		
	12.5	a	664	-403	-452	-462	-501	-137	-31	-52	98		
	19.4	a	633	-405	-467	-469	-502	-532	-515	-505	56		
	26.1	a	388	-414	-446	-445	-442	-529	-487	-513	-364		
	32.9	b	607	-406	-448	-486	-504	-505	-523	-477	-467		
	38.5	b	649	-447	-472	-497	-511	-523	-563	-559	-85		
	44.6	c	549	-417	-448	-457	-486	-492	-521	-533	-452		

PV = pore volume
RN = reservoir number
HL = half life (hours)
r2 = coefficient of determination
nd = not detected

Appendix B

Laboratory Inorganic Analyses for Bench-Scale Testing Involving the ZVI Technology

ADVENTUS

AAI11-640 Inorganics #1 results	Col. 1064 Feed (16GW34)	Col. 1064 Effluent	Col. 1065 Feed (16GW35)	Col. 1065 Effluent	RDL	Units
Calculated Parameters						
Anion Sum	3.97	1.29	4.62	2.25	N/A	me/L
Bicarb. Alkalinity (calc. as CaCO3)	162	20	134	6	1	mg/L
Calculated TDS	226	78	269	147	1	mg/L
Carb. Alkalinity (calc. as CaCO3)	1	ND	1	ND	1	mg/L
Cation Sum	4.00	1.31	4.84	2.38	N/A	me/L
Hardness (CaCO3)	170	36	210	90	1	mg/L
Ion Balance (% Difference)	0.350	NC	2.28	NC	N/A	%
Langelier Index (@ 20C)	0.574	-0.844	0.560	-2.38	N/A	N/A
Langelier Index (@ 4C)	0.324	-1.10	0.311	-2.63	N/A	N/A
Saturation pH (@ 20C)	7.38	8.88	7.38	9.08	N/A	N/A
Saturation pH (@ 4C)	7.63	9.13	7.63	9.33	N/A	N/A
Inorganics						
Ammonia-N	ND	ND	ND	ND	0.05	mg/L
Conductivity	383	151	474	286	1	umho/cm
Organic Carbon	6.0	4.9	5.7	1.2	0.2	mg/L
Organic Carbon (TOC)	5.9	5.6	5.6	1.8	0.20	mg/L
Orthophosphate (P)	ND	ND	ND	ND	0.01	mg/L
pH	7.95	8.03	7.94	6.71	N/A	pH
Sulphate (SO4)	14	21	59	67	1	mg/L
Alkalinity (Total as CaCO3)	163	20	135	6	1	mg/L
Chloride (Cl)	15	16	25	26	1	mg/L
Nitrite (N)	ND	ND	ND	ND	0.01	mg/L
Nitrate (N)	ND	ND	ND	ND	0.1	mg/L
Nitrate + Nitrite	ND	ND	ND	ND	0.1	mg/L
Metals						
Aluminum (Al)	ND	10	ND	ND	5	ug/L
Antimony (Sb)	ND	ND	ND	ND	0.5	ug/L
Arsenic (As)	ND	ND	ND	ND	1	ug/L
Barium (Ba)	35	57	34	210	2	ug/L
Beryllium (Be)	ND	ND	ND	ND	0.5	ug/L
Boron (B)	29	420	38	460	10	ug/L
Cadmium (Cd)	ND	ND	ND	ND	0.1	ug/L
Calcium (Ca)	64000	14000	79000	33000	200	ug/L
Chromium (Cr)	ND	ND	ND	ND	5	ug/L
Cobalt (Co)	3.5	ND	ND	ND	0.5	ug/L
Copper (Cu)	4	ND	5	ND	1	ug/L
Iron (Fe)	ND	ND	ND	ND	100	ug/L
Lead (Pb)	ND	ND	ND	ND	0.5	ug/L
Magnesium (Mg)	2700	66	3600	1600	50	ug/L
Manganese (Mn)	600	ND	ND	8	2	ug/L
Molybdenum (Mo)	ND	56	ND	3.1	0.5	ug/L
Nickel (Ni)	ND	ND	3	ND	1	ug/L
Phosphorus (P)	ND	170	ND	ND	100	ug/L
Potassium (K)	1400	1500	2600	2600	200	ug/L
Selenium (Se)	ND	ND	ND	ND	2	ug/L
Silicon (Si)	8300	360	3200	180	50	ug/L
Silver (Ag)	ND	ND	ND	ND	0.1	ug/L
Sodium (Na)	13000	13000	12000	12000	100	ug/L
Strontium (Sr)	370	120	270	140	1	ug/L
Thallium (Tl)	ND	ND	ND	ND	0.05	ug/L
Titanium (Ti)	ND	ND	ND	ND	5	ug/L
Uranium (U)	ND	ND	0.4	ND	0.1	ug/L
Vanadium (V)	ND	ND	ND	ND	0.5	ug/L
Zinc (Zn)	ND	ND	ND	ND	5	ug/L

ND = Not detected
N/A = Not Applicable
RDL = Reportable Detection Limit
EDL = Estimated Detection Limit
QC Batch = Quality Control Batch

AAI11-640 Inorganics #2 results	Col. 1064 Feed (16GW34)	Col. 1064 Effluent	Col. 1065 Feed (16GW35)	Col. 1065 Effluent	RDL	Units
Calculated Parameters						
Anion Sum	3.95	1.37	4.74	2.32	N/A	me/L
Bicarb. Alkalinity (calc. as CaCO3)	161	29	131	5	1	mg/L
Calculated TDS	223	79	273	149	1	mg/L
Carb. Alkalinity (calc. as CaCO3)	ND	ND	ND	ND	1	mg/L
Cation Sum	3.92	1.33	4.71	2.33	N/A	me/L
Hardness (CaCO3)	170	37	210	88	1	mg/L
Ion Balance (% Difference)	0.390	NC	0.290	NC	N/A	%
Langelier Index (@ 20C)	0.310	-1.34	0.163	-2.43	N/A	N/A
Langelier Index (@ 4C)	0.0600	-1.59	-0.0860	-2.68	N/A	N/A
Saturation pH (@ 20C)	7.39	8.72	7.41	9.12	N/A	N/A
Saturation pH (@ 4C)	7.64	8.98	7.66	9.37	N/A	N/A
Inorganics						
Ammonia-N	ND (1)	ND (1)	ND (1)	ND (1)	0.1	mg/L
Conductivity	387	160	489	290	1	umho/cm
Organic Carbon	6.4	4.7	4.7	0.9	0.2	mg/L
Organic Carbon (TOC)	6.3	5.2	4.7	1.3	0.20	mg/L
Orthophosphate (P)	0.01	ND	ND	ND	0.01	mg/L
pH	7.70	7.39	7.57	6.68	N/A	pH
Sulphate (SO4)	14	17	67	71	1	mg/L
Alkalinity (Total as CaCO3)	162	29	132	5	1	mg/L
Chloride (Cl)	15	16	25	26	1	mg/L
Nitrite (N)	ND	ND	ND	ND	0.01	mg/L
Nitrate (N)	ND	ND	ND	ND	0.1	mg/L
Nitrate + Nitrite	ND	ND	ND	ND	0.1	mg/L
Metals						
Aluminum (Al)	ND	5	ND	ND	5	ug/L
Antimony (Sb)	ND	ND	ND	ND	0.5	ug/L
Arsenic (As)	ND	ND	ND	ND	1	ug/L
Barium (Ba)	34	73	34	160	2	ug/L
Beryllium (Be)	ND	ND	ND	ND	0.5	ug/L
Boron (B)	23	260	36	350	10	ug/L
Cadmium (Cd)	ND	ND	ND	ND	0.1	ug/L
Calcium (Ca)	62000	14000	77000	32000	200	ug/L
Chromium (Cr)	ND	ND	ND	ND	5	ug/L
Cobalt (Co)	3.3	ND	ND	ND	0.5	ug/L
Copper (Cu)	3	ND	4	ND	1	ug/L
Iron (Fe)	ND	ND	ND	ND	100	ug/L
Lead (Pb)	ND	ND	ND	ND	0.5	ug/L
Magnesium (Mg)	2900	450	3900	1800	50	ug/L
Manganese (Mn)	570	ND	ND	10	2	ug/L
Molybdenum (Mo)	ND	86	ND	2.8	0.5	ug/L
Nickel (Ni)	ND	ND	1	ND	1	ug/L
Phosphorus (P)	ND	100	ND	ND	100	ug/L
Potassium (K)	1400	1400	2400	2400	200	ug/L
Selenium (Se)	ND	ND	ND	ND	2	ug/L
Silicon (Si)	8300	310	3400	110	50	ug/L
Silver (Ag)	ND	ND	ND	ND	0.1	ug/L
Sodium (Na)	12000	13000	12000	12000	100	ug/L
Strontium (Sr)	380	110	280	140	1	ug/L
Thallium (Tl)	ND	ND	ND	ND	0.05	ug/L
Titanium (Ti)	ND	ND	ND	ND	5	ug/L
Uranium (U)	ND	ND	0.4	ND	0.1	ug/L
Vanadium (V)	ND	ND	ND	ND	0.5	ug/L
Zinc (Zn)	ND	ND	ND	ND	5	ug/L

ND = Not detected
N/A = Not Applicable
RDL = Reportable Detection Limit
EDL = Estimated Detection Limit

via e-mail: Keri.Hallberg@CH2M.com

February 10, 2012

Keri Hallberg, PE
CH2M HILL
11301 Carmel Commons Blvd, Suite 304
Charlotte, NC 28226
704-543-3260 (direct)

Reference: Laboratory Testing of ZVI – Final Report Addendum
Feasibility Testing for ZVI PRB Application at OU1 in Marine Corps Air Station (MCAS) Cherry Point, Havelock, North Carolina
Adventus Reference # AAI11-640

Dear Keri:

Further to your request, this memorandum provides theoretical calculations to quantify the temporal changes in ZVI reactivity observed in a column test performed by Adventus. The final test report was provided to CH2M HILL on 27 January 2012.

Rate of ZVI Reactivity Loss Estimation

As shown in the final report, test results indicated no significant impediments to application of the ZVI technology at the site. However, the temporal degradation trends in cVOC degradation, especially in the GW34 column, showed that although ZVI reactivity was extremely high, the reactivity diminished gradually with operation time. One method of addressing the loss of reactivity is to include two iron zones in the PRB design:

- A zone of un-passivated iron that will need to provide sufficient residence time for VOC degradation, based on the obtained degradation parameters.
- A zone of iron that will be gradually passivated by precipitation, with the thickness of this zone dependent on the operation time and mass fluxes of constituents contributing to the secondary precipitation.

To quantify the rate of iron passivation, we have evaluated migration of concentration profiles of TCE, cDCE, cDCE and VC over the test period in the GW34 column (**Figure 1)**. Significant breakthrough of those compounds was observed during the test period at the first sampling port only (i.e.; 2.5 cm of ZVI and a residence time of 1.25 hrs)**.** The relative cVOC breakthrough at that distance at the end of the test (i.e.; 50.8 PVs of flow) varied from 9% for TCE and tDCE to 12% for cDCE (**Figure 1**). Assuming that 50% breakthrough would mean complete passivation of the ZVI zone, we have extrapolated those trends (i.e.; 12% breakthrough after 50.8 PVs of flow) and assumed that a 2.5 cm iron thickness would have been “passivated” after ca. 200 PVs of flow.

Based on the inorganic chemistry results presented in the final report, we have assumed that carbonate precipitation was the main mineral phase contributing to the observed loss of iron reactivity. Therefore, the passivation rate was normalized with respect to the influent level of carbonate alkalinity measured in the test. The reduction capacity of granular iron can be calculated by dividing the alkalinity (Alk.) [Average Alk. concentration $\times$ pore volume $\times$ number of pore volumes) by the mass of passivated iron (Passivated column zone length $\times$ column cross-section area $\times$ iron bulk density]. Iron specific alkalinity reduction calculations are shown in **Table 1**. The obtained alkalinity reduction rate value is 154 mg_{Alk}/g_{Fe} for Connelly iron.

The obtained normalized reduction capacity is an intrinsic property of granular iron in the presence of this site water and can be used for estimations of the iron passivation rate in a field-scale PRB at different groundwater velocities and alkalinity concentrations. Using the calculated reduction capacity due to precipitation (**Table 1**), the iron passivation rate in a field-scale PRB was calculated using the reported groundwater velocity of 0.2 ft/day and an assumed field alkalinity level of 162 mg/L (as measured in the tested water), using the following formula:

Iron passivation rate (= (Alk flux) $\div$ (Alk reduction capacity per vol.)
= (GW vel. $\times$ aquifer porosity $\times$ Alk conc.) $\div$ (Alk red. cap. $\times$ iron bulk density)

Based on those calculations and assuming an operational time of 10 years, it is expected that an iron thickness of 0.08 ft would be required to accommodate the precipitation effect (**Table 2**).

Please feel free to contact us if you have any questions pertaining to this memorandum.

Sincerely,

FMC's Adventus Environmental Solutions Team

A. Przepiora

Andrzej Przepiora, M.Sc., P.Geo.
Senior Geochemist

Cc: Eva Janzen, Adventus

Table 1: ZVI Passivation Calculation based on Column Test Results.

Influent Conc. Alkalinity (mg/L)	PV (L)	No. PVs	Alk. Mass Flux (mg)	Passivated iron length (cm)	Column x-sectional area (cm^2)	Iron Bulk density (g/cm^3)	Passivated Iron mass (g)	Alk. reduction capacity (mg_{Alk}/g_{Fe})
162	0.362	200	11728.8	2.5	11.34	2.69	76.3	153.80

Table 2: Anticipated ZVI Thickness to Accommodate Passivation.

Alk. Conc. (mg/L)	GW velocity [a] (ft/day)	Aquifer porosity [b]	Alk. reduction capacity (mg_{Alk}/g_{Fe})	Field Bulk density (g/cm^3)	Iron passivation (ft/yr)	Iron thickness for 10 yrs operation (ft)
162	0.2	0.25	153.8	2.4[c]	0.008	0.08

[a] Based on the information provided by CH2M HILL
[b] Assumed
[c] Typical field value measured in Connelly iron PRBs

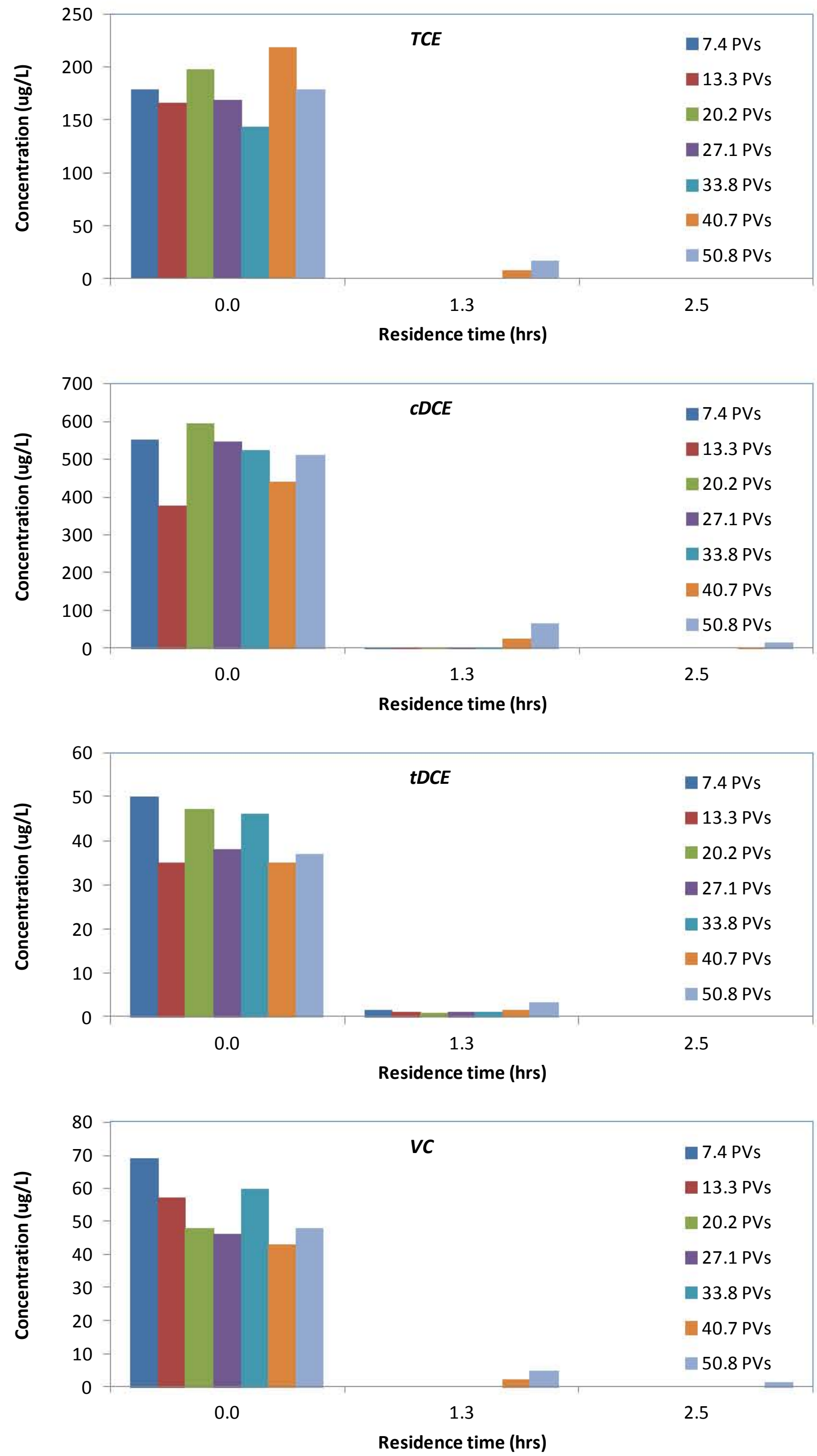


Figure 1: Temporal trends in the major cVOC concentrations in column the influent part of the GW-34 column with increasing number pore volumes (PVs) exchanged.

Appendix B
Grain Size Analysis Results Summary

TABLE B-1

Grain Size Results Summary

Marine Corps Air Station Cherry Point

Cherry Point, North Carolina

Sieve Size (mm)	Percent Passing - Soil Samples									
	OU1-16SB01-15-20	OU1-16SB01-35-40	OU1-16SB02-15-20	OU1-16SB02-35-40	OU1-16SB03-15-20	OU1-16SB03-35-40	OU1-16SB04-15-20	OU1-16SB04-35-40	OU1-16SB05-15-20	OU1-16SB05-35-40
4.75	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	99.8%	100.0%	100.0%	NM
2	99.5%	100.0%	99.8%	100.0%	100.0%	100.0%	99.2%	100.0%	99.7%	100.0%
0.6	94.9%	99.9%	92.3%	99.7%	98.6%	99.8%	87.2%	99.6%	92.6%	98.5%
0.425	90.0%	98.8%	80.9%	97.6%	96.1%	97.8%	72.6%	97.7%	84.1%	87.6%
0.3	80.9%	80.0%	66.6%	60.4%	88.3%	55.2%	57.9%	71.6%	72.7%	46.6%
0.15	46.1%	8.3%	26.3%	4.1%	38.0%	3.1%	13.2%	7.3%	13.8%	5.3%
0.075	21.0%	2.0%	12.0%	1.7%	5.1%	1.3%	4.4%	1.9%	3.5%	2.0%

Sieve Size (mm)	Percent Passing - ZVI			
	Course Connelly -8+50[1]	Fine Connelly -8+50[1]	Course Peerless -8+50[2]	Fine Peerless 14D[2]
4.75	100.0%	100.0%	100.0%	
2.36	95.0%	100.0%	95.0%	100.0%
1.18	75.0%	90.0%	75.0%	96.0%
0.6	25.0%	45.0%	30.0%	55.0%
0.3	0.0%	10.0%	2.0%	15.0%
0.15	0.0%	5.0%	0.0%	0.0%

[1]Connelly-GPM, Inc. (11/25/2002)

[2]Peerless Metal Powders and Abrasives (2/10/2002)

[3]GMA Industries (2/13/2012)

Sieve Size (mm)	Percent Passing - Sand					
	Lone Star #1C[4]	Ricci OON[5]	Ricci O[5]	0955-2MS[6]	Mortar Sand[7]	Concrete Sand[7]
2.36				95.0%	100.0%	96.0%
1.7	100.0%		100.0%			
1.18	98.0%	100.0%	99.0%	71.3%	97.0%	86.0%
0.85	60.0%	99.0%	50.0%			
0.60	18.0%	35.0%	5.0%	43.8%	74.0%	60.0%
0.425	2.0%	5.0%	1.0%			
0.30				27.4%	28.0%	21.0%
0.15				9.2%	3.0%	1.0%
0.075				2.5%	0.3%	0.1%

[4]Lone Star Industries, Inc. (08/08/2011)

[5]Ricci Brothers Sands Co., Inc. (08/09/2011)

[6]Martin Marietta Materials (12/02/2011 - 01/01/2012)

[7]RJ Bushhogging, Inc. (9/26/2011)

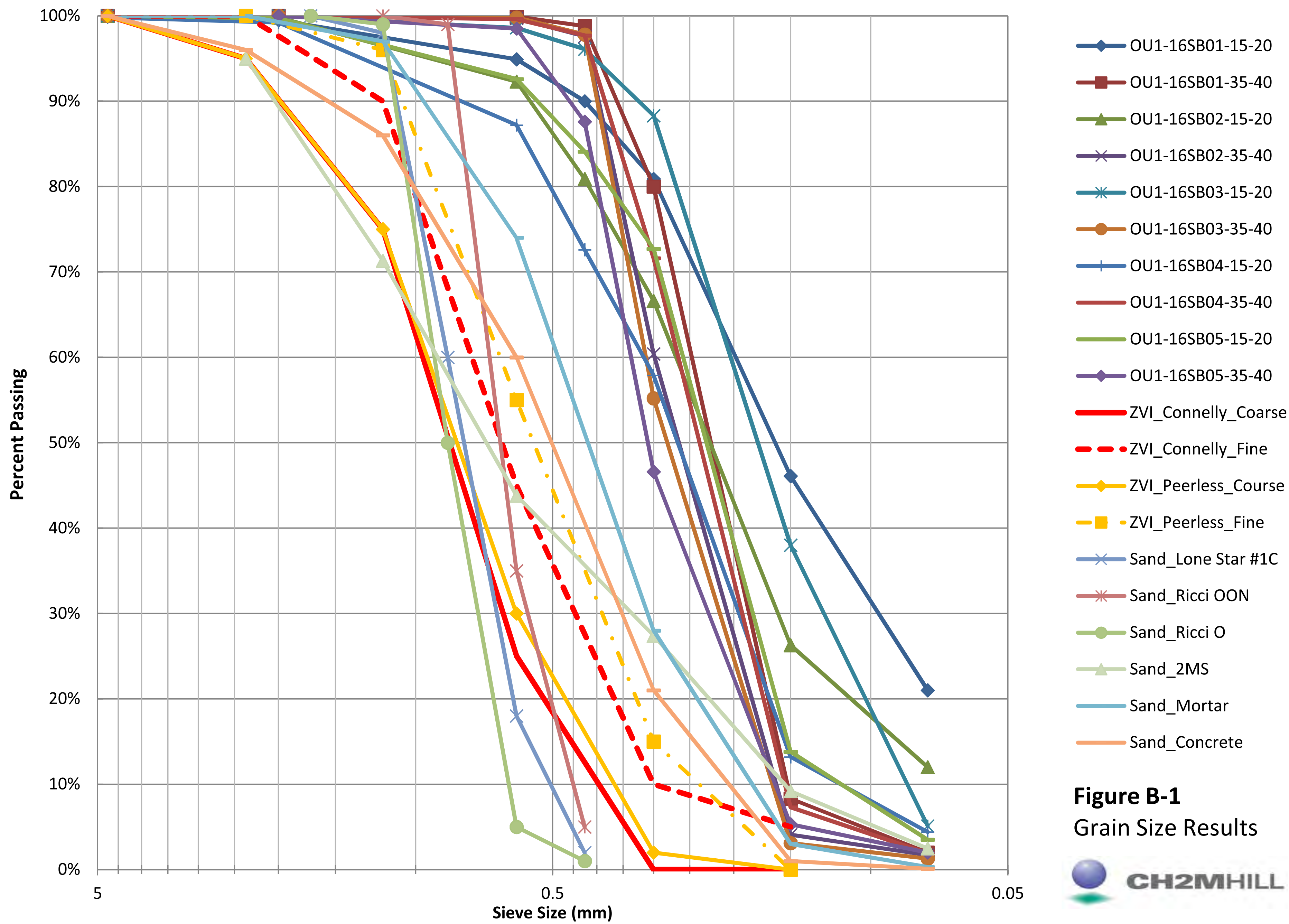
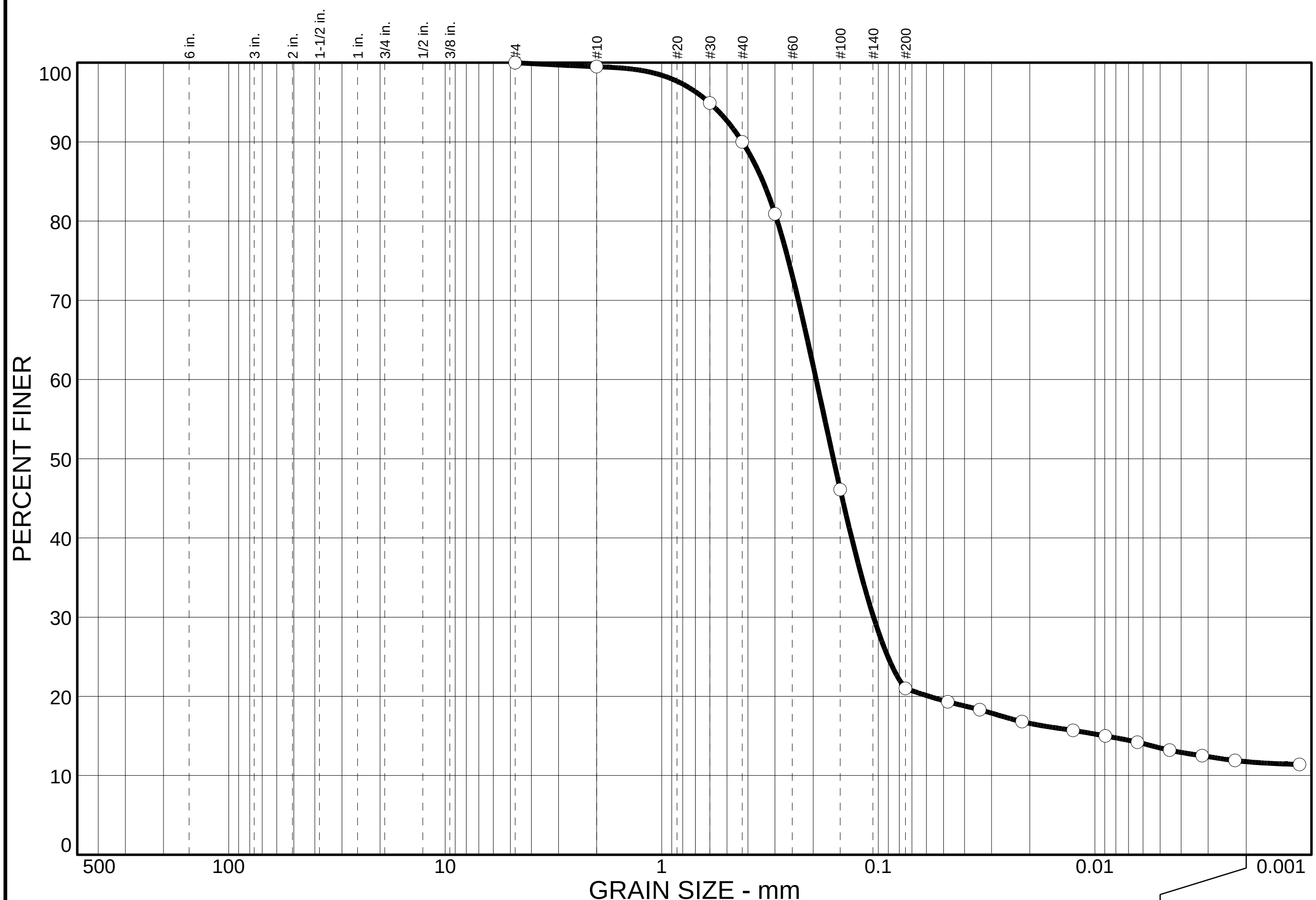


Figure B-1
Grain Size Results

CH2MHILL

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	79.0	9.2	11.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.5		
#30	94.9		
#40	90.0		
#50	80.9		
#100	46.1		
#200	21.0		
0.0477 mm.	19.3		
0.0340 mm.	18.3		
0.0217 mm.	16.8		
0.0126 mm.	15.7		
0.0089 mm.	15.0		
0.0064 mm.	14.2		
0.0045 mm.	13.2		
0.0032 mm.	12.5		
0.0023 mm.	11.9		
0.0011 mm.	11.4		

* (no specification provided)

Soil Description

Grayish Brown Clayey SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.341 D_{60}= 0.194 D_{50}= 0.161
D_{30}= 0.105 D_{15}= 0.0089 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

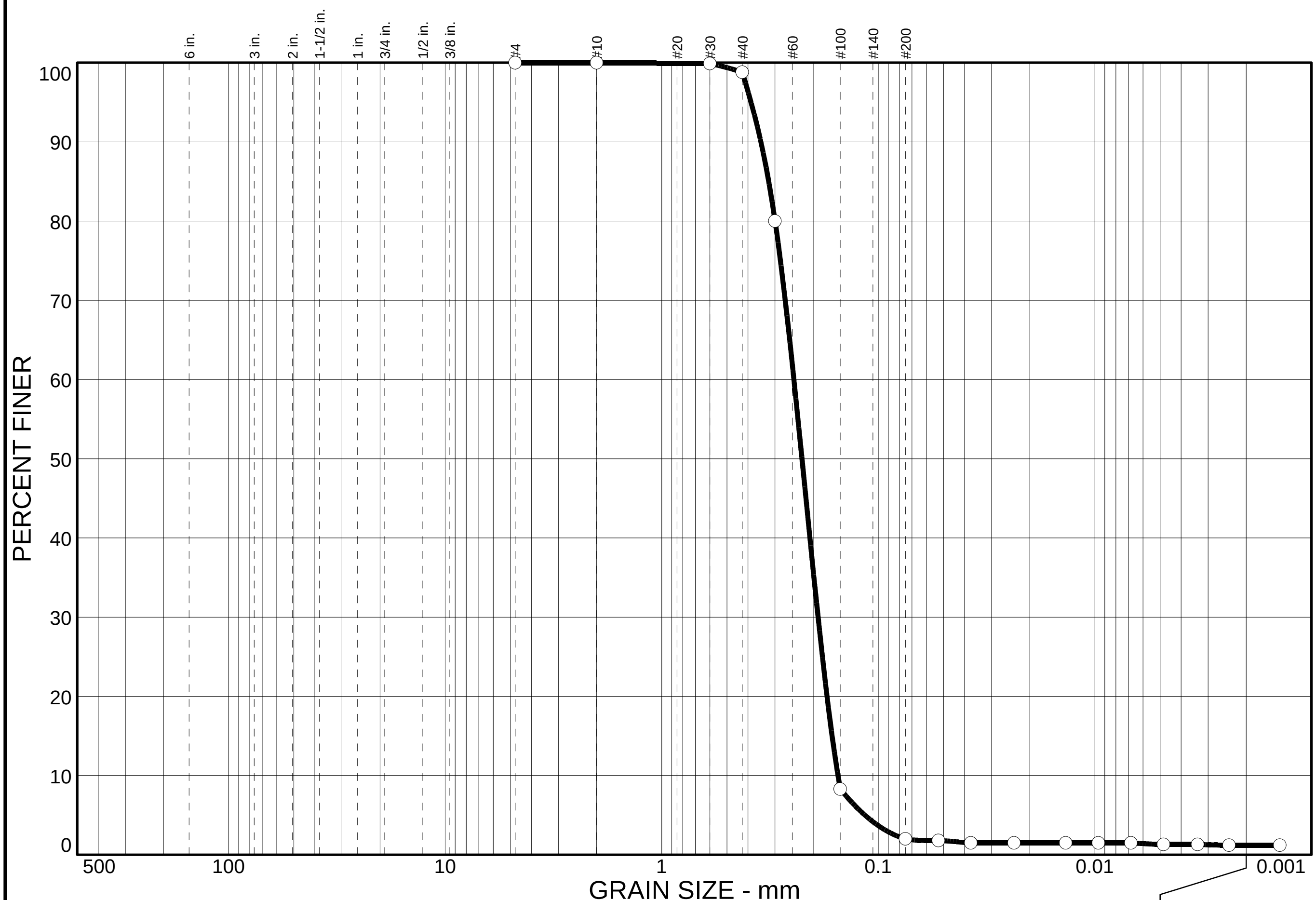
Sample No.: OU1-16SB01 **Source of Sample:** AY52513 **Date:** 1/18/12
Location: **Elev./Depth:** 1520-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.0	0.8	1.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.9		
#40	98.8		
#50	80.0		
#100	8.3		
#200	2.0		
0.0528 mm.	1.8		
0.0374 mm.	1.5		
0.0236 mm.	1.5		
0.0136 mm.	1.5		
0.0096 mm.	1.5		
0.0068 mm.	1.5		
0.0048 mm.	1.3		
0.0034 mm.	1.3		
0.0024 mm.	1.2		
0.0014 mm.	1.2		

* (no specification provided)

Soil Description

Light Gray Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.321 D_{60}= 0.246 D_{50}= 0.225
D_{30}= 0.190 D_{15}= 0.164 D_{10}= 0.154
C_u= 1.60 C_c= 0.96

Classification

USCS= AASHTO=

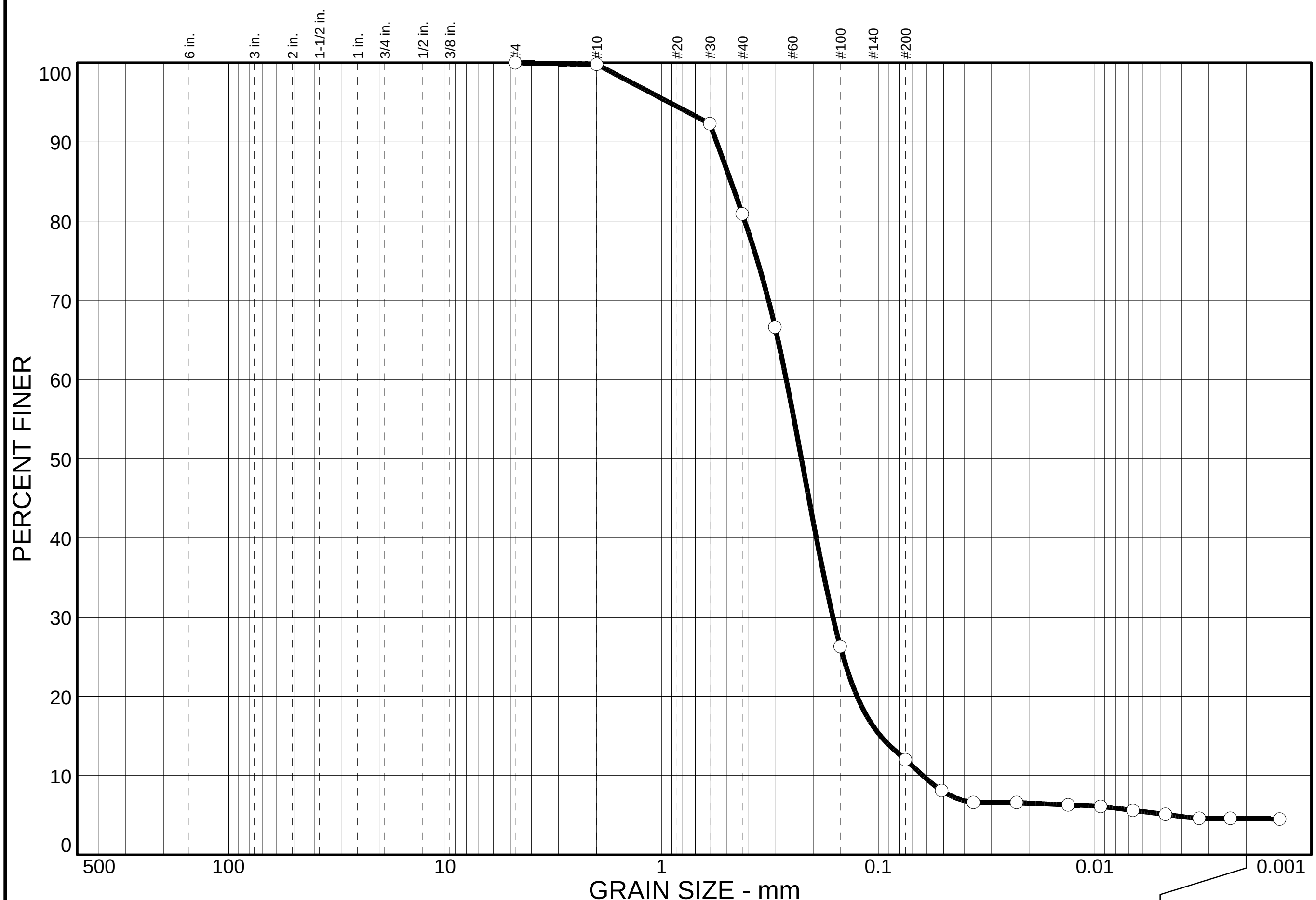
Remarks

Sample No.: OU1-16SB01 **Source of Sample:** AY52514 **Date:** 1/17/12
Location: **Elev./Depth:** 3540-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625
Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	88.0	7.4	4.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#30	92.3		
#40	80.9		
#50	66.6		
#100	26.3		
#200	12.0		
0.0510 mm.	8.1		
0.0364 mm.	6.6		
0.0230 mm.	6.6		
0.0133 mm.	6.3		
0.0094 mm.	6.1		
0.0067 mm.	5.6		
0.0047 mm.	5.1		
0.0033 mm.	4.6		
0.0024 mm.	4.6		
0.0014 mm.	4.5		

* (no specification provided)

Soil Description

Yellowish Brown Poorly Graded SAND w/ Silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.480 D_{60}= 0.266 D_{50}= 0.227
D_{30}= 0.162 D_{15}= 0.0977 D_{10}= 0.0623
C_u= 4.27 C_c= 1.58

Classification

USCS= AASHTO=

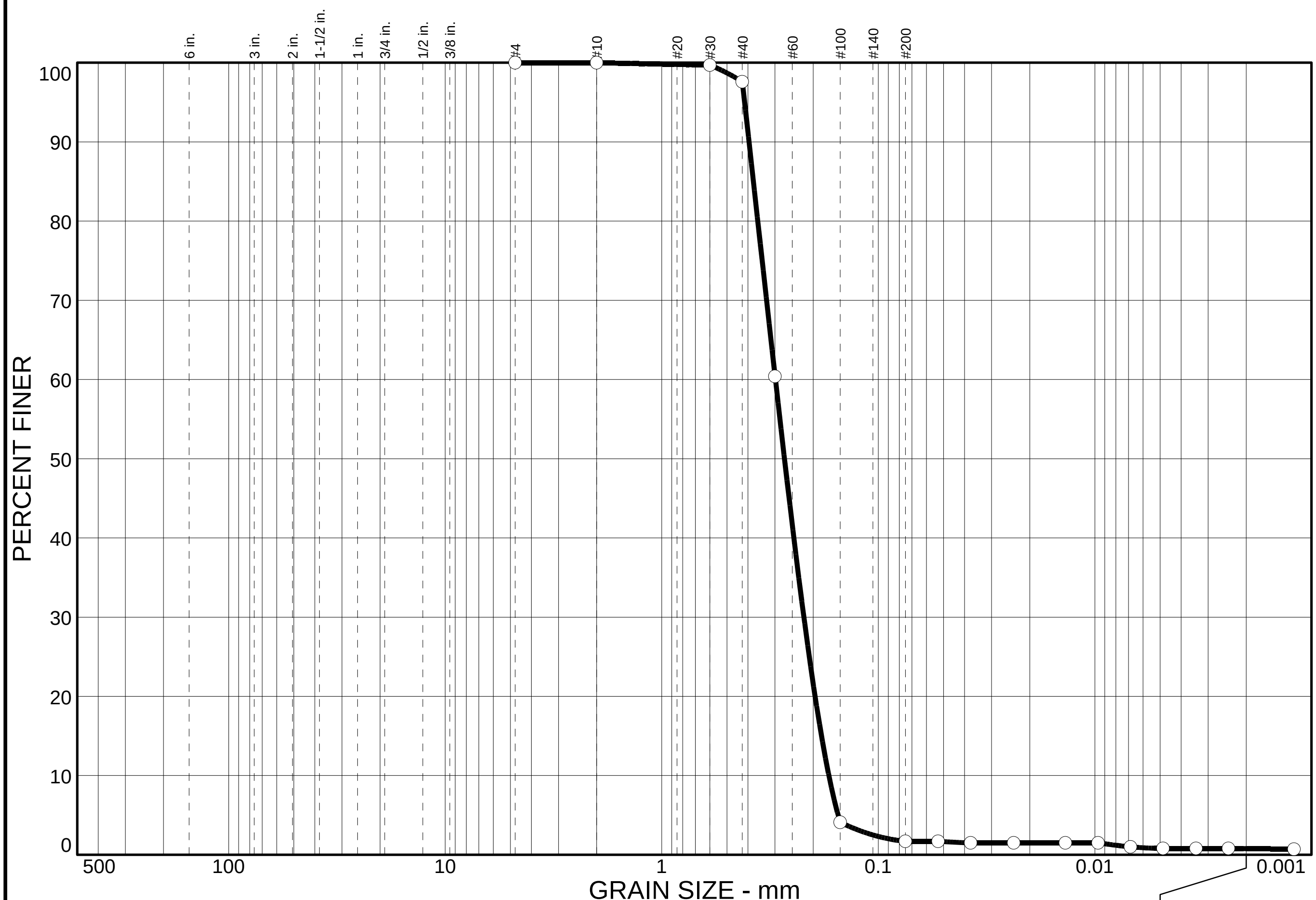
Remarks

Sample No.: OU1-16SB02 **Source of Sample:** AY52511 **Date:** 1/18/12
Location: **Elev./Depth:** 1520-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625
Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.3	0.9	0.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.7		
#40	97.6		
#50	60.4		
#100	4.1		
#200	1.7		
0.0529 mm.	1.7		
0.0375 mm.	1.5		
0.0237 mm.	1.5		
0.0137 mm.	1.5		
0.0097 mm.	1.5		
0.0069 mm.	1.0		
0.0048 mm.	0.8		
0.0034 mm.	0.8		
0.0024 mm.	0.8		
0.0012 mm.	0.7		

* (no specification provided)

Soil Description

Light Brownish Gray Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.378 D_{60}= 0.299 D_{50}= 0.271
D_{30}= 0.221 D_{15}= 0.183 D_{10}= 0.169
C_u= 1.76 C_c= 0.96

Classification

USCS= AASHTO=

Remarks

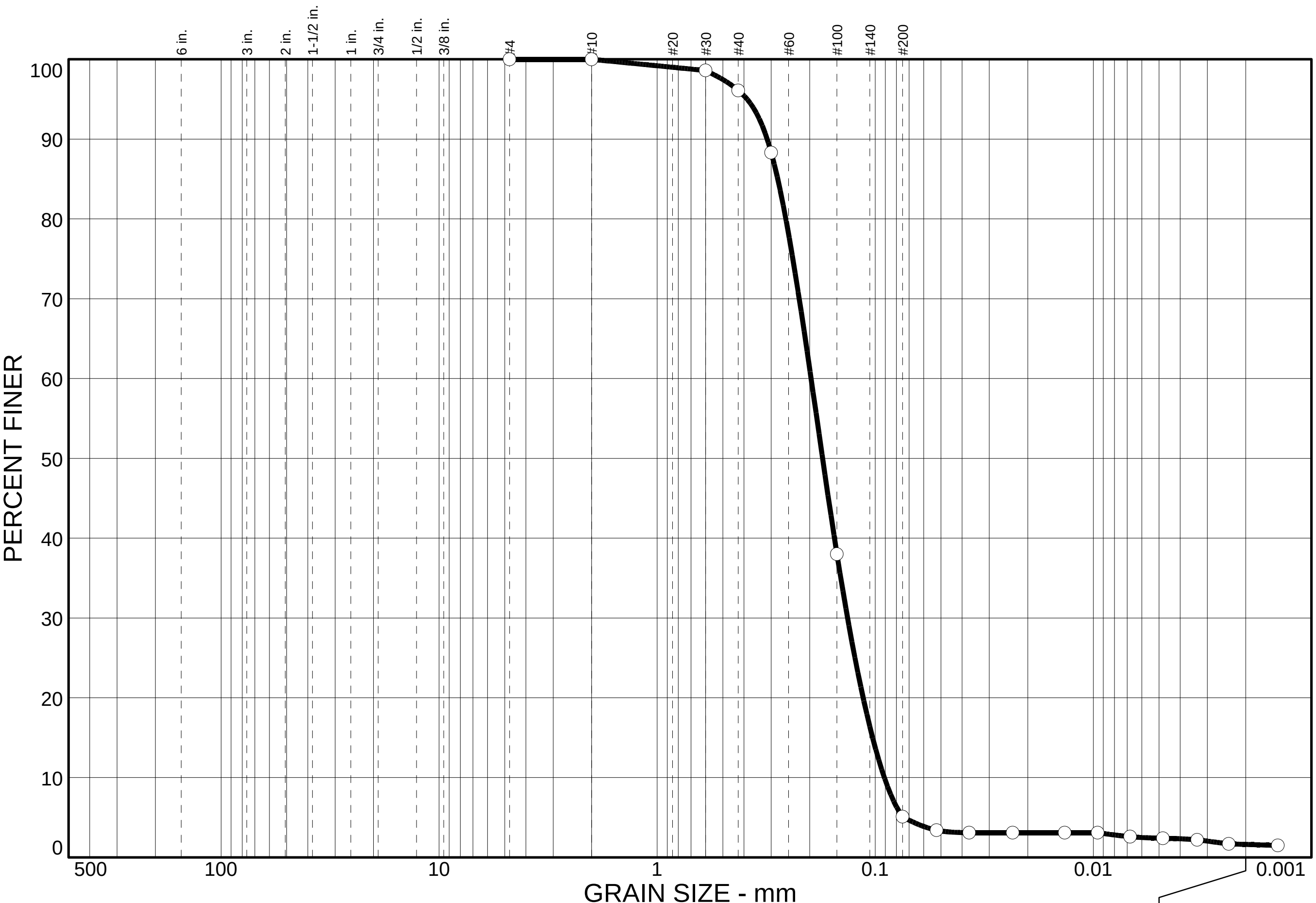
Sample No.: OU1-16SB02 **Source of Sample:** AY52512 **Date:** 1/18/12
Location: **Elev./Depth:** 3540-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	94.9	3.5	1.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	98.6		
#40	96.1		
#50	88.3		
#100	38.0		
#200	5.1		
0.0524 mm.	3.4		
0.0371 mm.	3.1		
0.0234 mm.	3.1		
0.0135 mm.	3.1		
0.0096 mm.	3.1		
0.0068 mm.	2.6		
0.0048 mm.	2.4		
0.0033 mm.	2.2		
0.0024 mm.	1.7		
0.0014 mm.	1.5		

* (no specification provided)

Soil Description

Light Yellowish Brown Poorly Graded SAND w/ Silt

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.280 D_{60}= 0.197 D_{50}= 0.175
D_{30}= 0.134 D_{15}= 0.103 D_{10}= 0.0909
C_u= 2.17 C_c= 1.00

Classification

USCS= AASHTO=

Remarks

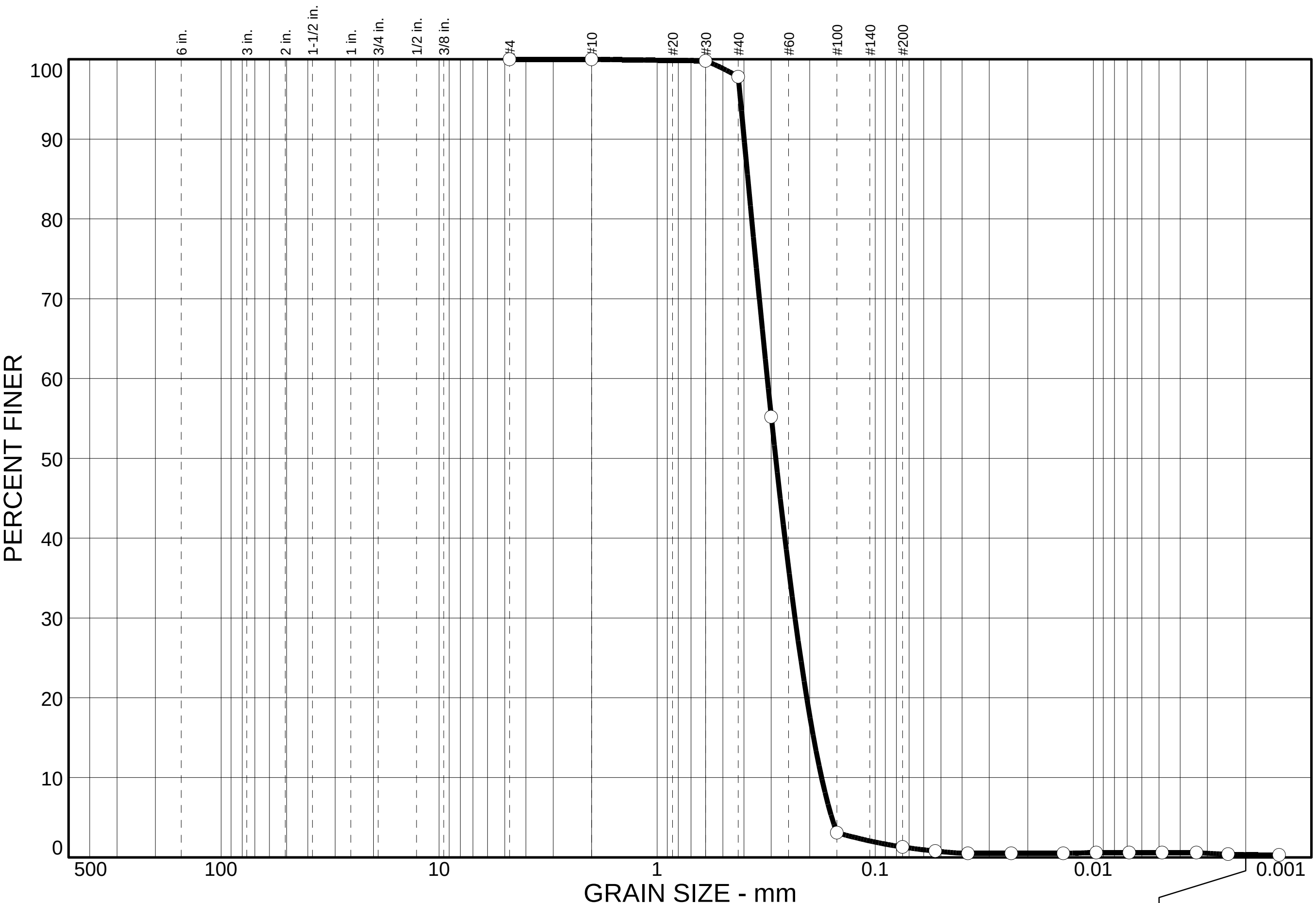
Sample No.: OU1-16SB03 **Source of Sample:** AY52509 **Date:** 1/17/12
Location: **Elev./Depth:** 1520-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.7	1.0	0.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.8		
#40	97.8		
#50	55.2		
#100	3.1		
#200	1.3		
0.0531 mm.	0.8		
0.0376 mm.	0.5		
0.0238 mm.	0.5		
0.0137 mm.	0.5		
0.0097 mm.	0.6		
0.0069 mm.	0.6		
0.0048 mm.	0.6		
0.0034 mm.	0.6		
0.0024 mm.	0.4		
0.0014 mm.	0.3		

* (no specification provided)

Soil Description

Pale Yellow Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.384 D_{60}= 0.313 D_{50}= 0.286
D_{30}= 0.234 D_{15}= 0.192 D_{10}= 0.176
C_u= 1.77 C_c= 0.99

Classification

USCS= AASHTO=

Remarks

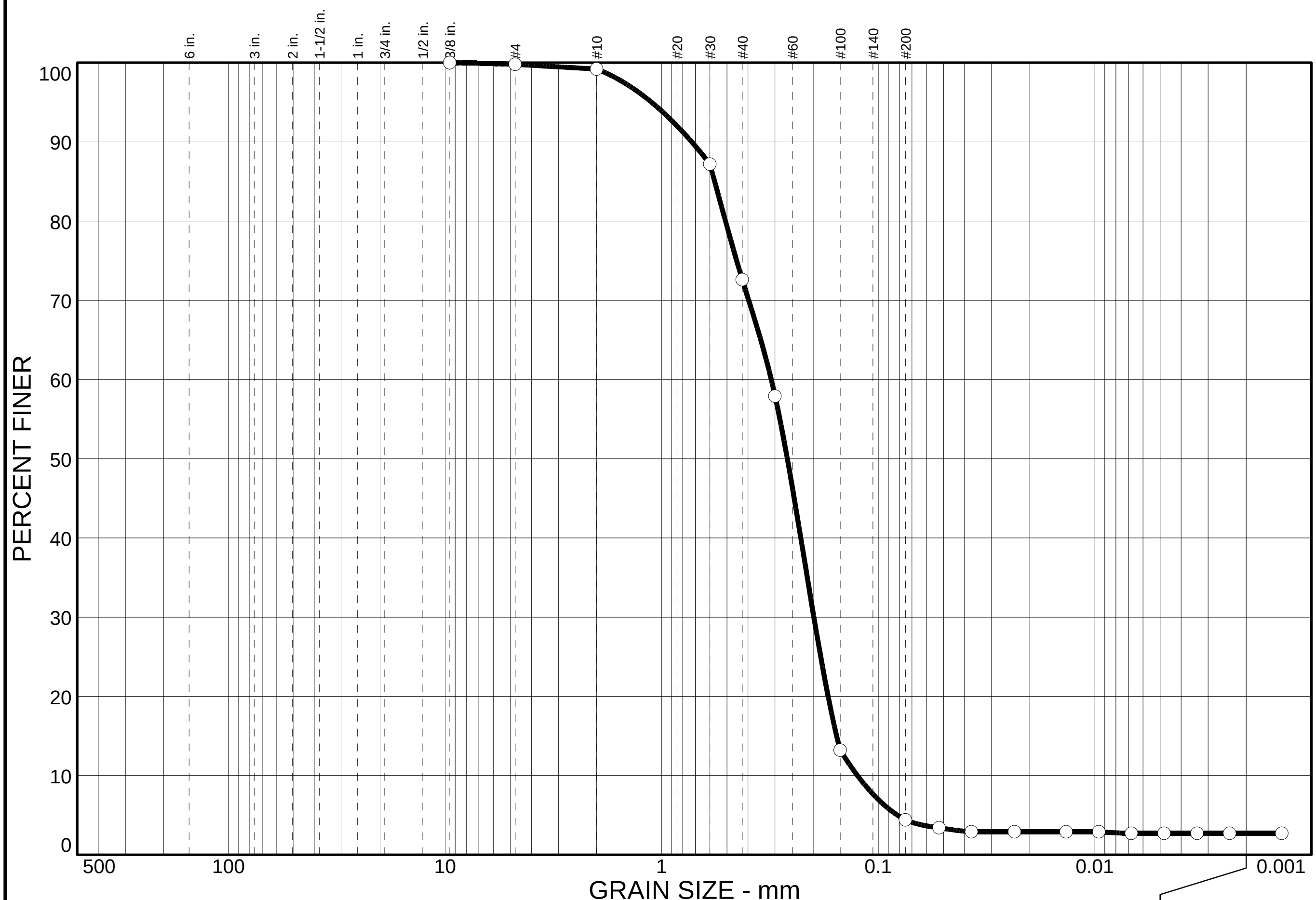
Sample No.: OU1-16SB03 **Source of Sample:** AY52510 **Date:** 1/17/12
Location: **Elev./Depth:** 3540-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	95.4	1.7	2.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3/8 in.	100.0		
#4	99.8		
#10	99.2		
#30	87.2		
#40	72.6		
#50	57.9		
#100	13.2		
#200	4.4		
0.0524 mm.	3.4		
0.0372 mm.	2.9		
0.0235 mm.	2.9		
0.0136 mm.	2.9		
0.0096 mm.	2.9		
0.0068 mm.	2.7		
0.0048 mm.	2.7		
0.0034 mm.	2.7		
0.0024 mm.	2.7		
0.0014 mm.	2.7		

* (no specification provided)

Soil Description

Reddish Yellow Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.570 D_{60}= 0.312 D_{50}= 0.263
D_{30}= 0.199 D_{15}= 0.156 D_{10}= 0.125
C_u= 2.50 C_c= 1.01

Classification

USCS= AASHTO=

Remarks

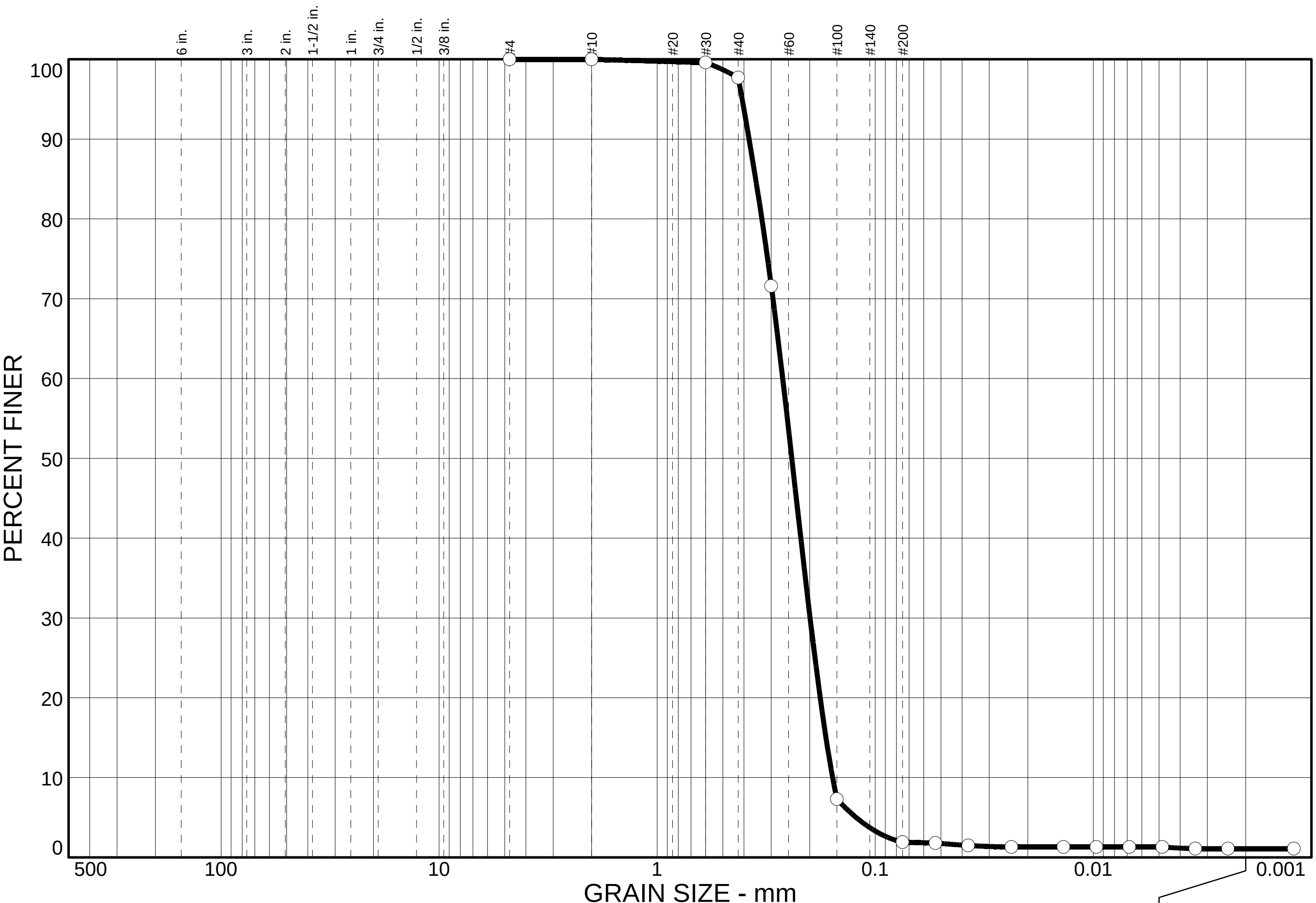
Sample No.: OU1-16SB04 **Source of Sample:** AY52505 **Date:** 1/18/12
Location: **Elev./Depth:** 1520-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.1	0.8	1.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#30	99.6		
#40	97.7		
#50	71.6		
#100	7.3		
#200	1.9		
0.0529 mm.	1.8		
0.0375 mm.	1.5		
0.0237 mm.	1.3		
0.0137 mm.	1.3		
0.0097 mm.	1.3		
0.0068 mm.	1.3		
0.0048 mm.	1.3		
0.0034 mm.	1.1		
0.0024 mm.	1.1		
0.0012 mm.	1.1		

* (no specification provided)

Soil Description

Yellow Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.354 D_{60}= 0.266 D_{50}= 0.242
D_{30}= 0.199 D_{15}= 0.168 D_{10}= 0.157
C_u= 1.69 C_c= 0.95

Classification

USCS= AASHTO=

Remarks

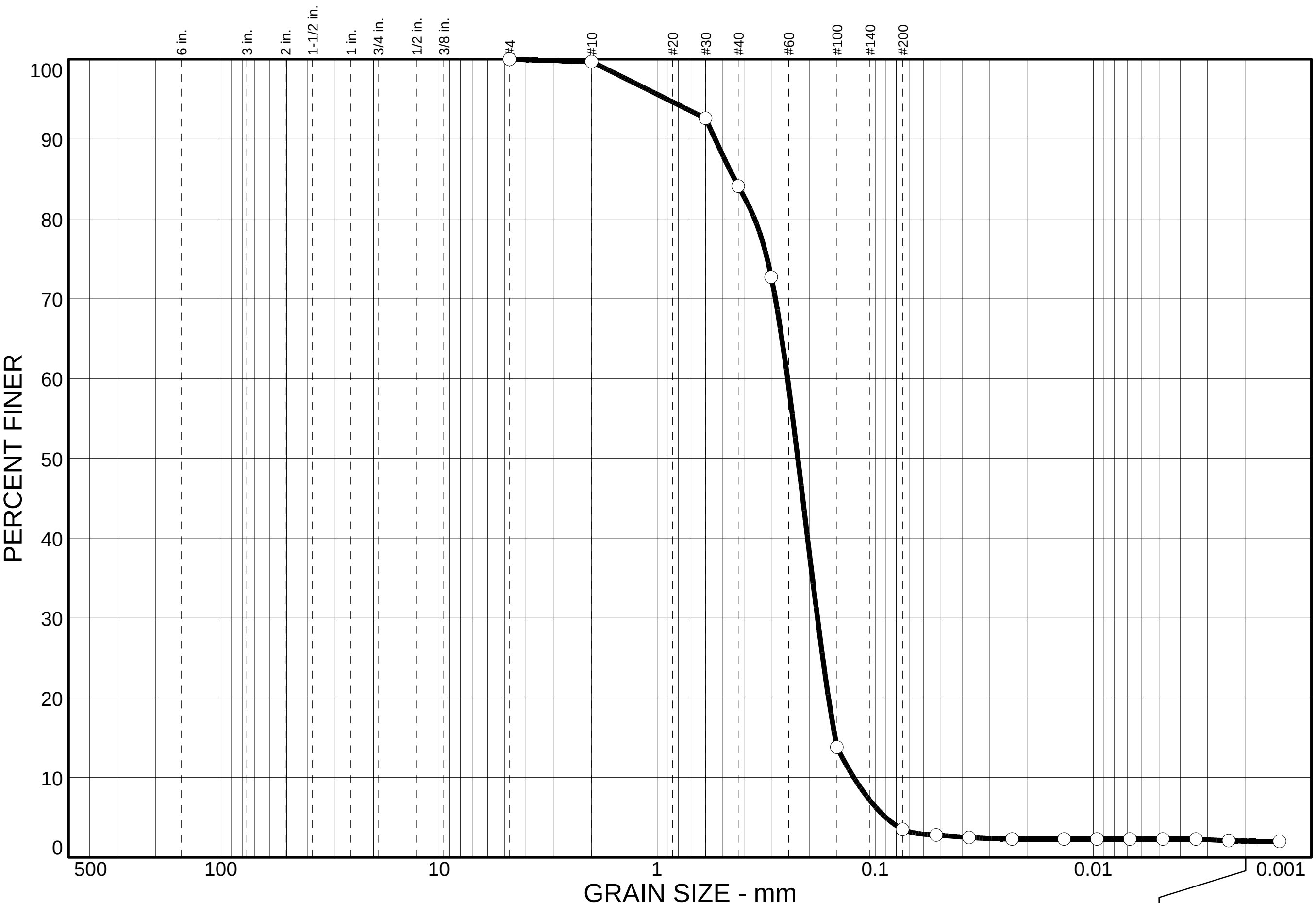
Sample No.: OU1-16SB04 **Source of Sample:** AY52506 **Date:** 1/18/12
Location: **Elev./Depth:** 3540-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	96.5	1.5	2.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.7		
#30	92.6		
#40	84.1		
#50	72.7		
#100	13.8		
#200	3.5		
0.0525 mm.	2.8		
0.0372 mm.	2.5		
0.0235 mm.	2.3		
0.0136 mm.	2.3		
0.0096 mm.	2.3		
0.0068 mm.	2.3		
0.0048 mm.	2.3		
0.0034 mm.	2.3		
0.0024 mm.	2.1		
0.0014 mm.	2.0		

* (no specification provided)

Soil Description

Brownish Yellow Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.442 D_{60}= 0.253 D_{50}= 0.227
D_{30}= 0.184 D_{15}= 0.153 D_{10}= 0.125
C_u= 2.02 C_c= 1.07

Classification

USCS= AASHTO=

Remarks

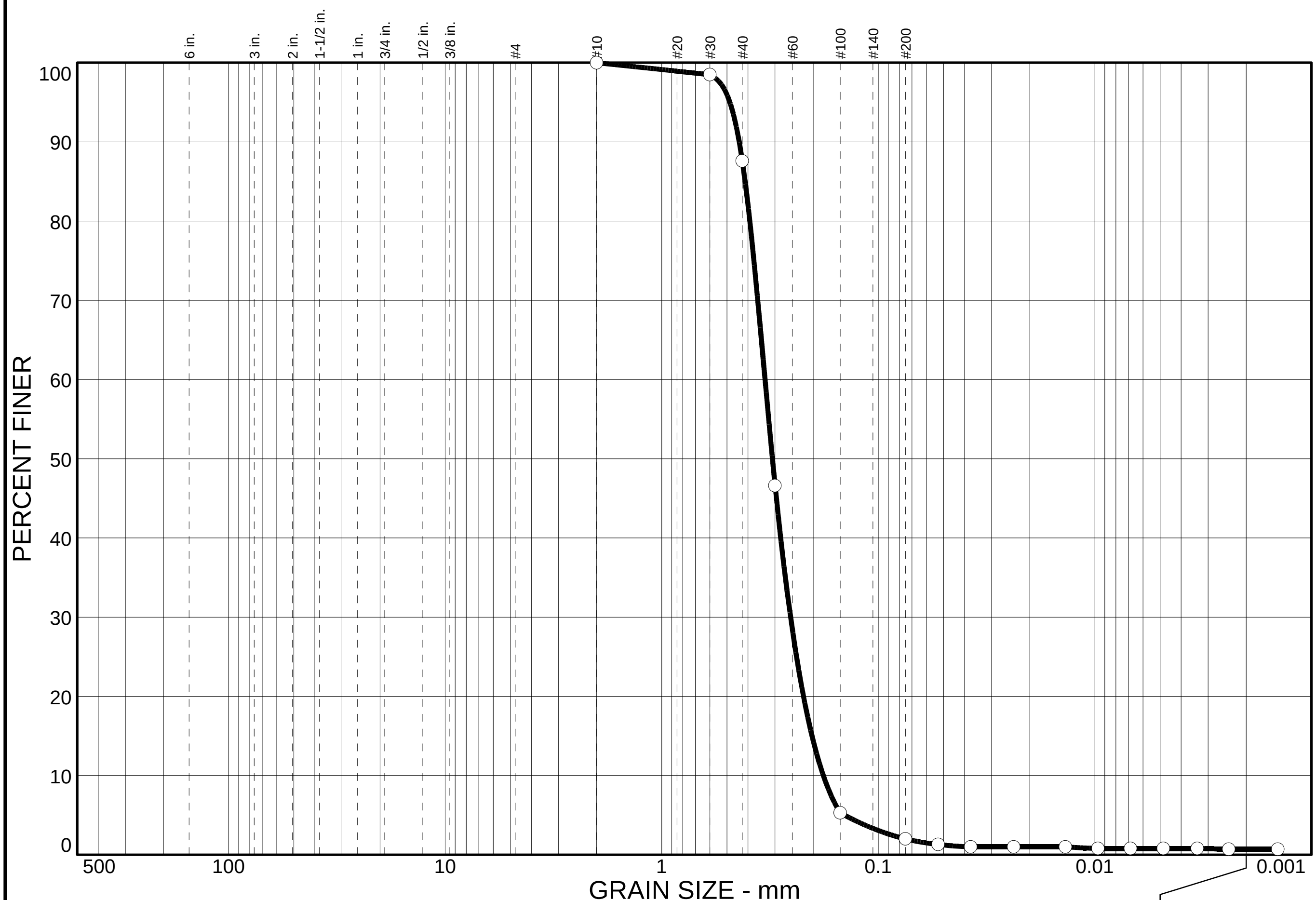
Sample No.: OU1-16SB05 **Source of Sample:** AY52507 **Date:** 1/13/12
Location: **Elev./Depth:** 1520-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

Particle Size Distribution Report



% COBBLES	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	98.0	1.3	0.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#30	98.5		
#40	87.6		
#50	46.6		
#100	5.3		
#200	2.0		
0.0529 mm.	1.3		
0.0375 mm.	1.0		
0.0237 mm.	1.0		
0.0137 mm.	1.0		
0.0097 mm.	0.8		
0.0068 mm.	0.8		
0.0048 mm.	0.8		
0.0034 mm.	0.8		
0.0024 mm.	0.7		
0.0014 mm.	0.7		

* (no specification provided)

Soil Description

Yellowish Brown Poorly Graded SAND

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= 0.412 D_{60}= 0.334 D_{50}= 0.309
D_{30}= 0.254 D_{15}= 0.203 D_{10}= 0.180
C_u= 1.86 C_c= 1.08

Classification

USCS= AASHTO=

Remarks

Sample No.: OU1-16SB05 **Source of Sample:** AY52508 **Date:** 1/17/12
Location: **Elev./Depth:** 3540-1211

COOPER TESTING LABORATORY

Client: APPL, Inc.
Project: ARF: 66625

Project No: 566-011 **Figure**

PEERLESS™

February 10, 2012

CH2M Hill
ATTN: James Frank
Raleigh/Durham, NC

E-mail: James.Frank@CH2M.com

SUBJECT: **Budgetary** pricing and information for 540 – 700 tons of ZVI for the proposed PRB Wall in N. C.

Dear James:

Reference our telephone conversation today. I am pleased to offer the following:

ZVI Cast Iron Aggregate Size 8/50 ---------------------------- $800/per net ton *
ZVI Cast Iron Aggregate Size 14D----------------------------- $800/per net ton *
ZVI Cast Iron Aggregate Size 50D------------------------------$800/per net ton *
ZVI Cast Iron Aggregate Size 8D custom blend-------------$775/per net ton **

* Typical Sieve Spec attached
** 8D will be a combination of any or all of the sizes, 8/50, 14D and/or 50D. We hope you'll choose Size 8D, if you do, we'll discuss with you what blend of sizes and percentages of each size you would like in this custom blend product.

Packaging Options:
3000# Bulk Bags---------------$17/per net ton
2000# Bulk Bags---------------$29/per net ton
1500# Bulk Bags---------------$34/per net ton
1000# Bulk Bags --------------$40/per net ton
750# Bulk Bags---------------$80/per net ton
500# Bulk Bags--------------$120/per net ton
250# Bulk Bags--------------$210/per net ton

Bulk bag & drum prices include pallets with protective plastic covers

New drums with steel lids and rings (1000-1300# per drum)---$20/each drum (4 drums per pallet)
Reconditioned drums with plastic hood covers (1000-1300# per drum)---$13/each drum (4 drums per pallet)

Typical Terms are 30% non refundable deposit with the order, and pre-payment for shipments one week prior to shipping. Above prices are F.O.B. Detroit, MI.

I am able to supply 700 tons of any of the ZVI Cast Iron Sizes to meet your delivery schedule of March/May, 2012. It would be a great assist to our production if we could supply you the size 8D.

Very truly yours,

Paul W. Tousley
President
Enc.

Noreen P. Warrens
Iron Sales

Peerless Metal Powders & Abrasive
124 South Military • Detroit, Michigan 48209
(313) 841-5400 Fax (313) 841-0240

PEERLESS™

PMP ZERO VALENT IRON AGGREGATE SIZE 8/50

TYPICAL 5 MINUTE ROTAP

SCREEN SIZE	% PASSING
4	100
8	95 - 100
16	75 - 98
30	30 - 58
50	2 - 19
100	0 - 7

BULK DENSITY - 150 POUNDS PER CUBIC FOOT (+ OR – 10 POUNDS)

PMP IRON AGGREGATES ARE 100% DRY AND OIL FREE

TYPICAL CHEMISTRY:

Element	Percentage
Iron	90+
Carbon	1.5 – 2.5
Silicon	2.00
Manganese	0.60
Sulfur	0.12
Phosphorus	0.14
Nickel	0.20
Chromium	0.20
Molybdenum	0.15
Copper	0.20

December, 2010

Peerless Metal Powders & Abrasive

124 South Military • Detroit, Michigan 48209
(313) 841-5400 Fax (313) 841-0240

PEERLESS™

PMP ZERO VALENT IRON AGGREGATE SIZE 14D

TYPICAL 5 MINUTE ROTAP

SCREEN SIZE	% PASSING
8	100
16	96 - 100
30	55 - 96
50	15 - 55
100	0 - 20
200	0 - 10

TYPICAL BULK DENSITY -165 POUNDS PER CUBIC FOOT (+ OR – 20 POUNDS)

PMP IRON AGGREGATES ARE 100% DRY AND OIL FREE

TYPICAL CHEMISTRY:

Element	Percentage
Iron	90+
Carbon	1.5 – 2.5
Silicon	2.00
Manganese	0.60
Sulfur	0.12
Phosphorus	0.14
Nickel	0.20
Chromium	0.20
Molybdenum	0.15
Copper	0.20

January, 2011

Peerless Metal Powders & Abrasive

124 South Military • Detroit, Michigan 4820[illegible]
(313) 841-5400 Fax (313) 841-024[illegible]

PEERLESS™

PMP ZERO VALENT IRON AGGREGATE SIZE 50D

TYPICAL 15 MINUTE ROTAP

SCREEN SIZE	% RETAINED
45	0
60	0
80	14
100	10
200	29
325	18
PAN	29
	100

TYPICAL BULK DENSITY RANGE 145 – 195 POUNDS PER CUBIC FOOT

PMP IRON AGGREGATES ARE 100% DRY AND OIL FREE

TYPICAL CHEMISTRY:

Element	Percentage
Iron	90+
Carbon	1.5 – 2.5
Silicon	2.00
Manganese	0.60
Sulfur	0.12
Phosphorus	0.14
Nickel	0.20
Chromium	0.20
Molybdenum	0.15
Copper	0.20

January, 2011

Peerless Metal Powders & Abrasive

124 South Military • Detroit, Michigan 48209
(313) 841-5400 Fax (313) 841-0240

LONE STAR INDUSTRIES, INC. - Filter Pack Sands
Graphs and Grain Size Parameters of Filter Pack Sands from information below

Lapis Lustre Kiln Dried Sands
Typical Grading Parameters

Cumulative Percent Passing U.S. Sieves

Product		Coarse Aquarium	Medium Aquarium	6 x 12	8 Mesh	#3
Nominal Sieve Size		4 x 12	6 x 16	6 x 16	8 x 16	8 x 20
Sieve #	mm					
¼ inch	6.300	100	100	100		
# 4	4.750	95-100	99-100	99-100		
# 6	3.350	75-98	90-97	80-97	100	100
# 8	2.360	10-30	44-64	20-55	98-100	98-100
# 12	1.700	0-5	10-44	5-28	30-75	55-89
# 16	1.180		0-10	0-3	2-15	10-46
# 20	0.850				0-4	1-13
# 30	0.600					0-5

Product		#2 / 12	#2 / 16	#1C	#1 /20	#0 /30
Nominal Sieve Size		12 x 20	16 x 30	16 x 40	20 x 40	30 x 50
Sieve #	mm					
# 8	2.360	100				
# 12	1.700	96-100	100	100		
# 16	1.180	30-70	90-99	97-99	100	
# 20	0.850	0-20	15-40	48-71	85-97	100
# 30	0.600	0-10	0-10	10-25	14-40	92-97
# 40	0.425			0-4	0-6	20-50
# 50	0.300					2-9
# 70	0.212					0-1

Product		#60	P - 30	LSI - 30	All Purpose
Nominal Sieve Size		40 x 70	20 x 50	30 x 70	8 x 100
Sieve #	mm				
# 4	4.750				100
# 8	2.360				98-100
# 12	1.700		100		
# 16	1.180		99-100		66-95
# 20	0.850		89-99	100	
# 30	0.600	100	80-95	90-96	24-70
# 40	0.425	94-100	30-60	45-80	
# 50	0.300	25-60	5-20	20-40	3-20
# 70	0.212	5-15	1-4	6-25	
# 100	0.150	0-4	0-1	2-10	0-6

-

RICCI BROS. Sand Co., Inc.

2099 Dragston Rd.
Port Norris NJ 08349

Toll Free in USA: 1-888-807-4224
Tel: (856) 785-0166
Fax: (856) 785-2136

info@riccisand.com

Industrial Sand

Why Ricci:

- Available in a variety of precise grain sizes; epoxy, floors, cement, & asphalt
- Quality control program assures consistent and repeatable grain size
- Top dressing or underlayment for artificial putting greens and practice areas
- Packaged in 100 lb. bags, 50 lb. bags, or 3000 lb. bulk sacks. Also available in bulk dump truck, triaxle, or by rail

Common Gradations - wt % Passing

ASTM E11 Sieve#	mm. Open	In. Open	OOO	P40	OO	ON	O	1	2	3	4
4	4.75	0.188								100	99
6	3.35	0.132							100	99	50
8	2.36	0.094						100	95	55	10
10	1.70	0.067		100			100	95	55	5	1
16	1.18	0.045		95		100	99	45	10	1	
20	0.85	0.033		80	100	99	50	5	1		
30	0.60	0.023	100	60	95	35	5	1			
40	0.42	0.016	95	35	40	5	1				
50	0.30	0.012	75	10	5	1					
60	0.25	0.010	45	5	2						
70	0.21	0.008	30	2	1						
100	0.15	0.006	5	1							

How to Purchase

Provide us with the grain sizes that you are looking for. Please include:

a. the largest and smallest ASTM E11 Sieve Sizes (16-30, 20-40)
b. the average E11 Sieve Number (#40)

Example Uses

- Filler sands with controlled grain size distributions for epoxy, flooring, cement and asphalt
- ASTM C144, C404, C897 mortar sands
- Pipe and foundry sands
- Reactor and geothermal sands
- Can batch blend to match virtually any particle size distribution

Other Properties

Specific gravity (ASTM C128): >2.50
Acid Solubility (AWWA B100): < 5%
Hardness (Mohs Scale): 6-8
Sphericity and Roundness (API RP56): 0.6
Sodium Soundness (ASTM C88): <15%
Test for Clay (ASTM C40 or C117): plate 1 and 2
Unit Weight and Voids (ASTM C29): 100 lb/cu ft
Chemical Analysis: SiO_2: 98-99; Al_2O_3: 0.03-0.3, Fe_2O_3: 0.03-0.3, Na_2O, K_2O, TiO_2, MnO_2, MgO: to 0.05.

c. the millimeter size range (0.30 - 0.85mm inclusive)
d. The reference to the ASTM Standard

Martin Marietta Materials

Basic Quality Statistical Summary Report

Period 12/02/2011 - 01/01/2012
Plant 44208-Clarks
Product 0955-2MS Sand
Specification 2MS Sand

Sieve/Test	Tests	Average	St Dev	Target	Specification
3/8" (9.5mm)	4	100.0	0.00		100-100
#4 (4.75mm)	4	100.0	0.00		95-100
#8 (2.36mm)	4	95.0	1.36		80-100
#16 (1.18mm)	4	71.3	5.45		45-95
#30 (0.6mm)	4	43.8	5.24		25-75
#50 (0.3mm)	4	27.4	4.39		8-35
#100 (0.15mm)	4	9.2	1.85		0.5-20
#200 (75um)	4	2.49	0.938		0-8
Pan	4	0.00	0.000		

Sample Status: Meets Specs

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS UNIT
1801 BLUE RIDGE RD. RALEIGH, N.C. 27607
09/26/2011
Fine Aggregate Test

Hicams No.: 598611
Contract No.:
County: Lenoir
Date Sampled: 08/19/2011
Sampled By: Ingram, Judy D
Sampled From: Stockpile - 1
Contractor:
Prod./Suppl.: RJ Bushhogging Inc.
Facility: Willis Neck Mine #1
Material: Sand, 4S

T.I.P. No.:
Field ID:
Engineer:
Received: 08/23/2011

Work Order No.:
P.O./Other No.:
Reported: 09/26/2011
Test Category: Source Approval/Eval
Represented Qty.: 2000.000 TON

MORTAR SAND

Lab No.: F369354

Test No.: AASHTO T112, T19, T27, T104, T71, T84
Location of Source: Stockpile
QA Indicator:
Property Owner:

SIEVE ANALYSIS

Sieve Size	Percent Passing
3/8"	
# 4	100
# 8	100
#16	97
# 30	74
# 40	
# 50	28
# 80	
# 100	3
# 200	0.3
Fineness Modulus	1.98
Deleterious Substance	0.2

STRUCTURAL STRENGTH

Compression Test on 2 inch Cubes

Strength Ratio: 3-Day: 107.0 %
7 Day: 121.9 %

Color: 2
Sp.Grav.: 2.64
Absorp.: 0.2 %
Soundness: % Loss

Unit Weight

Solid	164.8	lbs/ft3
Loose	92.3	lbs/ft3
Dry & Rodded	101.7	lbs/ft3

Comments:

V. O. Cordle

V. OWEN CORDLE
PHYSICAL TESTING ENGINEER

cc: RJ Bushhogging Inc.

R J BUSHHOGGING, INC.

MATERIAL INSPECTION GRADATION REPORT

CONCRETE SAND

SOURCE: WILLIS NECK MINE #1; STATE #407
COUNTY: CRAVEN
SIZE: 2S

DATE OF TEST	SAMPLE #	F.M.	3/8"	#4	#8	#16	#30	#50	#100	#200	PASSED	FAILED
1/5/12	DC-1	2.52	100	99	94	80	55	19	1	0.1	✓	
1/11/12	DC.2	2.62	100	99	90	75	53	20	1	0.2	✓	
1/20/12	DC-3	2.36	100	100	96	86	60	21	1	0.1	✓	

Appendix C
Construction Quality Management Plan

Version 1.0

Construction Quality Management Plan

Marine Corps Air Station
Cherry Point, North Carolina

Contract Task Order 097

May 2012

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

11301 Carmel Commons Blvd., Suite 304
Charlotte, North Carolina 28226
NC Engineering License #F-0699

DOCUMENT VERSION LOG

Construction Quality Management Plan

Navy CLEAN 8012 CTO-WE10

MCAS Cherry Point OU1, Site 16 ZVI PRB

Version	Date	Description
1.00	May 2012	This Version 1.0 of the Construction Quality Assurance Plan has been prepared under Navy CLEAN Contract No. N62470-08-D-1000, Contract Task Order 97 to describe procedures used to provide construction quality management/assurance for the construction and installation of the Marine Corps Air Station (MCAS) Cherry Point Operable Unit 1 (OU1), Site 16, Zero-Valent Iron (ZVI) Permeable Reactive Barrier (PRB).

Note: As each new version is published, a description of the changes made will be included on this table.

(This page intentionally left blank)

Contents

Figures

Attachments

Abbreviations and Acronyms

3POC	Three Phases of Control
AM	Activity Manager
ASTM	American Society for Testing and Materials International
CM	Construction Manager
COCs	contaminants of concern (COCs)
CQA	construction quality assurance
CQC	construction quality control
CQMP	Construction Quality Management Plan
CQP	Construction Quality Plan
DFOW	definable feature of work
DM	Document Manager
EOR/TL	Engineer of Record/Technical Lead
EPA	U.S. Environmental Protection Agency
FE	Field Engineer
FQM	Field Quality Manager
H&S	health and safety
HSO	Health and Safety Officer
HSP	Health and Safety Plan
IP	Implementation Plan
KA	Contract Administrator
MCL	maximum contaminant level
MSDS	Material Safety Data Sheet
NAVFAC	Naval Facilities Engineering Command
NCR	Non-Conformance Report
NELAP	National Environmental Laboratory Accreditation Program
PCM	Program Construction Quality Manager
PGM	Program Manager
PgQM	Program Quality Manager
PQM	Project Quality Manager
PM	Project Manager
RAO	Remedial Action Objective
RFI	request for information
RPM	Remedial Project Manager
SOW	Scope of Work
SWPPP	Storm Water Pollution Prevention Plan

(This page intentionally left blank)

SECTION 1

Introduction

This Construction Quality Management Plan (CQMP) has been prepared for Naval Facilities Engineering Command (NAVFAC) in support of the Marine Corps Air Station (MCAS) Cherry Point, Operable Unit (OU) 1, Site 16, Zero-Valent Iron (ZVI) Permeable Reactive Barrier (PRB). Version 1.0 of the CQMP has been prepared by CH2M HILL under Navy CLEAN Contract No. N62470-11-D-8012 Task Order WE10.

The activities described in this plan provide the procedures to be followed during installation of a PRB that is intended to intercept the groundwater plume and prevent the discharge of groundwater with chemicals of concern (COC) concentrations exceeding North Carolina Administrative Code Title 15A, Subchapter 2B, Surface Water and Wetland Standards. A detailed description of the site and the remedy scope are presented in the Implementation Plan (IP).

In addition, collection and analysis of samples during construction are described by the Uniform Federal Policy - Sampling and Analysis Plan (UFP-SAP) (CH2M HILL, 2012), procedures associated with site logistics and waste management are defined in the IP, and health and safety guidance is provided in the Health and Safety Plan (HSP).

1.1 Purpose

The purpose of this CQMP is to provide the standards, guidelines, processes, and procedures required to manage quality during construction of the PRB in accordance with the project plans and specifications.

The quality management system presented herein is a compilation of existing procedures and protocols that comply with Navy and U.S. Environmental Protection Agency (EPA) guidance and industry standards. This document includes a number of standard forms that were incorporated to ensure that existing standards of quality are met or exceeded during the remediation work activities.

Individuals and subcontractors performing work under this CQMP will be responsible for the quality of their work and for the implementation and adherence to applicable quality procedures consistent with the principles of continuous quality improvement.

1.2 Construction Quality Management Plan Objectives

Following are the objectives of this CQMP:

- Provide procedures for delivering the appropriate quality of services and products to meet the objectives specified in the IP.
- Establish clear responsibilities and accountabilities for key technical and quality staff and management decisions related to this project.
- Build quality into all aspects of this project.
- Enable the identification and resolution of performance problems and challenges and provide a standing process for corrective measures and continuous improvement of site practices.
- Maintain consistency among technical and management practices.

1.3 Construction Quality Management Plan Scope

This CQMP provides guidance to implement a quality program intended to document that the project has been implemented or constructed to meet or exceed the design criteria. This document consists of the following:

- **Section 1 Introduction:** Describes the purpose, objectives, and scope of this document.
- **Section 2 Construction Quality Organization:** Identifies the roles and responsibilities of key personnel.
- **Section 3 Project Communication:** Identifies lines of communication, project meetings, and means to document transmittals between parties.
- **Section 4 Submittals:** Describes the construction quality control (QC) submittal process.
- **Section 5 Quality Control Requirements:** Describes documentation procedures.
- **Section 6 Testing:** Describes the general inspection and testing requirements.
- **Section 7 Change Control:** Describes the change control process.
- **Section 8 Noncompliance and Corrective Action:** Describes the noncompliance and corrective action process.
- **Section 9 Construction Quality Plan:** Identifies the definable features of work (DFOWs) and describes the three phases of control (3POC) inspection process.

Specific construction quality assurance requirements for observation and verification testing are detailed in the attachments. **Attachment 1** contains general QC forms, and **Attachment 2** contains project-specific QC forms.

1.4 Key Concepts

There are two levels of activity to ensure the construction quality on this project: construction quality control (CQC) and construction quality assurance (CQA).

1.4.1 Construction Quality Control

CQC refers to those actions taken by the manufacturer, installer, or subcontractor to confirm that materials and workmanship meet or exceed the requirements of the construction contract or purchase order and the applicable plans and specifications. CQC consists of a planned system of inspections and testing procedures to directly monitor and control the quality of all furnished, constructed, or installed components. These activities are completely independent of CQA activities, except that they are monitored and reviewed as part of the CQA program.

1.4.2 Construction Quality Assurance

CQA refers to all measures taken to assess whether (and the extent to which) the manufacturer, installer, or subcontractor complies with the plans and specifications for the project. CQA primarily involves inspection of subcontractor CQC procedures to ensure that work conforms to project requirements. CQA includes inspections, testing, verifications, audits, and evaluations of materials and workmanship necessary to determine and document the quality of the constructed facility.

SECTION 2

Construction Quality Organization

This section describes the organization of the project staff necessary to implement this CQMP, their responsibilities and authority, and lines of communication. A project organizational chart is presented as **Figure 2-1**. The following subsections describe the responsibilities and authorities of the quality organization assigned to the project.

2.1 Authority and Responsibilities

This section lists the various roles and responsibilities within the quality organization. Designated names of individuals to perform these tasks are valid for March 2012 and are subject to change. A project organization chart is included in **Figure 2-1**.

2.1.1 Program Construction Quality Manager- Randy Underwood

The Program Construction Quality Manager (PCM) , in consultation with the Navy CLEAN Activity Manager (AM), is responsible for the following elements of work related to construction projects:

- Works with the Project Manager (PM) in assigning a Construction Manager (CM), and construction staff and directs their ongoing involvement in the project
- Leads development of construction approach to meet client needs
- Coordinates flow of feedback from construction staff to design staff for continuous improvement and change management
- Participates in construction task order initiation and work plan development regarding appropriate risk management, delivery strategies, and staffing and subcontracting strategies
- Evaluates subcontractor selection with input from the Contract Manager, PM, and Health and Safety Officer (HSO).

2.1.2 Project Manager – Keri Hallberg

The PM will perform overall project management of the Pilot Study. The PM is accountable for work activities undertaken as part of this project. As such, the PM will provide the managerial and administrative skills to ensure that resource allocation, planning, execution, and reporting meet contract and project requirements. The global quality-related responsibilities of the PM may include, but are not limited to, the following:

- Organizing the project staff and assigning responsibilities
- Understanding the project contract and scope of work (SOW)
- Ensuring that required submittals are completed and submitted, as required in the contract
- Communicating client requirements and quality practices to the project staff
- Identifying, documenting, and notifying the client and project team of changes in the SOW, design/engineering specifications, project documentation, and activities
- Supervising preparation and approval of project-specific procedures, project plans, and design/engineering specifications
- Approving project design basis, design parameters and reports
- Approving project construction methodologies
- Disseminating project-related information from the client.
- Serving as liaison for communications with the client and subcontractors
- Serving as liaison for communications between the project staff and other internal groups
- Investigating nonconformance and implementation of corrective actions
- Evaluating the effect of nonconformance on the project and the appropriateness of reporting such items to the client, and providing appropriate documentation for reporting

- Determining that changes, revisions, and rework are subject to the same quality requirements as the original work
- Serving as final reviewer prior to release of project information
- Approving and signing outgoing correspondence

The PM may assign a portion of these responsibilities to the CM, who will remain onsite throughout project field activities.

2.1.3 Construction Manager – Gerald Couch

The CM is responsible to the PM for efficiently applying the resources of the project team to execute the construction work activities. In addition, the CM is responsible for the technical, personnel, construction methodology, quality, safety, and local client interface details of the project and the project team while mobilized to the site. The CM will assist the PM to ensure that sufficient resource allocations to maintain project schedule and budget are maintained and will provide feedback to the PM on project progress, issues requiring resolution, and other project-specific issues, as required. Specific responsibilities of the CM include:

- Continuously monitoring work progress, quality, safety, and adherence to authorized work scopes, budgets, and schedules
- Enforcing the requirements of project plans and specifications
- Providing oversight and control of subcontractor services
- Managing the delivery of subcontractor services, including quality of workmanship, schedule, work sequencing, and budget in a safe manner
- Verifying that equipment delivered to the site is the equipment specified and is in working order
- Confirming that utility clearance is completed prior to performance of intrusive work
- Verifying that proper traffic signs are installed and that roads are maintained and can accommodate construction traffic
- Inspecting all delivered materials to verify that there are no defects in workmanship
- Monitoring delivery, handling, and storage of materials per the specifications
- Verifying that site storage facilities are protective and secure to prevent damage to equipment and materials per the specifications
- Reviewing manufacturer material certifications
- Ensuring that subcontractors and project team members have the required qualifications, training licenses, and certifications
- Ensuring that appropriate testing is performed in accordance with the specifications and project plans
- Preparing project documentation that supports verification that project objectives have been met
- Coordinating and communicating with site personnel, the PM, PCM, Field Quality Manager (FQM), and HSO to keep them fully informed of the work plan and progress
- Serving as liaison for communications with project staff and subcontractors, as well as with any onsite representatives
- Preparing weekly status reports
- Enforcing corrective actions for non-conformance identified onsite
- Leading weekly status meetings
- Coordinating 3POC for DFOWs for each subcontractor
- Performing Storm Water Pollution Prevention Plan (SWPPP) inspections and preparing SWPPP inspection reports, as necessary (procedures for these inspections are defined in the *IP.*

2.1.4 Engineer of Record/Technical Lead – Mike Perlmutter

The primary responsibility of the Engineer of Record/Technical Lead (EOR/TL) is to coordinate with the design team to make sure the design will fulfill performance requirements specified in the IP. The EOR/TL will support construction activities by assisting the CM either in the field or in the office. The EOR/TL will be supported by the design team to interpret the project design set forth in the construction documents and to address the IP challenges during the construction. In addition to the design-related services, the EOR/TL will be responsible for reviewing technical submittals for the project to determine they meet specifications outlined in the SOW. Specific responsibilities of the EOR/TL include the following activities:

- Clarify or interpret requirements of the plans and specifications
- Review subcontractor requests for information (RFIs) and provide response when necessary
- Engineer controls or change management options to account for unexpected site conditions or changes in construction and operation methodology
- Review submittals and approve if they meet specifications outlined in the SOW from subcontractors and vendors
- Interact with construction team on problem-solving and solutions

2.1.5 Project Quality Manager – Bill Hannah

The Project Quality Manager (PQM) has direct responsibility for developing and implementing the quality requirements defined in the IP and the CH2M HILL Environmental Services Business Group Quality Management Plan (CH2M HILL, 2010). The quality procedures defined by these plans are intended to assure the quality of environmental data collection and evaluation activities related to all aspects of the SOW, which include assessments, studies, designs, construction activities, and post-construction activities.

2.1.6 Field Quality Manager/Field Engineer- Jessica High

The FQM is assigned by the PM, with concurrence from the PCM and PQM, to implement and manage the site-specific QC requirements in accordance with the CQMP. The FQM is trained and experienced in performing inspections, surveillance, testing, and other QC functions, as required in the CQMP. The FQM may be assigned other project duties, as appropriate, such as site supervisor, project engineer, or HSO.

The FQM will review the CQMP and become familiar with project requirements. The FQM will assist and represent the PCM and PQM in implementation of the project plans. This position requires a thorough understanding of construction and remediation, as well as the project inspection and documentation requirements. The FQM is responsible for conducting submittal reviews to determine they meet specifications outlined in the SOW, oversight, and coordination of all testing activities, certifying the appropriate aspects of QC activities, and attending and preparing minutes for the weekly status meetings and the coordination meeting (Section 3.1.2). The FQM serves a critical role in the successful completion of project quality requirements.

Therefore, it is essential that the FQM be on the site at all times when construction is performed. In his/her absence, the FQM is responsible for designating an alternate FQM and obtaining concurrence from the PM, PCM, and PQM.

The FQM will be supported, as appropriate, by the CM and EOR/TL. The FQM’s responsibilities include, but are not limited to, the following:

- Performs field verification that the work is being conducted per the SOW, plans, and specifications.
- Performs field QA inspections and observations to ensure that the implemented remedial action conforms to project plans and the remedial design and specifications requirements.
- Leads reviews of pre-construction, construction, and post-construction submittals (to determine they meet specifications outlined in the SOWs) on the project and maintains the project Submittal Register. Evaluates submittals for acceptance on the project or facilitates submittal reviews by the EOR/TL.
- Leads review of project documents for accuracy, completeness, and correctness.
- Leads 3POC for DFOWs for each subcontractor. Leads QC meetings and disseminates meeting minutes/action items.
- Leads population, updating, and archiving of project tracking logs on a regular basis. Examples include: Daily Reports, RFIs, submittals and Submittal Register, photographs, field orders, etc.; but may delegate document reviews or preparation to other project team members.
- Prepares project documentation that supports verification that project objectives have been met
- Enforces corrective actions for non-conformance identified onsite

- Ensures that nonconforming items are corrected or addressed through nonconformance or deficiency reports
- Performs surveillance of project activities as necessary to ensure that the quality of service, products, and workmanship meets the requirements of the project

The FQM will also coordinate with and assist the PCM, PQM, and/or the Navy Remedial Project Manager (RPM) in the performance of quality audits and inspections.

The FQM has the authority to stop work on all or any project work activity due to nonconformance with the CQMP, project plans and specifications. Onsite personnel will be encouraged to discuss concerns with the FQM and supporting technical personnel. In the event the FQM is informed of and/or detects an incident of project nonconformance, the CM will perform an initial investigation, evaluate the corrective action required, document the incident, and report the incident to the PM, PCM, and PQM.

2.1.7 Document Manager - Jessica High

The Document Manager (DM) serves as the person primarily responsible for managing project documents and records. The DM reports to the PM and obtains support from the FQM and receives other administrative support. The DM functions as a member of the project team throughout the life of the project.

The PM, in consultation with the DM, decides on where and how project documents and records (hardcopy and electronic) will reside. The DM will then be responsible for coordinating document submittals, records management, tracking, and archiving. At project closure, the DM, in conjunction with the FQM and PM, will be responsible for archiving hardcopy and electronic versions of the project documents and records.

The DM's responsibilities include but are not limited to:

- Sets up the project folders for project archiving
- Tracks document status in the Submittal Register and trains the project team on the file structure and populating of files
- Confirms that all essential documents are placed in the project file
- Uploads documents into a central electronic location determined with the PM
- Works with the project team to submit essential project documents
- Archives documents and records

Project records provide objective evidence of operational, quality, health and safety (H&S), and regulatory-related activities. Project records must be identified, safeguarded, and retained to provide evidence of project activities and quality. Standard forms are used for project documentation whenever possible.

2.1.8 Subcontractors

Construction subcontractors will be selected by CH2M HILL to provide services during construction. Each subcontractor will work under the oversight of the CM. The subcontractors are responsible for furnishing and installing all project equipment and/or constructing applicable components of the facility in accordance with the design plans and specifications, meeting the acceptance requirements detailed in the IP. The subcontractor will be responsible for CQC requirements, as appropriate. Some of the subcontractors may also be designated as equipment suppliers.

The equipment suppliers are responsible for certifying that the products supplied conform to the plans and specifications approved by the EOR/TL. The equipment supplier will provide the CM with the equipment certification and operating instructions for products, as required in the technical specifications. Equipment suppliers and subcontractors are collectively referred to as "subcontractors" within this CQMP.

The subcontractors utilized for this project include the following:

1. Utility Location
2. One-Pass Trencher® services and iron/sand mixing
3. Surveying
4. Civil services including, but not limited, to site grading, silt fence installation, and site restoration

2.2 Conflict Resolution

If a nonconforming item is identified, the issue will be investigated by the FQM. If the FQM determines that corrective action is warranted, the FQM will document and review the issue with the CM, PM, PQM, and EOR/TL. If satisfactory resolution cannot be achieved between the CM, PM, PQM, and FQM, it will be elevated to the Program Manager (PGM) . The Navy RPM will be notified of any nonconformance having significant impact on the project cost or schedule.

The FQM has the authority to stop work on any nonconforming activity.

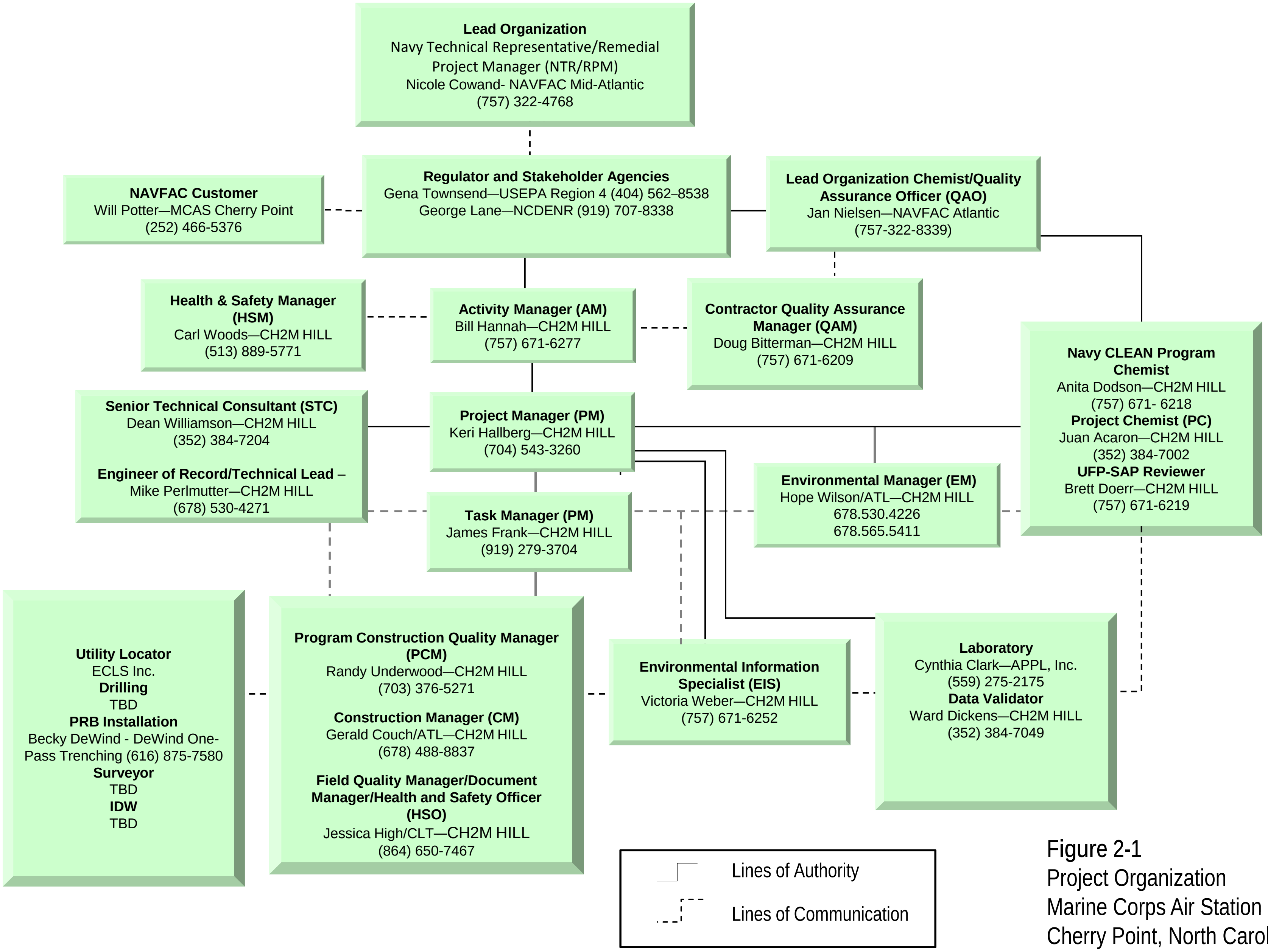


Figure 2-1
Project Organization
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

SECTION 3

Project Communication

Accurate, timely communications are required to avoid construction-related conflicts, errors, omissions, and delays. The project organization, stakeholders, and subcontractors must have an established communication network. Establishing open lines of communication is essential to maintaining strong working relationships and producing quality work.

3.1 Project Meetings

Project meetings will be scheduled to define and maintain responsibility and authority by promoting communication among various personnel responsible for designing, constructing, and observing the construction. The following subsections describe the project meetings anticipated during the work.

3.1.1 Pre-Construction Meeting

The PM will schedule and hold a pre-construction meeting with the PRB and site civil subcontractors at the site after CH2M HILL provides a notice to proceed to the subcontractors. The purpose of this meeting is to communicate or reiterate to all project stakeholders the critical success factors, the SOW, schedule, submittal requirements, documentation requirements, change management processes and procedures, construction means and methods, reporting and communication requirements, H&S requirements and protocols, and so forth.

The agenda will include, but not necessarily be limited to, the following:

- Designation of responsible personnel, including submittal reviewers/approvers
- Lines of authority and communication
- H&S
- Use of the site for storage, vehicle parking, access routes, and other site details
- NAVFAC requirements
- MCAS Cherry Point requirements
- Coordination with other contractors and stakeholders
- Temporary facilities and controls provided by CH2M HILL
- Security and housekeeping procedures
- Procedures for processing field decisions, submittals, substitutions, applications for payments, proposal requests, field orders, work change directives, and closeout procedures
- Progress schedules
- Procedures for testing and inspection
- Procedures for maintaining record documents

Minutes of the meeting will be prepared by CH2M HILL and distributed to the participants and those affected by decisions made. At a minimum, the CH2M HILL project team and major subcontractors will attend this meeting.

3.1.2 Coordination Meeting

After the pre-construction meeting, but prior to the start of site work, the CM and FQM will meet to discuss the CQMP. The purpose of this meeting is to develop a mutual understanding of the CQMP details, including submittal reviewers/approvers; inspectors/approvers of major milestone work performed; forms to be used; control activities and testing; administration of onsite and offsite work; schedule and method for transmitting submittals; coordination of subcontractors; and interrelationships among the PCM, FQM, Navy RPM, and other stakeholders.

Minutes of the meeting will be prepared by CH2M HILL and distributed to the project team and meeting attendees.

3.1.3 Project Status Meetings with Navy/Stakeholders

Project status meetings will be held weekly over the duration of the construction activities, and at important milestones during the project. The purpose of the meetings is to review work to date and schedule, discuss any required corrective actions, and discuss existing or potential construction or schedule problems.

Agenda will include, but will not necessarily be limited to, the following:

- Review of minutes of previous meeting
- Review of work progress since last meeting
- Identification of problems that impede planned progress
- Review of H&S concerns and issues
- Maintenance of progress schedule
- If necessary, corrective measures to make up for lost time
- Maintenance of quality and work standards
- Effect of proposed changes on progress schedule and coordination
- Change orders
- Other business relating to the work

At a minimum, the PM, CM, HSO, FQM, and major subcontractors will attend these meetings.

3.1.4 Weekly Progress Meetings

After the start of site work and throughout project execution, the CM will conduct weekly or bi-weekly progress meetings with each subcontractor. These meetings will be attended by the HSO, FQM, and subcontractor representatives as appropriate. The Navy RPM and stakeholders may attend and observe any of these meetings. As a minimum, the following will be accomplished at each meeting:

1. Review the minutes of the previous meeting.

2. Review the schedule.
   a. Progress since last meeting
   b. Work or testing accomplished since last meeting
   c. Rework items identified since last meeting
   d. Rework items completed since last meeting
   e. Identification of problems that impede planned progress
   f. If necessary, corrective measures to make up for lost time

3. Review the status of submittals.
   a. Submittals reviewed and approved since last meeting
   b. Submittals required in the near future

4. Review the work to be accomplished in the next 2 weeks and documentation required.
   a. Completion dates for rework items
   b. Inspections required
   c. Testing required
   d. Status of offsite work or testing
   e. Documentation required

5. Discuss H&S issues/concerns, such as near-misses and incidents.

6. Resolve quality issues, such as nonconformance, rework, and corrective actions.
   a. RFIs and logs
   b. Submittals and Submittal Register updates
   c. Waste Tracking Log
   d. Field Orders
   e. Sampling and testing

    f. Survey data
    g. Inspection schedule and documentation

7. Resolve production problems.
    a. Change orders
    b. Other business relating to the work

8. Address items that may require revising the CQMP or other project plans.
    a. Changes in procedures or quality processes
    b. Add/revise necessary form of documentation as applicable

Meeting discussions, decisions, and action items will be recorded in weekly status meeting minutes, which may be attached to the Daily Report, which discussed in greater detail in Section 5.2 below.

3.1.5 Daily Progress (Tailgate) Meetings

A progress meeting will be held daily at the work area, typically at the beginning or the end of the workday. At a minimum, the CM, HSO, and appropriate subcontractor representatives will attend the meeting. The purpose of the meeting is to accomplish the following tasks:

- Review the work location, activities, and accomplishments of the previous day
- Review the work location and activities for the day
- Discuss existing or potential construction or schedule problems

The HSM will ensure that all H&S-related inspections are completed prior to start work.

The CM or designated representative will document the meeting in pre-task plans and H&S-related inspection forms.

3.1.6 Problem or Work Deficiency Meetings

A special meeting may be held if a problem or deficiency is present or likely to occur. At a minimum, the CM, FQM, and appropriate subcontractors will attend the meeting. The purpose of the meeting will be to define and resolve a problem or recurring work deficiency in the following manner:

- Define and discuss the problem or deficiency
- Review alternative solutions
- Implement a plan to resolve the problem or deficiency

These meetings will be documented by the CM or designated representative.

SECTION 4

Submittals

Contract submittals are those that are clearly identified within the contract and specifications as required deliverables. Construction QC submittals are required to demonstrate compliance with the project plans and specifications designated in the SOW. Construction QC submittals include schedules, product data, material samples, administrative and close-out submittals, and additional technical support data presented for review and approval (i.e. waste tracking, surveying and test results). Submittal requirements are generally identified in the individual subsections of the specifications and summarized in the Submittal Register. For materials/equipment procured directly by CH2M HILL, the FQM is responsible for ensuring that the proper submittals are provided by the suppliers prior to accepting delivery. For materials/equipment supplied by a subcontractors, the FQM is responsible for ensuring that the proper submittals are provided and approved prior to delivery or installation.

4.1 Construction Quality Control Submittal Responsibilities

The CM is responsible for ensuring that the subcontractors and vendors present their submittals in a timely manner to ensure that the project schedule can proceed without any adverse impact; the FQM or PQM can facilitate the review process. Critical submittals and long lead-time materials must be identified as separate activities on the schedule. The FQM must ensure that the submittal packages are complete so valuable time is not wasted and effort lost on a re-submittal. Submittal status will be an agenda item of the weekly status meetings. The QC representative, subcontractors, and the submittal reviewer(s) will partner on this effort and look far enough ahead (could be 1 to 2 weeks) to ensure that the submittals are presented soon enough to be approved by the EOR/TL, FQM, and/or the Navy RPM and stakeholders. Timely submittal, review, and approval will enable the materials to be ordered and delivered to keep the project proceeding on or ahead of schedule.

The FQM will monitor submittal activities to verify the following items:

- Completeness of submittals
- Inclusion of all required submittals
- Submittal schedule status
- Current submittal status
- Re-submittals

The FQM will manage the logging and tracking of all submittals in the Submittal Register. Specific responsibilities regarding submittals include the following:

- Coordinating all submittal actions
- Maintaining necessary submittal records in an organized fashion
- Maintaining and tracking submittals in the Submittal Register
- Reviewing and certifying all submittals for compliance with the project plans and specifications
- Approving all submittals except those designated to be approved by the EOR/TL
- Checking all materials and equipment delivered to the project for compliance with the project plans and specifications

The FQM will spot check the approved submittals; submittals are approved by the FQM or EOR/TL.

In some cases, the FQM may elect to forward the submittal to the EOR/TL, who will route the submittal to the appropriate approver. Submittals requiring review/approval by either the FQM or the discipline leads should be clearly identified in the Submittal Register. The FQM is responsible for coordinating the submittal transmittal and approval process and for ensuring that the process does not impact the schedule. The FQM will monitor the construction submittal process to assure proper reviews are being completed and will consult with the EOR/TL or FQM regarding any questions or problems that may arise.

4.2 Submittal Review and Control

CH2M HILL will control and schedule all submittals. These submittals include all items listed in the contract document and listed or specified in the project specifications or technical scope and plans. The Submittal Register is included in **Attachment 1**. The form will be completed prior to executing work that requires "pre- construction submittals," such as planning documents (work plans and SOWs), employee certifications and qualifications, project schedules, survey data, and material acceptance samples and testing results. In-progress submittals will be processed and maintained during the project, with the status indicated on the Submittal Register as well. Units of measure used on all submittals will be consistent with those used in the project documents.

Each submittal will be reviewed for completeness and compliance with contract requirements by individuals qualified to perform the review of that specific item. The submittal reviewers and approvers will be designated during the pre-construction meeting.

The FQM and/or the field engineer (FE) will verify that each submittal complies with the project requirements. The EOR/TL is responsible for final evaluation of technical and design-related submittals. Submittals that do not comply with the requirements will be returned to the originator for correction and re-submittal. Substitutions or variations of specified requirements will be clearly noted. Certification of approved submittals will be indicated by FQM or EOR/TL signature and date on the submittal form. Justification for rejecting submittals will be provided by the FQM or EOR/TL in writing using a submittal review comments form and noted on the Submittal Register.

Submittals will include, but are not limited to, the following:

- Vendor design calculations
- Personnel qualifications (for example, heavy equipment operator)
- Product data/ material certifications
- Production, inspection, and test reports
- Progress reports, safety reports, manpower reports
- As-built or certified data
- QC logs and certifications
- Sample and test results
- Daily Reports
- Construction photographs
- Contract close-out documents

The FQM is responsible for ensuring that the Submittal Register is updated at least weekly, and will forward a copy of the Submittal Register to the PM, DM, and other team members at the end of each month.

SECTION 5

Quality Control Requirements

This section defines the reporting and documentation requirements associated with the QC procedures.

5.1 General

The quality of materials and workmanship will be controlled by the subcontractor who furnishes the work or material involved. However, the CM has the ultimate responsibility for subcontractor QC.

The FQM and CM will observe testing of the construction materials, workmanship (each DFOW and the associated activities), and the subcontractor's construction activities (e.g. ZVI quality information as related to both grain size distribution and lack of foreign objects or impurities, total depth of trench relative to ground surface, ZVI/sand ratio, verification of wells screens and drilling material). Specific construction requirements that are relevant to submittals, reporting and testing requirements, and verification testing are detailed in IP.

5.2 Daily Report

The Daily Report is a record of operations on the jobsite and must be prepared to account for each calendar day over the duration of the project. It is an essential tool for recording and reporting the daily production safety and QC activities of the project. On non-working days, a separate Daily Report need not be prepared, but the previous and subsequent Daily Reports must address and account for those non-working days. These reports are the official record of work performance and compliance with project plans and specifications. It is therefore critical that the reports be correct and timely.

Daily Reports will be prepared for this project to document tasks that are performed each day. The FQM is responsible for preparing work summary details involving sampling and testing. The CM is responsible for preparing work summary details for the corresponding construction site that he is assigned. The HSO will provide information on the H&S activities. Tasks (e.g., trenching, ZVI/sand mixing) being performed other than those managed by the FQM and CM, will be documented by those assigned individuals in discrete work summary reports. Individual work summary reports will be compiled into the applicable Daily Reports (i.e., sampling/testing or construction). These Daily Reports will be submitted to the CM and FQM for review and approval. The Daily Report (**Attachment 1**) will include at a minimum, the following:

- Activities performed for the day, including quality aspects of the project that are being performed by the subcontractor
- Planned activities, such as sampling, surveying, and inspections
- Scheduling and resource issues/concerns
- Site safety inspections and concerns
- Environmental concerns
- Project schedule and progress
- QC inspections
- Tests performed and their results
- Personnel and equipment onsite, including man-hours
- Materials received and inspected
- Tailgate safety meeting minutes and signatures--documented in pre-task safety plan form
- Changed conditions, delays, conflicts encountered, including QC issues
- DFOWs
- Submittal status

- Inspections conducted and findings/results
- Waste disposal summary

The project team will review the Daily Reports for accuracy and completeness because these reports are used to prepare the final report for the project. The PCM and FQM will review these reports to confirm that the quality processes and systems on the project are working as intended.

5.3 Project Records

Records that are generated by the QC system must be maintained in an orderly manner. The FQM will make sure the project quality records are readily available for reference. These should be arranged based on input from the DM and include the following items:

- Access agreements
- Submittals including Submittal Register
- Daily Reports
- Meeting minutes
- Inspection reports (preparatory phase, initial phase, follow-up phase)
- Pre-final and final inspection results
- Test results (e.g., waste characterization)
- Calibration records
- Contract modifications
- Field order and log
- RFIs arranged in numerical order and RFI log
- Nonconformance notices and corrective actions
- Certificates and qualifications
- Photographs and photo log
- Correspondence (emails, conversation records)

5.4 Field Documentation

The objective of field documentation is to ensure that appropriate project information is documented in logbooks during construction. This documentation is important for communicating activities with other staff members and the Navy RPM.

QC observations, inspections, and records of general QC activities on a regular basis include the following:

- Record pre- and post-construction conditions of the site and haul road
- Record daily progress and results of QA and QC sampling (magnetic separation testing, including record for calibration of weighing device)
- Record construction operations, sequence, staging, and so forth
- Maintain waste disposal records
- Describe deviations from expected conditions and unexpected problems and their resolution

The CM will maintain a record of daily QC activities during construction in a field logbook. The field logbook will be available upon request for review. All logbooks will be submitted to the FQM for archiving. The field logbook will be used to record information, such as:

- Date of entry
- Project name and location
- Time work starts every day
- Summary of weather conditions

- General description of work activities, size of work crew, and equipment and personnel onsite
- Duration and type of breaks
- Start time and duration of downtime resulting from equipment breakdown, weather, or emergencies
- Summaries of QC meetings and actions recommended
- QC testing equipment and personnel
- Identification of specific work locations
- Description of materials delivered to the site, including QC data provided by the subcontractors
- Decisions made regarding defective work or corrective measures implemented, or both
- Field tests
- Sampling activities

At the completion of logbook entries for each day, the bottom page of the logbook will be signed or initialed and dated to show that entries for that day are final.

A line-through will be placed on any portion of a logbook page that is unused. A one-line strike-through will be used to show corrections to entries. The strike-through will be initialed and dated. No correction fluid may be used.

The same information will be documented in the Daily Report.

5.5 Photographic Records

Photographic records will be made and kept as part of the CQA records. In addition to recording construction progress and "as-built" installation details, the photographic record will be used to document pre-existing conditions at each work site, and any deviations from design and nonconforming items or work. Each photograph will be assigned an identification number, date, location, and description. Any of the observers may photograph work for record purposes. The photographer will prepare a photo log and send it with the corresponding photos to the DM for archiving. The DM will archive and maintain the photographic record file (a copy of the photo log is provided in **Attachment 1**) using a digital camera that includes a date and time stamp to document when each photograph was taken.

(This page intentionally left blank)

SECTION 6
Testing

Sampling and testing will be performed to verify that control measures are adequate to provide a product that conforms to project plans and specifications. A sampling and testing log will be populated to log the sampling and testing conducted. Onsite testing will be performed by individuals with documented training and experience to perform the testing as determined by their supervisor and accepted by the PCM.

Testing services required for execution of the project will be contracted either directly by CH2M HILL or by its subcontractor(s). The testing services will be procured according to an SOW, which will be compliant with the project requirements and specifications, prepared by CH2M HILL. The SOW will specify specific testing methods professional services, and other measurement protocols as specified in the project plans, designs, and specifications. The SOW will also specify the nature of the report or deliverable required, including requirements for professional certification. Scheduling of site services will be the responsibility of the CM.

The following activities will be performed and documented during testing:

- Verify that testing procedures comply with contract requirements.
- Verify that facilities and testing equipment are available and comply with testing standards.
- Check instrument calibration data against traceable certified standards.
- Verify that recording forms, including all test documentation requirements, have been prepared.
- Record results of all tests, both passing and failing, on the Daily Report for the date conducted. Give section reference, location where tests were conducted, and the sequential control number identifying the test. Actual test reports may be submitted later with a reference to the test number and the date conducted.

The signed reports, certifications, and other documentation will be submitted as part of the construction completion report.

6.1 Sampling and Testing Log

As tests are performed, the FQM will record the following information on the Sampling and Testing Log: date the test was conducted, date the test results were received, results of the tests, whether they comply with the specifications, and any other applicable remarks. Applicable project requirements, tests, or analytical procedures are included in the IP.

The CM will obtain all test results and update the Sampling and Testing Log daily, and maintain the records onsite in the project files.

A copy of the Sampling and Testing Log will be attached to the Daily Report at the end of each day and forwarded to the CM, PM and PCM. The Sampling and Testing Log form for this project is included in **Attachment 1**.

SECTION 7

Change Control

RFIs will be used to communicate and document clarifications and modifications requested by CH2M HILL or subcontractors. The RFIs will be tracked by the FQM and logged by the PM so that each RFI is fully addressed and changes to the plans or specifications are completely and accurately documented. The RFI Form and RFI log template are included in **Attachment 1**.

Changes to materials, supplies, work approaches, and corrective actions during the construction effort will be documented in an overall effort to support sound engineering judgment and cost-effective project delivery. Changes during construction will be documented using the RFI process.

The RFI process involves identifying a situation in the field that requires change. This is done by either the subcontractor or CH2M HILL. When a change is identified by the subcontractor, the subcontractor reports the concern to the CH2M HILL FQM. The subcontractor then prepares an internal memorandum, in the form of an RFI, identifying the concern and forwards it to the CM for dissemination to the quality organization. Similarly, CH2M HILL may initiate RFIs with the Navy RPM when deemed necessary. In this case, the PM will lead the RFI process.

The RFI will contain the project number, an RFI identification number, and a title. The RFIs are numbered sequentially for the project and filed at the job site, and with the PM and the design/engineering team. The FQM forwards RFIs to the appropriate CH2M HILL team representative to evaluate the technical concern and prepare the appropriate response. The response includes a narrative explanation of the resolution or specifications required to complete the work are attached. The response is returned to the FE, forwarded to the FQM, who then disseminates the fully executed RFI to the appropriate parties after the cost and/or schedule impact (if any) has been evaluated and addressed.

The RFI process is a field construction tool for documenting changed field conditions or other issues that may require a deviation from requirements identified in the project specifications. The RFI is intended to obtain input and concurrence from the EOR/TL responsible for the design. Approval of the RFI by the EOR/TL does not constitute approval for CH2M HILL or its subcontractors to perform work that is outside the project scope or budget. In the event that an issue identified in the RFI may require a change to the project scope, schedule, or budget, this should be clearly conveyed in the RFI. In such instances, it is the responsibility of the PM, working closely with the contract administrator (KA), to seek and obtain proper approval from the Navy (in accordance with established Navy CLEAN Program procedures) prior to implementing the change recommended in the RFI.

(This page intentionally left blank)

SECTION 8

Non-Conformance and Corrective Action

CH2M HILL will notify the subcontractor of any detected noncompliance with the requirements noted in previous sections. A less formal communication (i.e., verbal/email) of the deficiency occurs first. Then, if corrective action is not put in place, formal notice in the form of a non-conformance report (NCR) is initiated by the FQM through the KA and will be sent to the subcontractor. Follow-up occurs through the CM, and if necessary, the PM (through the KA) would issue a Notice of Non-Conformance.

The subcontractor will take immediate corrective action after receipt of such notice. Such notice, when delivered to the subcontractor at the work site, will be deemed sufficient notification. If the subcontractor fails or refuses to comply promptly, CH2M HILL may issue an order stopping all or part of the work until satisfactory corrective action has been taken, as outlined in the terms and conditions of the subcontract.

The project team will monitor and inspect the remedial activity to ensure that materials, equipment, and work performed that do not conform to project requirements are identified and controlled to prevent unintended use or delivery. Through planning and the involvement of the quality team and other functional groups early in the planning process, actions can be taken to prevent potential noncompliance during project execution.

Noncompliance notification or stop work orders will be documented in the Daily Report and the NCR (see **Attachment 2**). Completion of corrective action will be noted on the Daily Report and finalized using the NCR. Verification of the corrective action and its results will be performed by the FQM and documented in the Daily Report.

8.1 Resolution of Conflicts

If the CH2M HILL team detects a nonconforming item, the issue will be investigated by the CM/functional lead and FQM. If the FQM determines that additional corrective action is warranted, the FQM will document and review the issue with the CM, PM, and EOR/TL. If satisfactory resolution cannot be achieved between the FQM and the PQM, it will be elevated to the PgQM, and if necessary, to the PGM. The Navy RPM will be notified of any nonconformance having significant impact on the project cost or schedule.

8.2 Corrective Measure Plan

Failing test results or NCRs will be resolved through a corrective measure plan. The corrective measure plan will be developed and implemented by the responsible entity and documented by the FQM in conjunction with the CM and PCM. The agreed-upon corrective measure will be documented by the FQM. Enforcement of the corrective measure plan is the responsibility of the CM.

(This page intentionally left blank)

SECTION 9

Construction Quality Plan

This construction quality plan (CQP) presents the construction quality management process that will be implemented on the project: 3POC. The protocol is intended to enhance quality and corresponding documentation of the quality process for each DFOW for the project. A DFOW is a task that is separate and distinct from other tasks and has separate control requirements. The DFOWs for this pilot study are as follows:

- Mobilization
- Site preparation
    - Fence removal
    - Overhead power line removal
    - Vegetation clearance
    - Water line disconnection
    - Silt fence construction
    - Soil staging area construction
    - Work platform construction
    - PRB corridor survey
    - Utility location
- ZVI PRB construction
  - Staging of PRB material (ZVI and sand)
  - Sand/ZVI mixing
  - Quality Assurance and Quality Control Testing (magnetic separation testing)
  - Trenching and Medium Placement
  - Residuals management
- Site restoration
  - Roadway
  - Grading
  - Re-vegetation
- As-Built Survey
- Drilling and installation of monitoring wells
- Decontamination and IDW management
- Demobilization

9.1 Construction Quality Plan Objectives

The objectives of this CQP are as follows:

- Outline the construction quality management protocols required by the 3POC inspection process
- Provide project-specific construction quality inspection and testing details to further integrate quality into construction and delivery aspects of the project

9.2 Project Performance Objectives

The project performance objectives (PPOs) were established to ensure the PRB is installed per the design:

- Determine accurate constructability depth. Target PRB depth is 45 feet below ground surface (bgs) using the DeWind One-Pass Trench System, but if a 45-foot depth cannot be achieved, a 35 to 40 foot depth bgs is required for the PRB to be considered protective of Slocum Creek.
- A ZVI loading factor for an 18-inch wide PRB of 0.2665 by volume, or 0.332 by mass, would be required to meet project remedial action objectives.

All other details regarding project specifications are documented in Section 4 of the IP.

9.3 Three Phases of Control

The 3POC system will be implemented as a subcontractor construction quality management process. The 3POC is a three-step inspection process that includes the Preparatory Phase, Initial Phase, and Follow-up Phase inspections. The process includes discussing the project requirements prior to initiating any construction work activities, assessing the quality of work early in the execution of work, and monitoring the work throughout the delivery until completion.

9.3.1 Preparatory Phase

The Preparatory Phase essentially concludes the planning and design process leading up to actual field work. It also serves to assure that the project IP and related documents have been completed and are ready to be implemented. The following events take place for each DFOW established by the PM/CM:

1. Confirm that the appropriate technical specifications are incorporated into the project work plan and construction design, and review specifications with the CM and other field team members.
2. Confirm that the appropriate contract designs are incorporated into the project work plan and review with the CM and other field team members.
3. Verify with the FQM that all pre-construction submittals (materials, H&S, project plans) have been approved by the proper approving authority.
4. Confirm with the FQM that the testing plan is consistent with the project plans and that adequate testing is included to assure quality delivery.
5. Confirm definition of preliminary work required at the work site and examine the work area with the CM. CM confirms that the required preliminary work has been properly completed.
6. Confirm availability of required materials and equipment. Confirm with FQM and CM that materials and equipment inspected comply with approved submittals.
7. Confirm with the HSO that the Health and Safety Plan (HSP) and Activity Hazard Analysis (AHA) have been reviewed and approved to ensure that safety concerns are adequately addressed and applicable safety requirements have been incorporated. Confirm that the appropriate material safety data sheets (MSDSs) have been identified and properly submitted.
8. Discuss with the CM the construction methods to be employed during the remedial action. Confirm that all field team members are aware of the identified checkpoints and areas of evaluation that will allow determination that the appropriate quality of construction is being achieved.

9.3.2 Initial Phase

The Initial Phase occurs at the startup of remedial activities, or construction, associated with a specific DFOW. Essentially, the Initial Phase confirms that the CQMP is being effectively implemented and the desired results are being achieved. Notification of the FQM that the crews are ready to start a particular DFOW is required prior to their actual start. Specific details associated with the Initial Phase are:

1. Establish the quality of workmanship necessary to properly deliver the DFOW in accordance with project requirements. The FQM assures that the appropriate CMs have made the subcontractor aware of expectations associated with the construction methods established during the Preparatory Phase. This assurance is to be achieved via observation of the initial work activities as well as interaction with the CM.
2. Resolve conflicts. The PQM will provide support to the CM in resolving conflicts involving quality issues. Should conflicts arise in establishing the baseline quality for the DFOW, the responsibility to resolve the conflict falls to the PQM. Should the conflict not be resolved in a manner that satisfies the contract

requirements, the PQM will elevate the conflict to the program level (PgQM) and issue an NCR (see **Section 8**). Should the issue jeopardize the results of the DFOW, or put the project at risk of non-compliant performance, the PQM may direct that work be stopped .

3. Evaluate the HSP and AHA against actual work conditions with the CM to assure that the hazard analysis conducted to prepare the HSP adequately addressed field conditions. Confirm that applicable safety requirements are being met during construction activities.

4. Observe and evaluate the performance of testing technicians. Confirm with the FQM and EOR/TL that testing is being performed in accordance with the testing plan and that required protocols are being observed. Review reports and documentation associated with extraction, packaging, transporting, and testing of samples. Note discrepancies and direct correction accordingly.

Upon completion of the Initial Phase activities, results are to be documented in the Daily Report.

9.3.3 Follow-Up Phase

Completion of the Initial Phase of QC activity then leads directly into the Follow-up Phase, which addresses the routine day-to-day activities on the project site. Inspection activities associated with each DFOW are to be addressed within the Daily Report. Specific concerns associated with the Follow-up Phase include:

1. Inspection of the work to assure that it is in compliance with the SOW.

2. Evaluation and confirmation that the quality of workmanship is being maintained at a level no less than that established during the Initial Phase

3. Evaluation and confirmation that required testing and surveying are being performed in accordance with procedures established during the Preparatory Phase and confirmed during the Initial Phase

Confirmation that non-conforming work is being corrected promptly and in accordance with the direction provided by the PQM.

9.4 Critical Inspections

Critical or “check-point” inspections are necessary prior to final acceptance of all completed DFOWs. A critical inspection provides the basis for accepting a DFOW and its suitability to perform the intended purpose. A critical inspection involves the observation, measurement, and possibly testing of the work at its point of installation to ensure compliance with project requirements. The QC organization will define the critical inspection tasks during the Preparatory Phase of the project and update the list of critical inspections over the course of the project. The project cannot begin field activities until the critical inspections tasks are listed on the Quality Control and Inspection Log (included in **Attachment 2**). A punch list inspection includes work that is not critical, but is required for successful completion of the work prior to client acceptance.

The FQM will be responsible for ensuring that the Quality Control and Inspection Log is completed. The results of inspections will be documented on the Daily Report.

(This page intentionally left blank)

SECTION 10
References

CH2M HILL. 2010. *Environmental Services Business Group Quality Management Plan, Edition 4.* August.

CH2M HILL. 2012. *Tier II Sampling and Analysis Plan, Groundwater Treatment Zero-Valent Iron, Permeable Reactive Barrier Pilot Study, Operable Unit 1*. February.

(This page intentionally left blank)

Attachment 1
General Quality Control Forms

Attachment 1 Contents

CH2MHILL

REQUEST FOR INFORMATION

REQUEST NO: Insert

Project:					**Project No.:**		
Contractor:	Insert				**TO No.:**		
Clarification Requested By:	Insert Name/ Insert Position						
Regarding:	**Plan Sheet**	Insert	**Specification Section**	Insert	**Scope of Work**	Insert	**Others:**

Brief Description of RFI: Insert

Description of Existing Condition and/or Deficiency:

Insert

Recommended Solution:

Insert .

Other Information:					
Cost Impact:	Yes/No	Schedule Impact:	Yes/No	Attached with this RFI: (Specify)	
Work Days:	TBD / Insert	Amount ($):	TBD / Insert	Supporting Document for Cost Impact:	TBD / Insert

Insert — **Printed Name**

Insert — **Title**

Insert — **Signature**

Insert — **Date**

CONTINUED FROM ITEM:

Response / Disposition / Concurrence:

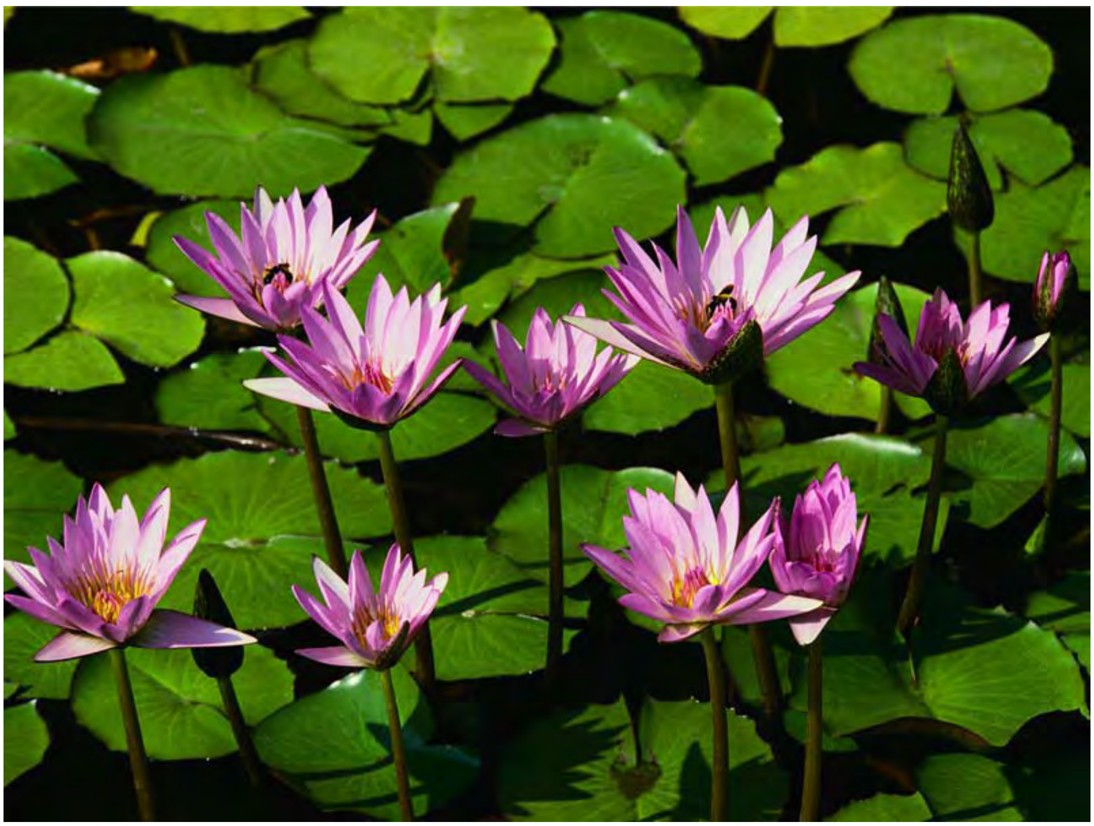
Printed Name	**Title**

Signature	**Date**

ATTACHMENT: Insert as applicable

PHOTOGRAPH NO. 1

Insert description, date taken, direction at which it was taken



Request For Information Log

CH2MHILL		Project Name:				Project Number:		
		Field Quality Manager:						
RFI #	**Description of Issue**	**Submitted To**	**Date**	**Returned To**	**Date**	**Response/Disposition**	**Status**	**Comment**
1								
2								
3								
4								

SUBMITTAL REGISTER

PROJECT NO.	OU1 Central Groundwater Plume ZVI PRB Pilot Study, MCAS Cherry Point, North Carolina		TASK ORDER NO.	TO-WE10	ACTIVITY / TASK:	Construction					
ITEM NO	DESCRIPTION OF SUBMITTAL (include well construction materials)	REFERENCE: Spec / Drawing	APPROVING REQUIREMENT: Approval (A) or Information (I)	APPROVING AUTHORITY: (CH or AF)	SUBMITTAL FREQUENCY: (One time, weekly, etc.)	DATE SUBMITTED TO APPROVER	APPROVIING AUTHORITY NAME	TITLE / COMPANY OR AGENCY	STATUS: -Approved -Rejected	DATE APPROVED	REMARKS

Waste Tracking Log

TO No	Project No	Project Name	Site Description	Container Type	Container Desig.	Waste Profile Sample No	Contractor	Transporter	Date Transported	Transporter EPA ID	Load ID	Disposal Facility	Disp Fac EPA ID	Media	Waste Type (Haz, Nonhaz, TSCA)	Waste Code/ Haz Waste No	Disposal Date	Manifest Number	Disposal Treatment Method (Enter disposal quantity under appropriate method)					Certif of Disp/ Destruc Date	Comments/ Notes	File Status (see note)
																			Incineration	Recycle	Landfill	Other	Unit			

FORM NO.:	275
TITLE:	Field Order
PURPOSE:	Orders minor revisions to the contract documents which do not involve changes in the contract price or contract times
PREPARED BY:	Engineer
DIRECTED TO:	Contractor
COPIES TO:	Owner, resident project representative
COMMENTS:	Use sparingly; if the revision involves changes in the contract price or times, either a Change Order or Written Amendment should be implemented

FIELD ORDER

TO CONTRACTOR: ______________________ FIELD ORDER NO: ______________

PROJECT: ______________________ PROJECT NO: ______________

OWNER: ______________________

ENGINEER: ______________________

The following minor changes in the work have been ordered and authorized:

Description of Changes:

Reason for Field Order:

Reference Drawing Sheets and Section(s) or Detail(s):

Reference Specification Section(s)/Paragraph(s):

The intent of this Field Order is to authorize minor variations to the Contract Documents not involving a change in Contract Price or Contract Times and which are compatible with the design concept of the completed Project. This Field Order is binding upon OWNER and also on CONTRACTOR who will perform the work promptly. If OWNER or CONTRACTOR believes an adjustment to the Contract Price or Contract Times is necessary, the party may make a claim therefore in accordance with the General Conditions.

Issued by Engineer:

By: ______________________
Authorized Representative

Date: ______________________

Contractor Receipt Acknowledgement:

By: ______________________

Title: ______________________

Date: ______________________

Copy:
1. Owner
2. Field File

	DAILY REPORT (ATTACH ADDITIONAL SHEETS IF NECESSARY)	SOP ES-P6-01, Final, Rev 1

CONTRACT NAME:	EPA RAC-2	REPORT NO:	
CONTRACT NUMBER:	EP-W-06-021	REPORT DATE:	
REVISION NUMBER:		REVISION DATE:	
TASK ORDER NUMBER:	0052	PROJECT NAME / LOCATION:	Grants Chlorinated Solvents Plume
PROJECT NUMBER:	411400	PROJECT DESCRIPTION:	ISTT Construction
PROJECT MANAGER:	Jeffrey Minchak	FIELD QUALITY MANAGER:	
CONSTRUCTION MANAGER:		H&S SAFETY Officer:	

AM WEATHER:		PM WEATHER:		MAX TEMP (F):		MIN TEMP (F):	

Summary of Work (Per Work Area)

SAFETY ACTIONS TAKEN TODAY/SAFETY INSPECTIONS CONDUCTED (Include Observations, Safety Violations, Corrective Instructions Given, Corrective Actions Taken, and Results of Safety Inspections Conducted:

TAILGATE TOPICS:

SAFE BEHAVIOR OBSERVATIONS:

OPERATIONS / PRODUCTION REPORT

Company	**Total Hours Today**
CH2M HILL	
Subcontractor 1- Location	
Subcontractor 2- Location	
Subcontractor 3- Location	
Total	
CH2M HILL	

EQUIPMENT ON HAND (Intial Inspection conducted to check if the Equipment is clean and in good working order/operable)

Description of Equipment	**Make/Model/Manufacture**	**Equipment ID Number**	**Inspection Performed By**

COMMENTS (acceptance status, inspection findings, etc.):

Planned Work / Test for Tomorrow:

Planned Work / Test for Next Week:

CHANGED CONDITIONS/DELAY/CONFLICTS ENCOUNTERED (List any conflicts with the project [i.e., scope of work and/or drawings], delays to the project attributable to site and weather conditions, etc.)

VISITORS AND DISCUSSIONS:

REGULATORY COMPLIANCE REPORT

PERMIT INSPECTIONS PERFORMED:

None

WASTE ACCUMULATION/STOCKPILE AREA INSPECTION

Inspection Performed By:				Signature of Inspector:			
Accumulation / Stockpile Area Inspected:		See Waste Tracking Log					
No of Containers:	Na	No of Tanks	N/A	No of Roll-Off Boxes:	N/A	No. of Drums	N/A

Inspection Results:

____

____

____

GENERAL COMMENTS

General Comments~ (rework, directives, etc.):

____

____

____

CONTRACTOR QUALITY CONTROL REPORT

(ATTACH ADDITIONAL SHEETS IF NECESSARY)

DEFINABLE FEATURES OF WORK STATUS

DFOW No.	Definable Feature Of Work	Preparatory	Initial	Follow-Up
1		☐	☐	☐
2		☐	☐	☐
3		☐	☐	☐
4		☐	☐	☐
5		☐	☐	☐
6		☐	☐	☐
7		☐	☐	☐
8		☐	☐	☐
9		☐	☐	☐

QUALITY CONTROL REPORT

Materials Delivered to Job Site

Quantity/Volume/Weight	Description of Materials Received	Make/Model/Manufacturer	Material Lot Number	Inspection Performed By

TESTS PERFORMED

Task/Activity Tested	Test Performed	Test Results (Pass/Fail) – Criteria

SUBMITTALS INSPECTION / REVIEW

Submittal No.	Submittal Description	Specification/Plan Reference	Submittal Approved?		Comment/Reason/Action
			Yes ☐	No ☐	
			Yes ☐	No ☐	

PREPARATORY	WAS PREPARATORY PHASE WORK PERFORMED TODAY? ☐ YES ☐ NO IF YES, FILL OUT AND ATTACH SUPPLEMENTAL PREPARATORY PHASE CHECKLIST.		
	DFOW No.(from list above).	TASK/ACTIVITY	PREPARATORY PHASE REPORT NO.

INITIAL AND FOLLOW-UP FEATURE OF WORK INSPECTIONS

DFOW No.(from list above)	Phase	Comment/Finding/Action/ QC Resolutions
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	
	Initial ☐ Follow up ☐	

REWORK ITEMS IDENTIFIED TODAY (NOT CORRECTED BY CLOSE OF BUSINESS)			**REWORK ITEMS CORRECTED TODAY (FROM REWORK ITEMS LIST)**	
TASK/ACTIVITY	DATE ISSUED	DESCRIPTION	TASK/ACTIVITY	CORRECTIVE ACTION(S) TAKEN
None				

ATTACHMENTS

List of Attachments: (examples, as applicable: submittals, meeting minutes, safety meeting minutes, COCs, weight tickets, manifests, profiles, rework item list, RFIs, DCNs, photographs, etc

PREPARER'S SIGNATURE DATE

NOTE: Write all entries legibly in ink. Line out all unused portions or designate as "not applicable". Preparer signs first and last name on each completed daily report. This form may be filled out electronically and signed electronically.

Grants Chlorinated Solvents Plume Superfund Site
ISTT Construction, TO0052

Location	Photo Number	Date	Time	Task and Description	View Direction	Taken By

CH2MHILL Constructors, Inc.

PREPARATORY PHASE REPORT

CH2MHILL Constructors, Inc.	PREPARATORY PHASE REPORT	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:
PROJECT NO: 411400	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:	

PERSONNEL PRESENT

NAME	POSITION	COMPANY/GOVERNMENT

SUBMITTALS

REVIEW SUBMITTALS AND/OR SUBMITTAL REGISTER.	HAVE ALL SUBMITTALS BEEN APPROVED? YES ☐ NO ☐
IF NO, WHAT ITEMS HAVE NOT BEEN SUBMITTED?	
ARE ALL MATERIALS ON HAND? YES ☐ NO ☐	
IF NO, WHAT ITEMS ARE MISSING?	
CHECK APPROVED SUBMITTALS AGAINST DELIVERED MATERIAL. (THIS SHOULD BE DONE AS MATERIAL ARRIVES).	
COMMENTS:	

MATERIAL STORAGE

ARE MATERIALS STORED PROPERLY? YES ☐ NO ☐	
IF NO, WHAT ACTION IS TAKEN?	

SPECIFICATIONS

REVIEW EACH PARAGRAPH OF SPECIFICATIONS.
DISCUSS PROCEDURE FOR ACCOMPLISHING THE WORK.
CLARIFY ANY DIFFERENCES.

PRELIM WORK & PERMITS

ENSURE PRELIMINARY WORK IS CORRECT AND PERMITS ARE ON FILE.	
IF NO, WHAT ACTION IS TAKEN?	

	PREPARATORY PHASE REPORT	REPORT NO:	REPORT DATE: REVISION NO: REVISION DATE:
PROJECT NO: 411400	DEFINABLE FEATURE OF WORK:	SITE/ACTIVITY:	

IDENTIFY TEST TO BE PERFORMED, FREQUENCY, AND BY WHOM.

TEST	FREQUENCY	PERFORMER

WHEN REQUIRED?

WHERE REQUIRED?

REVIEW TESTING PLAN.

HAVE TEST FACILITIES BEEN APPROVED?

TEST FACILITY	APPROVED?
	YES ☐ NO ☐
	YES ☐ NO ☐

ACTIVITY HAZARD ANALYSIS APPROVED? YES ☐ NO ☐

REVIEW APPLICABLE PORTION OF EM 385-1-1 AND AHA.

COMMENTS DURING MEETING.

OTHER ITEMS OR REMARKS:

CQC REPRESENTATIVE’S NAME	CQC REPRESENTATIVE’S SIGNATURE	DATE

CH2MHILL

OU1 Central Groudnwater Plume ZVI PRB Pilot Study
MCAS Cherry Point, North Carolina

Sign In Sheet (Insert Distal Location)

Date of Inspection:	____/____/____	**TO Number:**	**Site Location:**	Grants, NM
Type of Inspection: ***(Circle One)***	**Pre-Final**	**Final**	**Prepared By:**	

Attendees			
Printed Name	**Signature**	**Entity Represented**	**Date**
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /
			/ /

Findings / Punch List Items

Item No	Item Description	Resolution	Proposed Completion Date	Verified/Accepted By	Date Completed
1					
2					
3					
4					
5					

Comments/Remarks:

Sampling and Testing Log

CH2MHILL	**Project Name:** CP OU1 ZVI PRB Pilot Study	**Project Number:** 424578.PT.PT
	Field Quality Manager:	

PLAN Total Sand/ZVI Mix (yd^3)	Sample #	Sample Portion of Sand/ZVI Mix (yd^3)[1]	Date	Time	Sample Container Empty Weight (g)	Sand/ZVI Mix Sample + Sample Container Weight (g)	Net Sand/ZVI Mix Sample WET Weight (g)	Net Sand/ZVI Mix Sample DRY Weight (g)	Magnetic DRY Fraction Weight (g)	NON-magnetic DRY Fraction Weight (g)	Magnetic DRY Fraction + NON-magnetic DRY Fraction Weight CHECK (g)	% Difference[2]	ZVI Loading Factor[3]	Does Batch Meet Plan Specs? (Yes/No)[4]	Comments
1,333	1	0	--	--	--	--	--	--	--	--	--	--	--	--	--
1,333	2	50													
1,333	3	100													
1,333	4	150													
1,333	5	200													
1,333	6	250													
1,333	7	300													
1,333	8	350													
1,333	9	400													
1,333	10	450													
1,333	11	500													
1,333	12	550													
1,333	13	600													
1,333	14	650													
1,333	15	700													
1,333	16	750													
1,333	17	800													
1,333	18	850													
1,333	19	900													
1,333	20	950													
1,333	21	1,000													
1,333	21	1,050													
1,333	21	1,100													
1,333	21	1,150													
1,333	21	1,200													
1,333	21	1,250													
1,333	21	1,300													
1,333	21	1,333													

Notes:
1. ZVI/Sand testing is to be completed per every 50 cubic yards of material
2. % Difference between Sand/ZVI Mix Sample Dry Weight and the sum of the magnetic and non-magnetic dry weight fractions should be with +/- 5 percent. If not, sampling should be done again.
3. ZVI must meet or exceed a 0.2665 loading factor as stipulated in the IP.
4. If batch does not meet plan specifications, document change in ZVI/Sand mix in comment section.

Attachment 2
Project-Specific Quality Control Forms

Attachment 2 Contents

Defective/Rejected Work Notification
Non-Conformance/Deficiency Report
Critical Quality Control and Inspection Log
Submittal Review Comments
Transmittal of Contractor’s Submittal

CH2MHILL

DEFECTIVE/REJECTED WORK NOTIFICATION

TO SUBCONTRACTOR: ______________________ NOTIFICATION NO: ______________

PROJECT: ______________________ DATE ______________

LOCATION ______________________ Prepared by: ______________

Contract No: ______________________ CM: ______________

Pursuant to the GENERAL CONDITIONS of the Contract, you are hereby notified of the following noncompliance violation:

Specification Section: ______________________ SOW Section ______________

Drawing No. ______________________

Description of Non-Compliance:

Contract Requirement:

Violation Detected by: ☐ Measurement ☐ Rejected ☐ Observation/Inspection

Noncompliance Work is: ☐ Defective ☐ Rejected

Estimated Value of Noncomplying Work: $ ______________________

Defective work shall be corrected. Rejected work shall be removed and replaced. All costs shall be borne by the Subcontractor. Payment will not be made for defective or rejected work. Subcontractor shall notify the Resident Engineer in writing the proposed corrective actions and completion dates, personnel responsible for implementation of corrective actions and when defective or rejected work has been corrected.

Received by:

Engineer: ______________________ ______________________

Authorized Representative | Subcontractor Representative

Date: ______________________ ______________________

Title

____

Date

CH2MHILL Constructors, Inc.

NON-CONFORMANCE/DEFICIENCY REPORT

PART 1 – General Information

Date Submitted:	NCR Number:	
Submitted To:	Company/ Title/Position:	CH2M HILL/PM
Prepared By:	Company/ Title/Position:	CH2M HILL/RCQM
Project Name:	Project Number:	

PART 2 – Non-Conformance/Deficiency Report

Description of Non-Conforming Item or Condition or Deficiency							
Contract Requirement or Project Specification/Drawing							
Test/Inspection/Audit Identifying Non-Conformance/Deficiency							
Reportable Release?	Yes ☐			No ☐			
Material Name:	Not applicable			Quantity:	Not applicable		
Disposition:	Repair ☐		Rework ☐	Use-As-Is ☐		Reject ☐	

PART 3 – Investigation/Root Cause Determination

Personnel Responsible for Investigative Process:
Investigative Process Findings:
Probable Root and Contributing Cause(s):

PART 4 – Corrective Actions

Proposed Corrective Actions and Completion Dates:		
Personnel Responsible for Implementation of Corrective Actions:		
Resulting Actions and Effectiveness of Those Actions:		
Personnel Responsible for Monitoring Effectiveness of Corrective Actions:		
Corrective actions have been completed and monitored for effectiveness.		
Signature	Company/Title	Date

PART 5 – Response Approval

Responses Accepted By		
Signature	Company/Title	Date
Signature	Company/Title	Date

PART 6 – Quality Control Follow-Up

Comments/Findings of Follow-Up Observation / Inspection / Audit:		
Verification Results	Satisfactory ☐	Unsatisfactory ☐

PART 7 – NCR Closure

NCR Closed		
	Regional Construction Quality	
Signature	Company/Title	Date

CH2MHILL Constructors, Inc.

Critical Quality Control and Inspection Log

DATE OF REPORT	mm/dd/yyyy:	
REVISION NO	#	
REVISION DATE	mm/dd/yyyy:	

PROJECT NO: 424578 **PROJECT NAME:** CP OU1 Central Groundwater Plume ZVI PRB Pilot Study

Inspection Description

DFOW No.	Definable Feature of Work	Technical Spec Section(s)	Article No.	Critical Review / Inspection Activities (list review/inspection REQUIREMENTS for QC)	Submittal Required (Y/N)	Description of Required Submittal	Submittal Approved (Y/N)	AHA Prepared & Submitted	Preliminary Work Completed (Y/N)	Testing / Sampling (Y/N)	Critical Photographs (Y/N)	Performed By (Printed Name)	Performed By (Signature)	Date(s) Performed:	Daily Inspection Report No.(s)	COMMENTS (Include Area Inspected)
1	**Mobilization/ Site Preparation**															
	Subtask: Utility Clearances- NM One Call			1 Check if they are marked, and ensure that NMOC Call ticket # for utility locate has been provided and has not expired												
	Utility Clearances- Third Party			2 Check if they have been cleared by third party utility locator, utilize their report												
	Soil Erosion Control			3 Check if erosion control has been implemented												
	Construction Limits			4 Verify construction limits are defined and ensure that the exclusion zones are established/defined (whenever applicable)												
	Material Storage/Staging			5 Material staged in the designated areas. Verify that materials and screening equipment are stored in accordance with sampling and analysis plan and manufacturer's recommendations												
	H&S			6 Check for Hazards posed by material/equipt. mobilization and other H&S requirements prior to mobilization												
	Traffic Routes			7 Verify that traffic routes are in conformance with project plans, specifications, and other city/county requirements												
	Property Access			8 Verify that appropriate access and settlement agreement have been obtained for all properties												
	Permits			9 Check permit conditions, Soil Erosion and Sediment Control Plan, and Storm Water Pollution Prevention Plan, and other relevant permits	This is required prior to Mobilization of the Subcontractor											
2	**Demolition of Residential Structures**															
	Subtask: Universal Waste Assessment/Lead Based Paint			1 Verify that UWA/LBP assessment has been completed Verify wastes remain segregated, as necessary, during demolition ***See Waste Management section below***												
	Utility Survey			2 • Verify that the utilities have been located and marked prior to onset of demolition activities • Verify that permits for utility closure have been obtained by the demo subk • Ensure that all utility lines (including sewer, potable water, gas, electricity, and telephone) have been severed and capped												
	Competent Person			3 Verify that subcontractor has a demolition "competent person" onsite for demolition oversight												
	Sample/Testing Data Management			4 Check that chain of custody records, sample log and other sample-related information are maintained and uploaded into the server												
3	**Fence Construction- Barnes Property**															
	Subtask: Pre-construction			1 Check proposed fence construction and location against SOW maps												
	Securing fence to ground			2 Follow SOW requirements for securing fencing compound to the ground surface												
	Siting of gates			3 Ensure that location of 2 swing gates allows for unimpeded access into the fenced compound and that all gates can be fully opened and closed Ensure pedestrian gates swing fully open and access is not impeded												
	Locking mechanism			4 Ensure that all gates have mechanism that allow for locking/securing												
	Inspections			5 Continuously inspect fencing compound and gates for damage. If damage is found, inform FTL immediately.												
	Locks			6 Ensure combination locks have been procured and all combinations have been set to the same code, disseminate code at initial site meeting												
	Fence Repair			7 Engage fencing subcontractor to repair damaged fencing components												

CH2MHILL Constructors, Inc.

Critical Quality Control and Inspection Log

DATE OF REPORT: mm/dd/yyyy:
REVISION NO: #
REVISION DATE: mm/dd/yyyy:

PROJECT NO: 424578 **PROJECT NAME:** CP OU1 Central Groundwater Plume ZVI PRB Pilot Study

Inspection Description

DFOW No.	Definable Feature of Work	Technical Spec Section(s)	Article No.	Critical Review / Inspection Activities (list review/inspection REQUIREMENTS for QC)	Submittal Required (Y/N)	Description of Required Submittal	Submittal Approved (Y/N)	AHA Prepared & Submitted	Preliminary Work Completed (Y/N)	Testing / Sampling (Y/N)	Critical Photographs (Y/N)	Performed By (Printed Name)	Performed By (Signature)	Date(s) Performed:	Daily Inspection Report No.(s)	COMMENTS (Include Area Inspected)
4	**Drilling**															
	Subtask: Mobilization			1 Verify that all required equipment and materials are onsite and staged/stored in the designated area												
	Utility Locate			2 Verify that utility locates have been completed and the NMOC ticket is current (not expired)	This is required prior to set up at each boring location											
	Drill pad set up			3 Cover ground with plastic sheeting underneath drill pad Verify drilling location and correct borehold depth and auger flight size by cross-checking supplied maps and consulting with FTL as necessary	This is required prior to set up at each boring location											
	Vertical Borehole Drilling			4 Verify correct borehole depth and auger flight size by cross-checking supplied maps and consulting with the FTL, as necessary Verify total borehole depth by tagging the depth of the borehole with an engineers tape or similar	This is required prior to set up at each boring location											
	Angled Borehole Drilling			5 Verify correct borehole angle from horizontal, total depth, and auger flight size with maps and SOW Verify angle and TD using trigonometry												
	ISTT component installation			6 Verify specific ISTT component designed for borehole and secure proper equipment for installation Consult SOW during ISTT componet installation to ensure proper placement of component, sand, bentonite, grout, etc. ***See Installation of Wellheads and Piping section below***												
	Securing open borehole, as necessary			7 Secure open borehole per SOW if connection to ISTT system is not made immediately												
	As-Built Drawings			8 Complete As-Built drawing for each borehole/installed ISTT component, include all pertinent information including type of sand, bentonite, grout, etc., installation depths and volume/amount used ***See Installation of Wellheads and Piping section below***												
	IDW- soil			9 Ensure that soil is disposed of properly and any spills promptly cleaned Record roll-off bin number in field book when soil is put in to bin ***See Waste Management section below***												
	Decontamination			10 Ensure each piece of downhole drilling equipment has been decontaminated per the SOW prior to its use at a new location ***See Decontamination and Demobilization section below***												
5	**Installation of Wellheads and Piping**															
	Subtask: ISTT component installation			1 Check required ISTT components for installation at each borehole against design Verify construction of ISTT components is to specification												
	Erosion			2 Ensure that erosion control has been established per SWPPP												
	Pre-final and Final Inspections			3 Conduct Pre-Final and Final Inspections												
	As- Built Drawing			4 Document deviations from work plan												
6	**Installation of Electrical Conduits**															
	Subtask: ISTT component installation			1 Check required ISTT components for installation against design Verify construction of ISTT components is to specification												
	Pre-final and Final Inspections			2 Conduct Pre-Final and Final Inspections												
	As- Built Drawing			3 Document deviations from work plan												
7	**Installation of Equipment Compound and Treatment and Power Delivery Systems**															
	Subtask: ISTT component installation			1 Check required ISTT components for installation against design Verify construction of ISTT components is to specification												
	Pre-final and Final Inspections			2 Conduct Pre-Final and Final Inspections												
	As- Built Drawing			3 Document deviations from work plan												
	Start Up Verification			4 • Electrical hazard evaluation • Uniform power delivery • Leak testing • Blower operation												

CH2MHILL Constructors, Inc.

Critical Quality Control and Inspection Log

DATE OF REPORT	mm/dd/yyyy:	
REVISION NO	#	
REVISION DATE	mm/dd/yyyy:	

PROJECT NO: 424578 **PROJECT NAME:** CP OU1 Central Groundwater Plume ZVI PRB Pilot Study

Inspection Description

DFOW No.	Definable Feature of Work	Technical Spec Section(s)	Article No.	Critical Review / Inspection Activities (list review/inspection REQUIREMENTS for QC)	Submittal Required (Y/N)	Description of Required Submittal	Submittal Approved (Y/N)	AHA Prepared & Submitted	Preliminary Work Completed (Y/N)	Testing / Sampling (Y/N)	Critical Photographs (Y/N)	Performed By (Printed Name)	Performed By (Signature)	Date(s) Performed:	Daily Inspection Report No.(s)	COMMENTS (Include Area Inspected)
8	**Interior Construction**															
	Subtask: Air Knifing			1 • Verify design depth and diameter has been achieved • Verify that disposed material placement is carried out according to plans and specifications												
	ISTT component installation			2 Verify specific ISTT component designed for borehole and secure proper equipment for installation Consult SOW during ISTT componet installation to ensure proper placement of component, sand, bentonite, grout, etc. ***See Installation of Wellheads and Piping section below***												
	Securing open borehole, as necessary			3 Secure open borehole per SOW if connection to ISTT system is not made immediately												
	Raised Floor Construction			4 Verfy floor construction is completed according to plan and document deviations												
	As-Built Drawings			5 Complete As-Built drawing for each borehole/installed ISTT component, include all pertinent information including type of sand, bentonite, grout, etc., installation depths and volume/amount used ***See Installation of Wellheads and Piping section below***												
	IDW- soil			6 Ensure that soil is disposed of properly and any spills promptly cleaned Record roll-off bin number in field book when soil is put in to bin ***See Waste Management section below***												
	Decontamination			7 Ensure each piece of downhole drilling equipment has been decontaminated per the SOW prior to its use at a new location ***See Decontamination and Demobilization section below***												
9	**Waste Management**															
	Subtask: Health and Safety Requirements			1 • Ensure that all H&S related requirements, trainings, and certifications are current, including manifest signing if applicable • Ensure that all other H&S-related protocols for ACM /LBP demolition debris management are followed, as necessary • Ensure that proper PPE is used as required • Ensure that air monitoring is carried out as required whenever applicable												
	Bin arrival			2 Inspect roll-off bins for debris/waste and check integrity of latches, doors, etc. Record roll-off size, individual bin number and delivery date in field book or waste tracking data sheet Inspect covers and securing mechanism for rips, tears, holes prior to delivery driver leaving site												
	IDW Storage			3 Verify inside of roll-off is lined with polyethylene sheeting prior to placing waste into bin Monitor amount of IDW in each bin, do not fill bin more than half full (10 cu. yds) Cover roll-off bin when not in use Ensure roll-off is labeled with "Non-Hazardous Waste" label and remove any old/incorrect labels Clean up any spills immediately												
	IDW Sample Collection			4 Collect **one** sample for shipment to an analytical lab for every 100 cu yds (every tenth roll-off)												
	Waste Hauling			5 Ensure control number has been received from hauler and is applicable to current load Fill out manifest *EXACTLY* as in example, *ONLY* FTL or trained designee may sign waste manifests												
10	**Decontamination and Demobilization**															
	Subtask: Housekeeping and Site Restoration			1 Inspect work areas to ensure all temporary facilities, equipment and materials are safely removed from the site												
	Decontamination			2 Ensure equipment, tools, and machinery exposed to contamination is decontaminated before demobilization												
	Housekeeping and Site Restoration			3 Verify all debris removed and restoration complete												
	Equipment Removed			4 Verify all supplies and equipment removed												
	Document Archiving			5 • Drop hard copy of document archives at ABQ office to DM (Elaine Cotter) • Compile as-built drawings • Submit the archives log to PM, PQM and Document Manager • Compile all project files- Photos and Log, RFIs, Daily Reports, Submittals, Inspection Reports, Change Orders, As-Built Drawings												

SUBMITTAL REVIEW COMMENTS

CH2MHILL

DATE: ____________________ **PROJECT:** ____________________

SUBMITTAL NO.: ____________________ **PROJECT NO.:** ____________________

SPEC SECTION: ____________________ **REVIEWER NAME:** ____________________

DESCRIPTION: ____________________ **PAGE:** ____________________

SUBMITTAL TYPE: ☐**SHOP DRAWING** ☐**SAMPLE** ☐**INFORMATION**

☐ 1. APPROVED	☐ 4. REVISE & RESUBMIT - Resubmittal required
☐ 2. APPROVED AS NOTED	☐ 5. NOT SUBJECT TO REVIEW
☐ 3. PARTIAL APPROVAL – RESUBMIT AS NOTED Resubmittal required	

NO.	COMMENT	RELATED SPEC PARA./ DRAWING #

REV 03/02
Form 299SR

CH2MHILL

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: ____________________

TO: ______________________________
____
____
____
____

Submittal No.: ____________________

☐ New Submittal ☐ Resubmittal

Project: ____________________

Project No.: ____________________

Specification Section No.: ____________________

(Cover only one section with each transmittal)

FROM: ______________________________
Contractor
____
____
____

Schedule Date of Submittal: ____________________

SUBMITTAL TYPE: ☐ Shop Drawing ☐ Sample ☐ Informational

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

CONTRACTOR hereby certifies that (i) CONTRACTOR has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: ______________________________
CONTRACTOR (Authorized Signature)

Appendix D
Health and Safety Plan

Health and Safety Plan

OU1 Pilot Study

MCAS Cherry Point, North Carolina

Contract No. N62470-11-D-8012
Contract Task Order No. WE10

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Atlantic

May 2012

CH2MHILL

11301 Carmel Commons Blvd
Suie 304
Charlotte, NC 28226

Contents

ATTACHMENTS

Approval

This site-specific Health and Safety Plan (HSP) has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions and identified scope(s) of work and must be amended if those conditions or scope(s) of work change.

By approving this HSP, the Responsible Health and Safety Manager (RHSM) certifies that the personal protective equipment has been selected based on the project-specific hazard assessment.

Original Plan

RHSM Approval: Carl Woods **Date**: 2/28/2012

Field Operations Manager Approval: **Date:**

Revisions

Revisions Made By: **Date:**

Description of Revisions to Plan:

Revisions Approved By: **Date:**

1.0 Introduction

CH2MHILL

HSSE
TargetZero

Health, Safety, Security and Environment Policy

Protection of people and the environment is a CH2M HILL core value. It is our vision to create a culture within CH2M HILL that empowers employees to drive this value into all global operations and achieve excellence in health, safety, security and environment (HSSE) performance. CH2M HILL deploys an integrated, enterprise-wide behavior based HSSE management system to fulfill our mission and the expectations of our clients, staff, and communities based on the following principles:

- We require all management and supervisory personnel to provide the leadership and resources to inspire and empower our employees to take responsibility for their actions of their fellow employees to create a safety, healthy, secure and environmentally-responsible workplace.
- We provide value to clients by tailoring HSSE processes to customer needs and requiring all CH2M HILL employees and subcontractors to delivery projects with agility, personal service, and responsiveness and in compliance with HSSE requirements and company standards to achieve health, safety, and security and pollution prevention excellence. Our performance will aspire to influence others and continually redefine world-class HSSE excellence.
- We systematically evaluate our design engineering and physical work environment to verify safe and secure work conditions and practices are established, consistently followed, and timely corrected.
- We continually assess and improve our HSSE program to achieve and maintain world-class performance by setting and reviewing objectives and targets, reporting performance metrics, and routinely reviewing our program.
- We care about the safety and security of every CH2M HILL employee and expect all employees to embrace our culture, share our core value for the protection of people and the environment, understand their obligations, actively participate, take responsibility, and "walk the talk" on and off the job.

The undersigned pledge our leadership, commitment, and accountability for making this policy a reality at CH2M HILL.

Dated the 29th date of March, 2011.

Lee McIntire
Chief Executive Officer

John Madia
Chief Human Resources Officer

Mike Lucki
Chief Financial Officer

Margaret McLean
Chief Legal Officer

Mike McKelvy
President, Government, Environment, & Nuclear Division

Bob Card
President, Energy & Water Division

Jacqueline Rast
President, Facilities & Infrastructure Division

Fred Brune
President, International Division

Gene Lupia
President, Delivery Excellence

Keith Christopher
Senior Vice President, Health, Safety, Security and Environment

1.1 CH2M HILL Policy and Commitment

1.1.1 Safe Work Policy

It is the policy of CH2M HILL to perform work in the safest manner possible. Safety must never be compromised. To fulfill the requirements of this policy, an organized and effective safety program must be carried out at each location where work is performed.

CH2M HILL believes that all injuries are preventable, and we are dedicated to the goal of a safe work environment. To achieve this goal, every employee on the project must assume responsibility for safety.

Every employee is empowered to:

- Conduct their work in a safe manner;
- Stop work immediately to correct any unsafe condition that is encountered; and
- Take corrective actions so that work may proceed in a safe manner.

Safety, occupational health, and environmental protection will not be sacrificed for production. These elements are integrated into quality control, cost reduction, and job performance, and are crucial to our success.

1.1.2 Health and Safety Commitment

CH2M HILL has embraced a philosophy for health and safety excellence. The primary driving force behind this commitment to health and safety is simple: employees are CH2M HILL's most significant asset and CH2M HILL management values their safety, health, and welfare. Also, top management believes that all injuries are preventable. CH2M HILL's safety culture empowers employees at all levels to accept ownership for safety and take whatever actions are necessary to eliminate injury. Our company is committed to world-class performance in health and safety and also understands that world-class performance in health and safety is a critical element in overall business success.

CH2M HILL is committed to the prevention of personal injuries, occupational illnesses, and damage to equipment and property in all of its operations; to the protection of the general public whenever it comes in contact with the Company's work; and to the prevention of pollution and environmental degradation.

Company management, field supervisors, and employees plan safety into each work task in order to prevent occupational injuries and illnesses. The ultimate success of CH2M HILL's safety program depends on the full cooperation and participation of each employee.

CH2M HILL management extends its full commitment to health and safety excellence.

1.1.3 Project-Specific Health, Safety, and the Environment Goals

All management and employees are to strive to meet the project-specific Health, Safety, and the Environment (HSE) goals outlined below. The team will be successful only if everyone makes a concerted effort to accomplish these goals. The goals allow the project to stay focused on optimizing the health and safety of all project personnel and, therefore, making the project a great success.

The Project has established eleven specific goals and objectives:

- Create an injury-free environment;
- Have zero injuries or incidents;
- Provide management leadership for HSE by communicating performance expectations, reviewing and tracking performance, and leading by example;

- Ensure effective implementation of the HSP through education, delegation, and team work;
- Ensure 100 percent participation in HSE compliance;
- Continuously improve our safety performance;
- Maintain free and open lines of communication;
- Make a personal commitment to safety as a value;
- Focus safety improvements on high-risk groups;
- Continue strong employee involvement initiatives; and
- Achieve health and safety excellence.

2.0 Applicability

This HSP applies to:

- All CH2M HILL staff, including subcontractors and tiered subcontractors of CH2M HILL working on the site; and
- All visitors to the construction site in the custody of CH2M HILL (including visitors from the Client, the Government, the public, and other staff of any CH2M HILL company).

This HSP does not apply to the third-party contractors, their workers, their subcontractors, their visitors, or any other persons not under the direct control or custody of CH2M HILL.

This HSP defines the procedures and requirements for the health and safety of CH2M HILL staff and visitors when they are physically on the work site. The work site includes the project area (as defined by the contract documents) and the project offices, trailers, and facilities thereon.

This HSP will be kept onsite during field activities and will be reviewed as necessary. The HSP will be amended or revised as project activities or conditions change or when supplemental information becomes available. The HSP adopts, by reference, the Enterprise-wide Core Standards and Standard Operating Procedures (SOPs), as appropriate. In addition, the HSP may adopt procedures from the project Work Plan and any governing regulations. If there is a contradiction between this HSP and any governing regulation, the more stringent and protective requirement shall apply.

All CH2M HILL staff and subcontractors must sign the employee sign-off form included in this document as Attachment 1 to acknowledge review of this document. Copies of the signature page will be maintained onsite by the Safety Coordinator (SC).

3.0 General Project Information

3.1 Project Information and Background

Project Number: 424578

Client: Department of the Navy, NAVFAC Mid-Atlantic 424578

Project/Site Name: MCAS Cherry Point, Operable Unit 1, Site 16

Site Address: MCAS Cherry Point, North Carolina

CH2M HILL Project Manager: Keri Hallberg/CLT

CH2M HILL Office: Charlotte

DATE HSP Prepared: February 4, 2012

Date(s) of Site Work: March 2012 – June 2014

3.2 Site Background and Setting

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 Naval Aviation Depot [NADEP]), Combat Service Support Detachment 21 of the Second Force Service Support 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. In 1943, a massive aircraft assembly and repair facility (FRCE) was added. Hazardous wastes have been generated through historical aircraft assembly and maintenance operations since that time. These wastes have included plating wastes, organic solvents, paint removers and cleaners, oils and lubricants, waste petroleum, and polychlorinated biphenyls (PCBs).

OU1

OU1 is an industrial area approximately 565 acres in size, 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 flightline and runway to the northeast and southeast, and East Prong Slocum Creek to the southwest. This project will be conducted in the southwest portion of the site nearest to Slocum Creek.

See **Site Map** for work area.

3.3 Description of Tasks

All CH2M HILL and Subcontractor employees engaging in hazardous waste operations (HAZWOPER) or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65 (or if required by Subcontract). Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities. See the following tasks that fall under HAZWOPER requirements.

3.3.1 HAZWOPER-Regulated Tasks

- Installation of a 600′ long, 2′ wide and 45′ deep Zero Valent Iron (ZVI) Permeable Reactive Barrier (PRB) using a One Pass Trencher.
- Installation and development of 15 new monitoring wells using sonic drilling
    - 7 wells to 30 ft
    - 7 wells to 50 ft
    - 1 well to 75 ft
- Collecting groundwater samples from the 15 new monitoring wells at baseline, 3 months, 6 months, 9 months, 12 months, and 24 months after installation.
- IDW management
- PID field screening
- Soil Dewatering
- Groundwater Sampling/Monitoring
- Hand Augering
- Investigation-derived waste (drum) sampling and disposal
- Observation of material loading for offsite disposal

3.3.2 Non-HAZWOPER-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of federal or state Hazwoper regulations are not applicable. The following tasks do not involve exposure to safety or health hazards associated with the hazardous waste operations. Hazwoper training or medical requirements do not apply for the tasks listed below.

Tasks	Controls
• Delivery and staging of source materials (sand & iron) • Site Clearing • Waste removal/hauling • Utility Location • Surveying	• Brief on hazards, limits of access, and emergency procedures. • Post areas of contamination as appropriate. • Perform air sampling/monitoring as specified in this HSP.

Site Map

Note locations of Support, Decontamination, and Exclusion Zones; site telephone; first aid station; evacuation routes; and assembly areas.

4.0 Project Organization and Responsibilities

4.1 Client

Contact Name: Will Potter
Phone: (252) 466-5376
Facility Contact Name: Nicole Cowand
Phone: (757) 322-4768

4.2 CH2M HILL

4.2.1 Project Manager

PM Name: Keri Hallberg
CH2M HILL Office: CLT
Telephone Number: 704-543-3260
Cellular Number: 704-975-9381

The project manager (PM) is responsible for providing adequate resources (budget and staff) for project-specific implementation of the HSE management process. The PM has overall management responsibility for the tasks listed below. The PM may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this document:

- Incorporate standard terms and conditions, and contract-specific HSE roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).
- Select safe and competent subcontractors by:
  - Choosing potential subcontractors based on technical ability and HSE performance;
  - Implementing the subcontractor prequalification process;
  - Ensuring that acceptable certificates of insurance, including CH2M HILL as named additional insured, are secured as a condition of subcontract award; and
  - Ensuring HSE submittals, subcontract agreements, and appropriate site-specific safety procedures are in place and accepted prior field mobilization.
- Ensure copies of training and medical monitoring records, and site-specific safety procedures are being maintained in the project file accessible to site personnel.
- Provide oversight of subcontractor HSE practices per the site-specific safety plans and procedures.
- Manage the site and interfacing with 3rd parties in a manner consistent with the contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented.
- Provide visible support and motivation for HSE programs, rules, procedures, processes, and training, leading by example and encouraging CH2M HILL employees to take ownership of HSE issues.
- Intervene or stop work when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition is encountered.
- Make available to and require CH2M HILL employees to complete required HSE training within established timelines and provide project numbers for such training.

- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites.
- Promptly report all work-related HSE incidents or near misses.
- Wear any required personal protective equipment.
- Ensure CH2M HILL employees complete required HSE training within established timelines.
- Conduct, cooperate, or assist with HSE incident investigations.
- Consult with the Human Resources Delivery Partner before taking any disciplinary action (other than verbal counseling) associated with CH2M HILL Policy 203 and/or HSE programs rules, procedures, processes and training.

4.2.2 CH2M HILL Responsible Health and Safety Manager

RHSM Name: Carl Woods CH2M HILL Office: CIN Telephone Number: 513-889-5771 Cellular Number:513-319-5771

The RHSM is responsible for the following:

- Review and evaluate subcontractor HSE performance using the pre-qualification process;
- Approve HSP and its revisions as well as Activity Hazard Analyses (AHA);
- Review and evaluate subcontractor site-specific safety procedures for adequacy prior to start of subcontractor's field operations;
- Support the oversight (or SC's direct oversight) of subcontractor and tiered subcontractor HSE practices;
- Permit upgrades and downgrades in respiratory protection after reviewing analytical data;
- Conduct audits as determined by project schedule and coordination with PM; and
- Participate in incident investigations, lessons learned, loss and near loss reporting.

4.2.3 CH2M HILL Project Environmental Manager

EM Name: Hope Wilson CH2M HILL Office: ATL Telephone Number: 678-530-4226 Cellular Number: 678-656-5411

The Project EM is responsible for the following:

- Provide environmental program support in areas such as training, auditing, planning, permit tracking, and subcontractor oversight as needed or as specified in the project environmental plan;
- Review and evaluate qualifications for subcontractors with a history of environmental non-compliance and for waste transportation and disposal subcontractors;
- Evaluate any spills, releases, or environmental permit incidents for appropriate follow-up actions, notifications, and recordkeeping requirements; and
- Provide environmental compliance and environmental management expertise and advice to the project team as needed during the course of the project.

4.2.4 CH2M HILL Safety Coordinator

SC Name: Gerald Couch CH2M HILL Office: ATL Telephone Number: 678-530-4077 Cellular Number: 678-488-8837

The SC is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify this HSP is current and amended when project activities or conditions change;
- Verify CH2M HILL site personnel and subcontractor personnel read the HSP and sign the Employee Sign-Off Form, prior to commencing field activities;
- Verify CH2M HILL site personnel have completed any required specialty training (for example, fall protection, confined space entry, among others) and medical surveillance as identified in this HSP;
- Verify that project files include copies of subcontractor training and medical monitoring records, and accepted site-specific safety procedures prior to start of subcontractor's field operations;
- Act as the project "Hazard Communication Coordinator" and perform the responsibilities outlined in the HSP;
- Act as the project "Emergency Response Coordinator" and perform the responsibilities outlined in the HSP;
- Post the Occupational Safety and Health Administration (OSHA) job-site poster; the poster is required at sites where project field offices, trailers, or equipment-storage boxes are established. If you work in a state with an OSHA State Plan, make sure the State Plan poster is posted, if required;
- Hold and/or verify that safety meetings are conducted and documented in the project file initially and as needed throughout the course of the project (as tasks or hazards change);
- Verify that project health and safety forms and permits are being used as outlined this HSP;
- Perform oversight and assessments of subcontractor HSE practices per the site-specific safety plan and verify that project activity self-assessment checklists are being used as outlined this HSP;
- Coordinate with the RHSM regarding CH2M HILL and subcontractor operational performance, and 3rd party interfaces;
- Verify appropriate personal protective equipment (PPE) use, availability, and training;
- Ensure that the overall, job-specific, HSE goals are fully and continuously implemented;
- Conduct accident investigations including root cause analysis;
- Calibrate and conduct air monitoring in accordance with the HSP; maintain all air monitoring records in project file;
- Maintain HSE records and documentation;
- Facilitate OSHA or other government agency inspections including accompanying inspector and providing all necessary documentation and follow-up;
- Deliver field HSE training as needed based on project-specific hazards and activities;
- Consistently and even-handedly enforce HSE rules, procedures, and requirements at the office and/or on project work sites;
- Wear any required personal protective equipment;

- Conduct, cooperate, or assist with HSE incident investigations;
- Contact the PM and RHSM when standards of conduct or CH2M HILL Policy 203 has been violated by a CH2M HILL employee;
- Contact the RHSM and PM in the event of an incident;
- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, stop affected work until adequate corrective measures are implemented, and notify the PM and RHSM as appropriate; and
- Document all oral health and safety-related communications in project field logbook, daily reports, or other records.

4.3 CH2M HILL Subcontractors

(Reference CH2M HILL SOP HSE-215, *Contracts and Subcontracts)*

Subcontractor - Trenching: DeWind One Pass Trenching LLC Subcontractor Contact Name: Greg DeWind Telephone: 616-875-7580
Subcontractor - Drilling: TBD Subcontractor Contact Name: Telephone:
Subcontractor – Utility Locate and Survey: ECLS Subcontractor Contact Name: G.Darrell Taylor Telephone: 910-897-3257

Subcontractors must comply with the following activities, and are responsible to:

- Comply with all local, state, and federal safety standards;
- Comply with project and owner safety requirements;
- Actively participate in the project safety program and either hold or attend and participate in all required safety meetings;
- Provide a qualified safety representative to interface with CH2M HILL;
- Maintain safety equipment and PPE for their employees;
- Maintain and replace safety protection systems damaged or removed by the subcontractor's operations;
- Notify the SC of any accident, injury, or incident (including spills or releases) immediately and submit reports to CH2M HILL within 24 hours;
- Install contractually required general conditions for safety (for example, handrail, fencing, fall protection systems, floor opening covers);
- Conduct and document weekly safety inspections of project-specific tasks and associated work areas;
- Conduct site-specific and job-specific training for all subcontractor employees, including review of the CH2M HILL HSP, subcontractor HSPs, and subcontractor AHAs and sign appropriate sign-off forms; and
- Determine and implement necessary controls and corrective actions to correct unsafe conditions.

The subcontractors listed above may be required to submit their own site-specific HSP and other plans such as lead or asbestos abatement compliance plans. Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit their plans to CH2M HILL for review and acceptance before the start of field work.

Subcontractors are also required to prepare AHAs before beginning each activity posing hazards to their personnel. The AHA shall identify the principle steps of the activity, potential health and safety hazards for each step and recommended control measures for each identified hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements, and training requirements for the safe operation of the equipment listed must be identified.

4.4 Employee Responsibilities

All personnel are assigned responsibility for safe and healthy operations. This concept is the foundation for involving all employees in identifying hazards and providing solutions. For any operation, individuals have full authority to stop work and initiate immediate corrective action or control. In addition, each worker has a right and responsibility to report unsafe conditions or practices. This right represents a significant facet of worker empowerment and program ownership. Through shared values and a belief that all accidents are preventable, our employees accept personal responsibility for working safely.

Each employee is responsible for the following performance objectives:

- Understanding and abiding by CH2M HILL and client HSE programs, rules, procedures, processes, and training, including any that are project-specific;
- Completing all required HSE training made available and accessible within established timelines;
- Always wearing any required personal protective equipment;
- Intervening or stopping work for you or other CH2M HILL employees when an unsafe condition or behavior is encountered or observed, and/or when an environmentally compromising condition exists;
- Promptly notifying a supervisor, PM, SC, or RHSM when an unsafe condition or behavior is observed, and/or when an environmentally compromising condition exists;
- Promptly reporting a supervisor, PM, SC, or RHSM all work-related health, safety , and environmental incidents or near misses;
- Attending required project HSE pre-task briefings and meeting prior to performing work; and
- Cooperating or assisting with HSE incident investigations.

4.4.1 Employee Authority

Each employee on the project has the obligation and authority to shut down any perceived unsafe work and during employee orientation, each employee will be informed of their authority to do so.

4.5 Client Contractors

(Reference CH2M HILL SOP HSE-215, *Contracts, Subcontracts and HSE Management Practices*)

Contractor: N/A Contact Name: Telephone: Contractor Task(s): Contractor: Contact Name: Telephone: Contractor Task(s):

This HSP does not cover contractors that are contracted directly to the client or the owner. CH2M HILL is not responsible for the health and safety or means and methods of the contractor's work, and we must never assume such responsibility through our actions (such as advising on health and safety issues). In addition to these instructions, CH2M HILL team members should review contractor safety plans so that we remain aware of appropriate precautions that apply to us. Self-assessment checklists are to be used by the SC and CH2M HILL team members to review the contractor's performance only as it pertains to evaluating CH2M HILL exposure and safety. The RHSM is the only person who is authorized to comment on or approve contractor safety procedures.

Health and safety-related communications with contractors should be conducted as follows:

- Request the contractor to brief CH2M HILL team members on the precautions related to the contractor's work;
- When an apparent contractor non-compliance or unsafe condition or practice poses a risk to CH2M HILL team members:
  - Notify the contractor safety representative;
  - Request that the contractor determine and implement corrective actions;
  - If necessary, stop affected CH2M HILL work until contractor corrects the condition or practice; and
  - Notify the client, PM, and RHSM as appropriate.

If apparent contractor non-compliance or unsafe conditions or practices are observed, inform the contractor safety representative (CH2M HILL's obligation is limited strictly to informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

If an apparent imminent danger is observed, immediately warn the contractor employee(s) in danger and notify the contractor safety representative (CH2M HILL's obligation is limited strictly to immediately warning the affected individual(s) and informing the contractor of the observation; the contractor is solely responsible for determining and implementing necessary controls and corrective actions).

All verbal health and safety-related communications will be documented in project field logbook, daily reports, or other records.

5.0 Standards of Conduct

All individuals associated with this project must work injury-free and drug-free and must comply with the following standards of conduct, the HSP, and the safety requirements of CH2M HILL. Commonly accepted standards of conduct help maintain good relationships between people. They promote responsibility and self-development. Misunderstandings, frictions, and disciplinary action can be avoided by refraining from thoughtless or wrongful acts.

5.1 Standards of Conduct Violations

All individuals associated with this project are expected to behave in a professional manner. Violations of the standards of conduct would include, but not be limited to:

- Failure to perform work;
- Inefficient performance, incompetence, or neglect of work;
- Willful refusal to perform work as directed (insubordination);
- Negligence in observing safety regulations, poor housekeeping, or failure to report on-the-job injuries or unsafe conditions;
- Unexcused or excessive absence or tardiness;
- Unwillingness or inability to work in harmony with others;
- Discourtesy, irritation, friction, or other conduct that creates disharmony;
- Harassment or discrimination against another individual;
- Failure to be prepared for work by wearing the appropriate construction clothing or bringing the necessary tools; or
- Violation of any other commonly accepted reasonable rule of responsible personal conduct.

5.2 Disciplinary Actions

The Environmental Services (ES) business group employees, employees working on ES business group projects, and subcontractor employees are subject to disciplinary action for not following HSE rules and requirements. Potential disciplinary action is equally applicable to all employees including management and supervision. Disciplinary action may include denial of access to the worksite, warnings, reprimands, and other actions up to and including termination depending on the specific circumstances.

5.3 Subcontractor Safety Performance

CH2M HILL should continuously endeavor to observe subcontractors' safety performance and adherence to their plans and AHAs. This endeavor should be reasonable, and include observing for hazards or unsafe practices that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s).

5.3.1 Observed Hazard Form

When apparent non-compliance or unsafe conditions or practices are observed, notify the subcontractor's supervisor or safety representative verbally, and document using the Observed Hazard Form, included as an attachment to this HSP, and require corrective action.

If necessary, stop subcontractor's work using the Stop Work Order Form until corrective actions is implemented for observed serious hazards or conditions. Update the Observed Hazard Form to document corrective actions have been taken. The subcontractor is responsible for determining and implementing necessary controls and corrective actions.

5.3.2 Stop Work Order

CH2M HILL has the authority, as specified in the contract, and the responsibility to stop work in the event any CH2M HILL employee observes unsafe conditions or failure of the subcontractor to adhere to its safe-work practices, or observes a condition or practice that may result in a release or violation of an environmental requirement. This authority and action does not in any way relieve the subcontractor of its responsibilities for the means and methods of the work or, therefore, of any corrective actions. Failure to comply with safe work practices can be the basis for restriction or removal of the subcontractor staff from the job site, termination of the subcontract, restriction from future work, or all three.

When an apparent imminent danger is observed, immediately stop work and alert all affected individuals. Remove all affected CH2M HILL employees and subcontractor staff from the danger, notify the subcontractor's supervisor or safety representative, and do not allow work to resume until adequate corrective measures are implemented. Notify the PM, Contract Administrator (KA) and RHSM.

When repeated non-compliance or unsafe conditions are observed, notify the subcontractor's supervisor or safety representative and stop affected work by completing and delivering the Stop Work Order Form (attached to this HSP) until adequate corrective measures are implemented. Consult the KA to determine what the contract dictates for actions to pursue in event of subcontractor non-compliance including work stoppage, back charges, progress payments, removal of subcontractor manager, monetary penalties, or termination of subcontractor for cause.

5.4 Incentive Program

Each project is encouraged to implement a safety incentive program that rewards workers for exhibiting exemplary safety behaviors. Actions that qualify are those that go above and beyond what is expected. Actions that will be rewarded include spotting and correcting a hazard, bringing a hazard to the attention of your foreman, telling your foreman about an incident, coming up with a safer way to get the work done, or stopping a crew member from doing something unsafe. The program will operate throughout the project, covering all workers. The incentive program will be communicated to all employees during the project employee orientation and project safety meetings.

5.5 Reporting Unsafe Conditions/Practices

Responsibility for effective health and safety management extends to all levels of the project and requires good communication between employees, supervisors, and management. Accident prevention requires a pro-active policy on near misses, close calls, unsafe conditions, and unsafe practices. All personnel must report any situation, practice, or condition which might jeopardize the safety of our projects. All unsafe conditions or unsafe practices will be corrected immediately. CH2M HILL has zero tolerance of unsafe conditions or unsafe practices.

No employee or supervisor will be disciplined for reporting unsafe conditions or practices. Individuals involved in reporting the unsafe conditions or practices will remain anonymous.

The following reporting procedures will be followed by all project employees:

- Upon detection of any unsafe condition or practice, the responsible employee will attempt to safely correct the condition;
- The unsafe condition or practice will be brought to the attention of the worker's direct supervisor, unless the unsafe condition or practice involves the employee's direct supervisor. If so, the SC needs to be notified at once by the responsible employee;
- Either the responsible employee or responsible employee's direct supervisor is responsible for immediately reporting the unsafe condition or practice to the SC;
- The SC will act promptly to correct the unsafe condition or practice; and
- Details of the incident or situation will be recorded by the SC in the field logbook or use the Observed Hazard Form if subcontractor was involved.

6.0 Safety Planning and Change Management

6.1 Daily Safety Meetings and Pre-Task Safety Plans

Daily safety meetings are to be held with all project personnel in attendance to review the hazards posed and required HSE procedures and AHAs that apply for each day's project activities. The Pre-Task Safety Plans (PTSPs) serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews.

At the start of each day's activities, the crew supervisor completes the PTSP, provided as an attachment to this HSP, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools and equipment that will be used to perform these tasks are listed, along with the hazards posed and required HSE procedures, as identified in the HSP and AHA. The use of PTSPs promotes worker participation in the hazard recognition and control process while reinforcing the task-specific hazard and required HSE procedures with the crew each day.

6.2 Change Management

This HSP addresses all known activities and associated hazards. As work progresses, if significant changes are identified which could affect health and safety at the site, coordinate with the RHSM to determine whether a HSP update is necessary.

The following are examples of changes that may require a revision to the plan:

- Change in CH2M HILL staff;
- New subcontractor to perform work;
- New chemicals brought to site for use;
- Change in scope or addition of new tasks;
- Change in contaminants of concern (COCs) or change in concentrations of COCs; and
- New hazards or hazards not previously identified that are not addressed in this HSP.

6.3 Agency Inspection Guidance

(Reference CH2M HILL SOP HSE-201, *Agency Inspections and Communications*)

Agency inspections (e.g., OSHA, EPA, other regulatory agencies) are on the rise. CH2M HILL implements safety and environmental programs in order to ensure safety to workers, the public, and the environment. This plan addresses things like labeling containers, completing the hazard communication training using the attachments to this HSP, listing training requirements and PPE requirements, and addressing project-specific hazards. Field personnel need to contact the RHSM to update this plan if hazards are encountered that are not addressed.

SOP HSE-201 addresses agency inspections in detail, and the attached **Target Zero Bulletin on Agency Inspections** provides a good summary of the inspection process and what to do if an agency such as OSHA or EPA shows up at the site. It is critical to make immediate notification to the RHSM if an inspector arrives (and EM if it is environmental-related); they can help facilitate and make additional notifications.

Review the Target Zero Bulletin and keep it with your Health and Safety Plan/Environmental Plan. Make it a topic at a safety meeting and keep it readily available in the event of an inspection.

7.0 Project Hazard Analysis

A health and safety risk analysis (Table 1) has been performed for each task. In the order listed below, the RHSM considers the various methods for mitigating the hazards. Employees are trained on this hierarchy of controls during their hazardous waste training and reminded of them throughout the execution of projects:

- Elimination of the hazards (use remote sampling methodology to avoid going into a confined space);
- Substitution (reduce exposure to vapors by using of a geoprobe instead of test pitting);
- Engineering controls (ventilate a confined space to improve air quality);
- Warnings (establish exclusion zones to keep untrained people away from hazardous waste work);
- Administrative controls (implement a work-rest schedule to reduce chance of heat stress); or
- Use of PPE (use of respirators when action levels are exceeded).

The hazard controls and safe work practices are summarized in the following sections of this HSP:

- General hazards and controls;
- Project-specific hazards and controls;
- Physical hazards and controls;
- Biological hazards and controls; and
- Contaminants of concern.

7.1 Activity Hazard Analysis

An AHA must be developed for each CH2M HILL job activity. The AHA shall define the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard. In addition, a listing of the equipment to be used to perform the activity, inspection requirements to be performed and training requirements for the safe operation of the equipment listed must be identified. Workers are briefed on the AHA before performing the work and their input is solicited prior, during, and after the performance of work to further identify the hazards posed and control measures required. The AHA shall identify the work tasks required to perform each activity, along with potential HSE hazards and recommended control measures for each hazard.

The following hazard controls and applicable CH2M HILL core standards and SOPs should be used as a basis for preparing AHAs.

AHAs prepared for CH2M HILL activities are included as an attachment to this HSP.

7.2 Subcontractor Activity Hazard Analysis

CH2M HILL subcontractors are required to provide AHAs specific to their scope of work on the project for acceptance by CH2M HILL. Each subcontractor shall submit AHAs for their field activities, as defined in their scope of work, along with their project-specific safety plan and procedures. Additions or changes in field activities, equipment, tools, or material used to perform work or hazards not addressed in existing AHAs requires either a new AHA to be prepared or an existing AHA to be revised.

Table 1 – General Activity Hazard Analysis

Potential Hazard	PRB Installation	Soil Dewatering	Sonic Drilling and well installation	Groundwater Monitoring	Surveying Utility locate	IDW drum sampling and disposal	Observation of loading material for offsite disposal	Hand augering
Benzene	X	X	X	X		X		X
Biological Hazards	X	X	X	X	X	X	X	X
Chemical Hazard-Dermal/Inhallation	X	X	X	X		X		X
Chemical Injections (remediation)	X							
Chlorinated VOCs	X	X	X	X		X		X
Compressed Gas Cylinders	X		X	X				
Drilling			X					X
Drum Handling		X	X			X		
Drum Sampling		X	X			X		
Earthmoving /Heavy Equipment	X	X	X					
Electrical Safety	X	X	X	X	X			X
Excavations	X							
Field Vehicles	X	X	X	X	X	X	X	X
Fire Prevention	X	X	X	X	X	X	X	X
Forklifts						X		
Groundwater Sampling				X				
Hand & Power Tools	X	X	X	X	X	X		X
Knife Use	X		X					
Lockout /Tagout	X	X	X					
Manual Lifting	X	X	X	X	X	X	X	X
Methylene Chloride	X	X	X	X		X		X
Noise	X	X	X	X	X	X	X	X
Pressurized Lines/ Equipment	X	X	X	X				X
Pressure Washing Equipment/ Decontamination	X	X	X					
Temperature Extremes	X	X	X	X	X	X	X	X
Traffic Control	X	X	X	X	X	X	X	X
Ultraviolet Light exposure (sunburn)	X	X	X	X	X	X	X	X
Utilities (underground/overhead)	X	X	X					X
Vinyl Chloride	X	X	X	X		X		X
Work Alone				X			X	

8.0 General Hazards and Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. It is a summarized list of requirements. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented.

8.1 Bloodborne Pathogens

(Reference CH2M HILL SOP HSE-202, *Bloodborne Pathogens*)

Exposure to bloodborne pathogens may occur when rendering first aid or cardiopulmonary resuscitation (CPR), or when coming into contact with landfill waste or waste streams containing potentially infectious material (PIM).

Employees trained in first-aid/CPR or those exposed to PIM must complete CH2M HILL's 1-hour bloodborne pathogens computer-based training module annually. When performing first-aid/CPR the following shall apply:

- Observe universal precautions to prevent contact with blood or other PIMs. Where differentiation between body fluid types is difficult or impossible, consider all body fluids to be potentially infectious materials;
- Always wash your hands and face with soap and running water after contacting PIMs. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes; and
- If necessary, decontaminate all potentially contaminated equipment and surfaces with chlorine bleach as soon as possible. Use one part chlorine bleach (5.25 percent sodium hypochlorite solution) diluted with 10 parts water for decontaminating equipment or surfaces after initially removing blood or other PIMs. Remove contaminated PPE as soon as possible before leaving a work area.

CH2M HILL will provide exposed employees with a confidential medical examination should an exposure to PIM occur. This examination includes the following procedures:

- Documenting the exposure;
- Testing the exposed employee's and the source individual's blood (with consent); and
- Administering post-exposure prophylaxis.

8.2 Chemical Storage

The following are general guidelines for storing chemicals and other hazardous materials:

- Keep acids away from bases;
- Keep oxidizers (nitric acid, nitrates, peroxides, chlorates) and organics away from inorganic reducing agents (metals);
- Keep flammables and corrosives in appropriate storage cabinets;
- Do not store paper or other combustibles near flammables;
- Use secondary containment and lipped shelving that is secured; and
- Have a fire suppression system available.

8.2.1 Storage of Flammable/Combustible Liquids

- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids.

- Approved safety cans shall be used for the handling and use of flammable liquids in quantities of 5 gallons (19 liters) or less. Do not use plastic gas cans.
- For quantities of 1 gallon (3.78 liters) or less, the original container may be used for storage and use of flammable liquids.
- Flammable or combustible liquids shall not be stored in areas used for stairways or normally used for the passage of people.

8.2.2 Indoor Storage of Flammable/Combustible Liquids

- No more than 25 gallons (95 liters) of flammable or combustible liquids shall be stored in a room outside of an approved storage cabinet.
- Quantities of flammable and combustible liquids in excess of 25 gallons (95 liters) shall be stored in an acceptable or approved cabinet.
- Cabinets shall be conspicuously lettered: "FLAMMABLE: KEEP FIRE AWAY."
- Not more than 60 gallons (228 liters) of flammable or 120 gallons (456 liters) of combustible liquids shall be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area.

8.2.3 Outside Storage of Flammable/Combustible Liquids

- Storage of containers (not more than 60 gallons [228 liters] each) shall not exceed 1,100 gallons (4180 liters) in any one area. No area shall be within 20 feet (6.1 meters) of any building.
- Storage areas shall be graded to divert spills away from buildings and surrounded by an earthen dike.
- Storage areas may not be located near a storm drain. Overflow and spills must be diverted away from storm drains or surface waters.
- Storage areas shall be free from weeds, debris, and other combustible materials.
- Outdoor portable tanks shall be provided with emergency vent devices and shall not be closer than 20 feet (6.1 meters) to any building.
- Signs indicating no smoking shall be posted around the storage area.

8.2.4 Storage of Hazardous Waste

- All facilities storing ignitable and combustible liquids and hazardous wastes must be designed, constructed, maintained, and operated to minimize the possibility of a fire, explosion, or any release of hazardous constituents.
- Flammable wastes should be stored more than 50 feet from the property line.

8.2.5 Storage of Chemical Injection Chemicals/Materials

When chemical injection remediation technologies are being used at a site, the following storage guidelines must be followed:

- Some injection chemicals, such as strong oxidizers, may have stringent storage requirements per local or National Fire Codes. Verify that appropriate storage provisions are in place prior to starting work.

  NOTE: Counties and cities may have requirements specific to storing these chemicals. Also, storage and use of certain chemicals such as potassium permanganate and hydrogen peroxide may be subject to the new Chemical Facility Anti-Terrorism Standards of the Department of Homeland Security – the applicability depends on the chemical, quantity/concentration, and type of facility.

Please contact the project Environmental Manager to determine whether chemicals are subject to these standards.

- Injection chemicals must be stored in a designated, secured area with spill prevention capabilities. Review MSDS or other information to determine potential incompatible materials. Incompatible materials shall not be stored together. Ensure all containers are labeled.

8.3 Driving Safety

Follow the guidelines below when operating a vehicle:

- Refrain from using a cellular phone while driving. Pull off the road, put the vehicle in park and turn on flashers before talking on a cellular phone;
- Never operate a personal digital assistant (PDA), or other device with e-mail, internet, or text messaging function while driving a vehicle;
- Obey speed limits; be aware of blind spots or other hazards associated with low visibility. Practice defensive driving techniques, such as leaving plenty of room between your vehicle and the one ahead of you;
- Do no drive while drowsy. Drowsiness can occur at any time, but is most likely after 18 hours or more without sleep;
- Maintain focus on driving. Eating, drinking, smoking, adjusting controls can divert attention from the road. Take the time to park and perform these tasks when parked rather than while driving; and
- Ensure vehicle drivers are familiar with the safe operation of vehicles of the type and size to be operated. Large vehicles such as full size vans and pick-ups have different vision challenges and handling characteristics than smaller vehicles.

8.4 Electrical Safety

(Reference CH2M HILL SOP HSE-206, *Electrical Safety*)

Below are the hazard controls and safe work practices to follow when using electrical tools, extension cords, and/or other electrical-powered equipment or when exposed to electrical hazards. Ensure the requirements of the referenced SOP are followed:

- Only qualified personnel are permitted to work on unprotected energized electrical systems;
- Only authorized personnel are permitted to enter high-voltage areas;
- CH2M HILL employees who might from time to time work in an environment influenced by the presence of electrical energy must complete Awareness Level Electrical Safety Training located on the CH2M HILL Virtual Office;
- Do not tamper with electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until lockout/tagout procedures are implemented;
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment, remove from service;
- CH2M HILL has selected Ground Fault Circuit Interrupters (GFCIs) as the standard method for protecting employees from the hazards associated with electric shock;
    - GFCIs shall be used on all 120-volt, single phase 15 and 20-amphere receptacle outlets which are not part of the permanent wiring of the building or structure.

- An assured equipment grounding conductor program may be required under the following scenarios:
  - GFCIs cannot be utilized;
  - Client requires such a program to be implemented; or
  - Business group decides to implement program in addition to GFCI protection.
- Extension cords must be equipped with third-wire grounding. Cords passing through work areas must be covered, elevated or protected from damage. Cords should not be routed through doorways unless protected from pinching. Cords should not be fastened with staples, hung from nails, or suspended with wire;
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved;
- Operate and maintain electric power tools and equipment according to manufacturers' instructions;
- Maintain safe clearance distances between overhead power lines and any electrical conducting material unless the power lines have been de-energized and grounded, or where insulating barriers have been installed to prevent physical contact. Maintain at least 10 feet (3 meters) from overhead power lines for voltages of 50 kV or less, and 10 feet (3 meters) plus 0.4 inches (1.0 cm) for every 1 kV over 50 kV;
- Temporary lights shall not be suspended by their electric cord unless designed for suspension. Lights shall be protected from accidental contact or breakage; and
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.

8.5 Field Vehicles

- Field vehicles may be personal vehicles, rental vehicles, fleet vehicles, or project vehicles.
- Maintain a first aid kit, bloodborne pathogen kit, and fire extinguisher in the field vehicle at all times.
- Utilize a rotary beacon on vehicle if working adjacent to active roadway.
- Familiarize yourself with rental vehicle features prior to operating the vehicle:
  - Vision Fields and Blind Spots
  - Vehicle Size
  - Mirror adjustments
  - Seat adjustments
  - Cruise control features, if offered
  - Pre-program radio stations and Global Positioning System (GPS), if equipped
- Always wear seatbelt while operating vehicle.
- Adjust headrest to proper position.
- Tie down loose items if utilizing a van or pick-up truck.
- Close car doors slowly and carefully. Fingers can get pinched in doors.
- Park vehicle in a location where it can be accessed easily in the event of an emergency. If not possible, carry a phone.
- Have a designated place for storing the field vehicle keys when not in use.

- Ensure back-up alarms are functioning, if equipped. Before backing a vehicle, take a walk around the vehicle to identify obstructions or hazards. Use a spotter when necessary to back into or out of an area.
- See the Vehicle Accident Guidance attached to this HSP, if a vehicle incident is experienced in a rental or fleet vehicle.

8.6 Fire Prevention

(Reference CH2M HILL SOP HSE-403, *Hazardous Material Handling*)

Follow the fire prevention and control procedures listed below.

8.6.1 Fire Extinguishers and General Fire Prevention Practices

- Fire extinguishers shall be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet (30.5 meters). When 5 gallons (19 liters) or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet (15.2 meters). Extinguishers must:
  - be maintained in a fully charged and operable condition;
  - be visually inspected each month; and
  - undergo a maintenance check each year.
- The area in front of extinguishers must be kept clear.
- Post “Exit” signs over exiting doors, and post “Fire Extinguisher” signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet (3 meters) from any building.
- Solvent waste and oily rags must be kept in a fire resistant, covered container until removed from the site.
- Keep areas neat. Housekeeping is important.

8.6.2 Dispensing of Flammable/Combustible Liquids

- Areas in which flammable or combustible liquids are dispensed in quantities greater than 5 gallons (22.7 liters) (shall be separated from other operations by at least 25 feet (7.6 meters).
- Drainage away from storm drains or surface waters or other means of containment shall be provided to control spills.
- Adequate natural or mechanical ventilation shall be provided to maintain the concentration of flammable vapor at or below 10 percent of the lower flammable limit.
- Dispensing of flammable liquids from one container to another shall be done only when containers are electrically interconnected (bonded).
- Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks is prohibited.
- Dispensing devices and nozzles for flammable liquids shall be of an approved type.

8.7 General Practices and Housekeeping

The following are general requirements applicable to all portions of the work:

- Site work should be performed during daylight hours whenever possible;
- Good housekeeping must be maintained at all times in all project work areas;

- Common paths of travel should be established and kept free from the accumulation of materials;
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions;
- Provide slip-resistant surfaces, ropes, or other devices to be used;
- Specific areas should be designated for the proper storage of materials;
- Tools, equipment, materials, and supplies shall be stored in an orderly manner;
- As work progresses, scrap and unessential materials must be neatly stored or removed from the work area;
- Containers should be provided for collecting trash and other debris and shall be removed at regular intervals;
- All spills shall be quickly cleaned up; oil and grease shall be cleaned from walking and working surfaces;
- Review the safety requirements of each job you are assigned to with your supervisor. You are not expected to perform a job that may result in injury or illness to yourself or to others;
- Familiarize yourself with, understand, and follow jobsite emergency procedures;
- Do not fight or horseplay while conducting the firm's business;
- Do not use or possess firearms or other weapons while conducting the firm's business;
- Report unsafe conditions or unsafe acts to your supervisor immediately;
- Report emergencies, occupational illnesses, injuries, vehicle accidents, and near misses immediately;
- Do not remove or make ineffective safeguards or safety devices attached to any piece of equipment;
- Report unsafe equipment, defective or frayed electrical cords, and unguarded machinery to your supervisor;
- Shut down and lock out machinery and equipment before cleaning, adjustment, or repair. Do not lubricate or repair moving parts of machinery while the parts are in motion;
- Do not run in the workplace;
- When ascending or descending stairways, use the handrail and take one step at a time;
- Do not apply compressed air to any person or clothing;
- Do not wear steel taps or shoes with metal exposed to the sole at any CH2M HILL project location;
- Do not wear finger rings, loose clothing, wristwatches, and other loose accessories when within arm's reach of moving machinery;
- Remove waste and debris from the workplace and dispose of in accordance with federal, state, and local regulations;
- Note the correct way to lift heavy objects (secure footing, firm grip, straight back, lift with legs), and get help if needed. Use mechanical lifting devices whenever possible; and
- Check the work area to determine what problems or hazards may exist.

8.8 Hazard Communication

(Reference CH2M HILL SOPs HSE-107, *Hazard Communication* and HSE-403, *Hazardous Material Handling*)

The hazard communication coordinator is to perform the following:

- Complete an inventory of chemicals brought on site by CH2M HILL using the chemical inventory form included as an attachment to this HSP;
- Confirm that an inventory of chemicals brought on site by CH2M HILL subcontractors is available;
- Request or confirm locations of material safety data sheets (MSDSs) from the client, contractors, and subcontractors for chemicals to which CH2M HILL employees potentially are exposed;
- Before or as the chemicals arrive on site, obtain an MSDS for each hazardous chemical and include on the chemical inventory sheet (attached to this HSP) and add the MSDS to the MSDS attachment section of this HSP;
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly;
- Give employees required chemical-specific HAZCOM training using the chemical-specific training form included as an attachment to this HSP; and
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

8.9 Knife Use

Open-bladed knives (for example, box cutters, utility knives, pocket knives, machetes, and multi-purpose tools with fixed blades such as a Leatherman™) are prohibited at worksites except where the following three conditions are met:

- The open-bladed knife is determined to be the best tool for the job;
- An approved Activity Hazard Analysis (AHA) or written procedure is in place that covers the necessary safety precautions (work practices, PPE, and training); and
- Knife users have been trained and follow the AHA.

8.10 Lighting

Lighting shall be evaluated when conducting work inside buildings, confined spaces, or other areas/instances where supplemental light may be needed (e.g., work before sunrise or after sunset). A light meter can be used to evaluate the adequacy of lighting. The following are common requirements for lighting and the conditions/type of work being performed:

- While work is in progress outside construction areas shall have at least 33 lux (lx);
- Construction work conducted inside buildings should be provided with at least 55 lux light;
- The means of egress shall be illuminated with emergency and non-emergency lighting to provide a minimum 11 lx measured at the floor. Egress illumination shall be arranged so that the failure of any single lighting unit, including the burning out of an electric bulb will not leave any area in total darkness.

8.11 Manual Lifting

(Reference CH2M HILL SOP HSE-112, *Manual Lifting*)

Back injuries are the leading cause of disabling work and most back injuries are the result of improper lifting techniques or overexertion. Use the following to mitigate the hazards associated with lifting:

- When possible, the task should be modified to minimize manual lifting hazards;
- Lifting of loads weighing more than 40 pounds (18 kilograms) shall be evaluated by the SC using the Lifting Evaluation Form contained in SOP HSE-112;
- Using mechanical lifting devices is the preferred means of lifting heavy objects such as forklifts; cranes, hoists, and rigging; hand trucks; and trolleys;
- Personnel shall seek assistance when performing manual lifting tasks that appear beyond their physical capabilities;
- In general, the following steps must be practiced when planning and performing manual lifts: Assess the situation before you lift; ensure good lifting and body positioning practices; ensure good carrying and setting down practices; and
- All CH2M HILL workers must have training in proper manual lifting training either through the New Employee Orientation or through Manual Lifting module located on the VO.

8.12 Personal Hygiene

Good hygiene is essential for personal health and to reduce the potential of cross-contamination when working on a hazardous waste site. Implement the following:

- Keep hands away from nose, mouth, and eyes during work;
- Keep areas of broken skin (chapped, burned, etc.) covered; and
- Wash hands with soap and water prior to eating, smoking, or applying cosmetics.

8.13 Shipping and Transportation of Hazardous Materials

(Reference CH2M HILL SOP HSE-417, *Hazardous Materials Transportation*)

The U.S. Department of Transportation (DOT) has specific regulations governing shipping of hazardous materials (also called dangerous goods). Chemicals brought to the site might be defined as hazardous materials by the U.S DOT. Hazardous wastes that may be shipped offsite are also defined as hazardous materials by U.S. DOT. Other wastes may also be U.S. DOT hazardous materials. To confirm whether a material or a waste is a U.S. DOT hazardous material, check with the ESBG Waste Coordinator (Lisa Schwan/ATL), the project EM, or the CH2M HILL Dangerous Goods Shipping Coordinators (John Blasco/BAO or Rob Strehlow/MKW).

All staff who affect shipment of hazardous materials, including receiving hazardous materials, preparing profiles or manifests, packaging hazardous wastes, labeling, or transporting hazardous materials by road, are called HazMat employees (note CH2M HILL cannot transport hazardous wastes by public road). HazMat employees must receive CH2M HILL online training in shipping dangerous goods. CH2M HILL's online Dangerous Goods Shipping course can be found on the CH2M HILL HSSE website.

All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. If the material is a product that is being shipped (e.g., calibration gas), use the HazMat ShipRight tool on the CH2M HILL virtual office (under Company Resources – Online Shipping). Contact the Dangerous Goods Shipping coordinators, the ESBG Waste Coordinator or the project EM for additional information.

49 CFR 172 requires that all hazmat employees be aware of potential transportation security concerns. Hazardous materials security is addressed in CH2M HILL's Hazardous Materials SOP (HSE-403). The following points are provided as an overview of security measures to increase awareness of this important matter:

- It is essential that each employee understand the security risks involved with transporting hazardous materials;
- All transporters of hazardous materials must be prequalified by a Contracts Administrator who evaluate the carrier's safety rating, security measures, and employee screening procedures;
- When shipping hazardous materials, check driver credentials and ask about shipping details;
- When receiving a hazardous materials shipment, inspect packages for signs of tampering or damage to the contents. Verify the drivers and company information on the form with the driver; and
- If there is suspicious or unusual behavior (e.g., driver without credentials, evasive answers) or any discrepancies identified, do not offer or accept the shipment, and immediately notify the project manager or the RHSM.

Employees responsible for shipping hazard materials must also review the CH2M HILL Transportation Security Plan (HSE-417 Appendix A).

8.14 Substance Abuse

(Reference CH2M HILL SOP HSE-105, *Drug-Free Workplace)*

Employees who work under the influence of controlled substances, drugs, or alcohol may prove to be dangerous or otherwise harmful to themselves, other employees, clients, the company, the company's assets and interests, or the public. CH2M HILL does not tolerate illegal drug use, or any use of drugs, controlled substances, or alcohol that impairs an employee's work performance or behavior.

Prohibitions onsite include:

- Use or possession of intoxicating beverages while performing CH2M HILL work;
- Abuse of prescription or nonprescription drugs;
- Use or possession of illegal drugs or drugs obtained illegally;
- Sale, purchase, or transfer of legal, illegal or illegally obtained drugs; and
- Arrival at work under the influence of legal or illegal drugs or alcohol.

Drug and/or alcohol testing is applicable under CH2M HILL Constructors, Inc. and munitions response projects performed in the United States. In addition, employees may be required to submit to drug and/or alcohol testing as required by clients. When required, this testing is performed in accordance with SOP HSE-105, Drug-Free Workplace. Employees who are enrolled in drug or alcohol testing are required to complete annual training located on the CH2M HILL Virtual Office (VO).

9.0 Project-Specific Hazard Controls

This section provides safe work practices and control measures used to reduce or eliminate potential hazards. These practices and controls are to be implemented by the party in control of either the work or the particular hazard. Each person onsite is required to abide by the hazard controls. Always consult the appropriate CH2M HILL SOP to ensure all requirements are implemented. CH2M HILL employees and subcontractors must remain aware of the hazards affecting them regardless of who is responsible for controlling the hazards. CH2M HILL employees and subcontractors who do not understand any of these provisions should contact the RHSM for clarification.

9.1 Benzene

(Reference CH2M HILL SOP HSE-503, *Benzene*)

Benzene is considered a "Confirmed Human Carcinogen." CH2M HILL is required to control employee workplace exposure to benzene when personal exposures is at or above 0.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the OSHA Benzene standard, 29 CFR 1910.1028. The elements of the CH2M HILL benzene program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of benzene and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Benzene);* and
- Record keeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person; and
- Review the fact sheet included as an attachment to this HSP.

9.2 Chemical Injections ("Chemical" ZVI PRB)

The remedial action objectives for this project will be facilitated via the subsurface injection of ZVI mixture via a custom fabricated, One Pass Trenching system. Where these chemical injection remediation technologies are engaged within the site target areas, the procedures and handling practices identified below must be implemented

Pre-Injection

1. Review the Material Safety Data Sheets (MSDSs) for the materials which are expected to be utilized in the chemical injection processes for this contract task order and:

   – Document training in accordance with the Hazard Communication section of this plan.
   – Ensure that appropriate spill response materials are present (e.g., absorbent media for oil, neutralizing agents for potassium permanganate, secondary containment for larger chemical tanks).

2. Evaluate potential for “daylighting”of chemical injection in the work area:

   – Evaluation should identify known or potential pathways such as existing monitoring wells screened at the same depth interval as the planned injection, wells that were not properly abandoned, and utility corridors.
   – Identify potential surface release areas such as nearby sensitive areas (e.g., wetlands) storm drains, ditches, or streams, and ensure that mitigation measures are in place (e.g., temporarily blocking storm sewer drains).
   – Contact the project Environmental Manager for assistance in identifying release scenarios and mitigation measures.

Operations

- For PPE and air monitoring requirements, refer to the PPE section and Site Monitoring section of this plan. PPE shall be used to minimize potential exposure to identified site contaminants of concern and injection solutions during site injection operations. In addition, good personal hygiene practices and procedures must be practiced.
- If repairs to the delivery system components are necessary after the PRB instllation operations have been initiated, the heavy equipment must be shut down before conducting repair work.
- Components must be stored in a designated, secured area with spill prevention capabilities. Review MSDS or other information to determine potential incompatible materials. Incompatible materials shall not be stored together.
- Only qualified personnel, by prior training or experience, may operate the heavy equipment components/array(s).
- Appropriate spill response materials for all chemicals must be present at the job site. Only qualified (by training and previous experience) who have proper PPE and equipment available shall provide spill response operations.
- Station a portable eye wash in the immediate work area where chemical injections are occurring, along with wash facilities for hygienic practices and PPE decontamination.
- If PPE becomes saturated and may potentially impact work clothing, dermal surfaces, or mucous membranes, change PPE immediately.
- Verify the competency and integrity of the heavy equipment utilized in the installation of the PRB.
- Remove/stow all unnecessary equipment and material in the area.
- Use face shields in combination with safety glasses or goggles when the potential for exposure to chemical splashes may exist.
- Wear appropriate PPE for materials used and when working around pressurized lines.

- All pressured lines and fittings should be 'tethered' or otherwise secured to minimize whipping or 'launching' of lines in the event of an equipment failure. Any "quick connect" type fittings (compressed air or fluid) should be secured with appropriate pins, clips to prevent accidental disengagement of the fitting during operation.
- Maintain site security to keep unauthorized personnel out of the operational area.

9.3 Compressed Gas Cylinders

(Reference CH2M HILL SOP HSE-403, *Hazardous Materials Handling*)

Below are the hazard controls and safe work practices to follow when working around or using compressed gas cylinders. Ensure the requirements in the referenced SOP are followed.

- Cylinders and pressure-controlling apparatus shall be inspected for defects and leakage prior to use. Damaged or defective items shall not be used. If a cylinder is found to be defective, the gas distributor shall be notified and subsequent instructions followed. If a leak should develop at a fuse plug or other safety device, the cylinder shall be removed from the work area.
- Cylinders shall be labeled with the identity of the contents. Cylinders not labeled shall be sent back to the cylinder distributor. The color of the cylinder shall not be used exclusively to identify cylinder contents.
- Valve caps must be in place when cylinders are transported, moved, or stored.
- Cylinders must be secured in an upright position at all times.
- Cylinder valves must be closed when cylinders are not being used and when cylinders are being moved.
- Cylinders must be secured on a cradle, basket, or pallet when hoisted; they may not be hoisted by choker slings.
- Eye protection (safety glasses or goggles) shall be worn when using cylinders.
- Cylinders must be shielded from welding and cutting operations and positioned to avoid being struck or knocked over; contacting electrical circuits; or exposed to extreme heat sources.
- Cylinders inside buildings shall be stored in dry, well-ventilated locations at least 20 feet (6.1 meters) from highly combustible materials. Cylinders should be stored in definitely assigned places away from elevators, stairs, or gangways. Assigned storage areas shall be located where cylinders will not be knocked over or damaged.
- Oxygen cylinders in storage shall be separated from fuel gas cylinders or combustible materials by a minimum of 20 feet (6.1 meters) or by a noncombustible barrier at least 5 feet (1.5 meters) high, having a fire resistance rating of at least 0.5 hour.
- Signs indicating no smoking shall be provided for storage areas containing flammable gas cylinders.
- Complete the self-assessment checklist for compressed gas cylinders are being used.

9.4 Drilling Safety

(Reference CH2M HILL SOP HSE-204, *Drilling*)

Below are the hazard controls and safe work practices to follow when working around or performing drilling. Ensure the requirements in the referenced SOP are followed.

- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the rig is properly leveled and stabilized before raising the mast.

- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. Maintain a minimum distance of 10 feet (3 meters) between mast and overhead lines (<50 kV) and an additional 0.4 inches for every 1 kV over 50kV. Verify the voltage of nearby overhead power lines to determine the minimum distance.
- If the project site is suspected of munitions or explosives of concern (MEC) contamination, requirements of the *Explosives Usage and Munitions Response (MR)* SOP HSE-610 shall be followed. MECs include unexploded ordnance (UXO), discarded military munitions, materials that present a potential explosive hazard, chemical warfare materials, munitions constituents, and contaminated soil or groundwater. "Down-hole" avoidance support may be required to prevent accidental contact with UXO. Safety requirements will be based on the risk assessment identified within the MR (safety) ORE (Opportunity Risk Evaluation).
- Personnel should stand clear before rig startup.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used (cable tool, air rotary, hollow-stem auger, etc.).
- Do not wear loose-fitting clothing, watches, etc., that could get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around the drill rig.
- The drill rig must be equipped with a kill wire or switch, and personnel are to be informed of its location.
- Be aware and stand clear of heavy objects that are hoisted overhead.
- The driller is to verify that the rig is properly maintained in accordance with the drilling company's maintenance program.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The driller is responsible for housekeeping (maintaining a clean work area).
- The drill rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig, and stay as far away as possible. Notify emergency personnel immediately.
- Use the drilling self-assessment checklist attached to this HSP to evaluate drilling operations.

9.5 Drum and Portable Tank Handling

Below are the hazard controls and safe work practices to follow when overseeing the movement of drums or when handling drums:

- Ensure that personnel are trained in proper lifting and moving techniques to prevent back injuries;
- Ensure drum or tank bungs and lids are secured and are labeled prior to moving;
- Ensure that drums and tanks remain covered except when removing or adding material or waste. Covers and/or lids will be properly secured at the end of each workday;
- Provide equipment to keep the operator removed from the drums to lessen the likelihood of injury. Such equipment might include: a drum grappler attached to a hydraulic excavator; a small front-end

loader, which can be either loaded manually or equipped with a bucket sling; a rough terrain forklift; Roller conveyor equipped with solid rollers; drum carts designed specifically for drum handling;

- Make sure the vehicle selected has sufficient rated load capacity to handle the anticipated loads, and make sure the vehicle can operate smoothly on the available road surface;
- Ensure there are appropriately designed Plexiglas cab shields on loaders, backhoes, etc., when handling drums containing potentially explosive materials;
- Equipment cabs should be supplied with fire extinguishers, and should be air-conditioned to increase operator efficiency;
- Supply operators with appropriate respiratory protective equipment when needed;
- Ensure that drums are secure and are not in the operator's view of the roadway;
- Prior to handling, all personnel should be warned about hazards of handling;
- Before moving anything, determine the most appropriate sequence in which the various drums, portable tanks, and other containers should be moved (e.g. small containers may have to be removed first to permit heavy equipment to enter and move the drums;
- Overpack drums and an adequate volume of absorbent should be kept near areas where minor spills may occur;
- Use containers or overpacks that are compatible with the waste or materials;
- Drums containing liquids or hazardous waste will be provided with secondary containment and may not be located near a storm water inlet or conveyance;
- Allow enough aisle space between drum pallets and between drums and other equipment that the drums can be easily accessed (at least 2 to 3 feet) by fire control equipment and similar equipment.; and
- Make sure that a spill kit is available in drum or tank storage areas (or where liquids are transferred from one vessel to another).

9.6 Drum Sampling Safety

Personnel are permitted to handle and/or sample drums containing certain types of waste (drilling waste, investigation-derived waste, and waste from known sources) only. Handling or sampling drums with unknown contents requires a plan revision or amendment approved by the RHSM. The following control measures will be taken when sampling drums:

- Minimize transportation of drums;
- Sample only labeled drums or drums from a known waste stream;
- Do not sample bulging or swollen drums. Contact the RHSM;
- If drums contain, or potentially contain, flammable materials, use non-sparking tools to open;
- Use the proper tools to open and seal drums;
- Reseal bung holes or plugs whenever possible;
- Avoid mixing incompatible drum contents;
- Sample drums without leaning over the drum opening;
- Transfer/sample the content of drums using a method that minimizes contact with material;

- Use the PPE and perform air monitoring as specified in the PPE and Site Monitoring sections of this HSP;
- Take precautions to prevent contaminated media from contacting the floor or ground, such as having plastic under the sampling area, having a spill kit accessible during sampling activities; and
- If transferring/sampling drums containing flammable or combustible liquids, drums and liquid transfer equipment should be grounded and bonded to reduce the potential of a static discharge.

9.7 Earthmoving Equipment (Heavy Equipment)

(Reference CH2M HILL, SOP HSE-306, *Earthmoving Equipment*)

Below are the hazard controls and safe work practices to follow when working around or operating heavy equipment. Ensure the requirements in the referenced SOP are followed.

- CH2M HILL authorizes only those employees qualified by training or previous experience to operate material handling equipment.
- CH2M HILL employees must be evaluated prior to operating earthmoving equipment by a CH2M HILL earthmoving equipment operator evaluation designated person. This evaluation will be documented according to SOP HSE-306, Earthmoving Equipment.
- Equipment must be checked at the beginning of each shift to ensure the equipment is in safe operating condition and free of apparent damage. The check should include: service brakes, parking brakes, emergency brakes, tires, horn, back-up alarm, steering mechanism, coupling devices, seat belts and operating controls. All defects shall be corrected before the equipment is placed in service. Documentation of this inspection must be maintained onsite at all times (use the Earthmoving Equipment Inspection form if operated by CH2M HILL).
- Equipment must be on a stable foundation such as solid ground or cribbing; outriggers are to be fully extended.
- Equipment must not be used to lift personnel; loads must not be lifted over the heads of personnel.
- Equipment, or parts thereof, which are suspended must be substantially blocked or cribbed to prevent shifting before personnel are permitted to work under or between them. All controls shall be in a neutral position, with the motors stopped and brakes set.
- Equipment which is operating in reverse must have a reverse signal alarm distinguishable from the surrounding noise or a signal person when the operators view is obstructed.
- When equipment is used near energized power lines, the closest part of the equipment must be at least 10 feet (3 meters) from the power lines less than 50 kilovolts (kV). Provide an additional 4 feet (1.2 meters) for every 10 kV over 50 kV. A person must be designated to observe clearances and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means. All overhead power lines must be considered to be an energized until the electrical utility authorities indicate that it is not an energized line and it has been visibly grounded.
- Underground utility lines must be located before excavation begins; refer to the Utilities (underground) section.
- Operators loading and unloading from vehicles are responsible for seeing that vehicle drivers are in the vehicle cab or in a safe area.
- The parking brake shall be set whenever equipment is parked; wheels must be chocked when parked on inclines.

- When not in operation, the blade or bucket must be blocked or grounded; the master clutch must be disengaged when the operator leaves the cab. When equipment is unattended, power must be shut off, brakes set, blades or buckets landed and shift lever in neutral.

9.8 Forklift Operations

(Reference CH2M HILL, SOP HSE-309, *Forklifts*)

Below are the hazard controls and safe work practices to follow when working around or operating forklifts. Ensure the requirements in the referenced SOP are followed.

- A rated lifting capacity must be posted in a location readily visible to the operator.
- A forklift truck must not be used to elevate employees unless a platform with guardrails, a back guard, and a kill switch is provided on the vehicle. When guardrails are not possible, fall arrest protection is required.
- The subcontractor operating the forklift must post and enforce a set of operating rules for forklift trucks.
- Only certified forklift operators shall operate forklifts.
- Stunt driving and horseplay are prohibited.
- Employees must not ride on the forks.
- Employees must never be permitted under the forks (unless forks are blocked).
- The driver must inspect the forklift once a shift and document this inspection.
- The operator must look in the direction of travel and must not move the vehicle until all persons are clear of the vehicle.
- Forks must be carried as low as possible.
- The operator must lower the forks, shut off the engine, and set the brakes (or block the wheels) before leaving the forklift operator's position unless maintenance or safety inspections require the forklift to be running.
- Trucks must be blocked and have brakes set when forklifts are driven onto their beds.
- Extreme care must be taken when tilting elevated loads.
- Every forklift must have operable brakes capable of safely stopping it when fully loaded.
- Forklifts must have parking brakes and an operable horn.
- When the operator is exposed to possible falling objects, industrial trucks must be equipped with overhead protection (canopy).
- If using certified CH2M HILL forklift operators—forklifts must be inspected and documented daily using the forklift inspection form.

9.9 Groundwater Sampling/Water Level Measurements

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are performing groundwater sampling and/or water level measurements.

- Full coolers are heavy. Plan in advance to have two people available at the end of the sampling effort to load full coolers into vehicles. If two people won't be available use several smaller coolers instead of fewer large ones.

- Wear the appropriate PPE when sampling, including safety glasses, nitrile gloves, and steel toe boots (see PPE section of this HSP).
- Monitor headspace of wells prior to sampling to minimize any vapor inhalation (refer to the "Site Monitoring" section of this HSP).
- Use caution when opening well lids. Wells may contain poisonous spiders and hornet or wasp nests.
- Use the appropriate lifting procedures (see CH2M HILL SOP HSE-112) when unloading equipment and sampling at each well.
- Avoid sharp edges on well casings.
- If dermal contact occurs with groundwater or the acid used in sample preservation, immediately wash all affected skin thoroughly with soap and water.
- Avoid eating and drinking on site and during sampling.
- Use ear plugs during sampling if sampling involves a generator.
- Containerize all purge water and transport to the appropriate storage area.
- Use two people to transport full coolers/containers whenever possible. If two people are not available use a dolly to move coolers. If the coolers weigh more than 40 pounds Attachment 1 of the HSE-112, *Manual Lifting*, shall be completed by the SC. If the coolers weigh more than 50 pounds they should never be lifted by one person.

9.10 Hand and Power Tools

(Reference CH2M HILL, SOP HSE-210, *Hand and Power Tools*)

Below are the hazard controls and safe work practices to follow when personnel or subcontractors are using hand and power tools. Ensure the requirements in the referenced SOP are followed:

- Tools shall be inspected prior to use and damaged tools will be tagged and removed from service;
- Hand tools will be used for their intended use and operated in accordance with manufacturer's instructions and design limitations;
- Maintain all hand and power tools in a safe condition;
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool;
- Do not carry or lower a power tool by its cord or hose;
- Portable power tools will be plugged into GFCI protected outlets;
- Portable power tools will be Underwriters Laboratories (UL) listed and have a three-wire grounded plug or be double insulated;
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters);
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed;
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials;
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications;

- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.); and
- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

Machine Guarding

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, chains, pinch points or any other sources of mechanical injury.
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

9.11 Haul Trucks

Below are the hazard controls and safe work practices to follow when working around or operating haul trucks:

- Haul truck operators should be familiar with their equipment and inspect all equipment before use;
- Haul truck operators should ensure all persons are clear before operating truck or equipment. Before moving operators should sound horn or alarm, all equipment should be equipped with a working back up alarm;
- Haulage trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots;
- Employees should stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator;
- If possible minimize steep grades on haul roads;
- Where grades are steep provide signage indicating the actual grade as well as measures for a runaway truck;
- Trucks are to be operated within the manufacturer's recommendations (for example- retarder charts indicate the combination of loads, grades and speeds that should not be exceeded if the truck's retarder is to work properly – to ensure the truck does not descend grade at speeds greater than listed);
- Haul roads should be well lit, sufficiently wide (at least 50% of the width of the equipment on both sides of road) and equipped with reflectors to indicate access points;
- Haul roads should have adequate right-of-way signs indicating haul directions;
- Haul trucks will follow designated haul roads; and
- Haul trucks will comply with posted speed limits.

9.12 Lockout/Tagout Activities

(Reference CH2M HILL SOP HSE-310, *Lockout and Tagout*)

Lockout/tagout (LO/TO) shall be performed whenever service or maintenance is necessary on equipment that could cause injury to personnel from the unexpected equipment energizing or start-up or unexpected release of stored energy. Energy sources requiring lockout/tagout may include electrical, pneumatic, kinetic, and potential.

If work on energized electrical systems is necessary—contact the RHSM. Specific training and procedures are required to be followed before any work on energized electrical systems can be performed and are NOT covered in this section. Energized electrical work is defined as work performed **on or near** energized electrical systems or equipment with exposed components operating at 50 volts or greater. Working near energized live parts is any activity inside a Limited Approach Boundary (anywhere from 3.5 feet to 24 feet [1 meter 7.3 meters] depending on voltage). Examples of energized electrical work include using a voltmeter to troubleshoot electrical systems and changing out controllers.

When lockout/tagout is necessary to perform maintenance/repair of a system, all the requirements of SOP HSE-310, Lockout and Tagout, shall be met including the following bulleted items:

- When CH2M HILL controls the work, CH2M HILL must verify that subcontractors affected by the unexpected operation of equipment develop a written lockout/tagout program, provide training on lockout/tagout procedures and coordinate its program with other affected subcontractors. This may include compliance with the owner or facility lockout/tagout program.
- When CH2M HILL personnel are affected by the unexpected operation of equipment they must complete the electrical safety awareness module on the VO. Authorized personnel shall inform the affected personnel of the LO/TO. Affected personnel shall not tamper with LO/TO devices.
- Standard lockout/tagout procedures include the following six steps: 1) notify all personnel in the affected area of the lockout/tagout, 2) shut down the equipment using normal operating controls, 3) isolate all energy sources, 4) apply individual lock and tag to each energy isolating device, 5) relieve or restrain all potentially hazardous stored or residual energy, and 6) verify that isolation and deenergization of the equipment has been accomplished. Once verified that the equipment is at the zero energy state, work may begin.
- All safe guards must be put back in place, all affected personnel notified that lockout has been removed and controls positioned in the safe mode prior to lockout removal. Only the individual who applied the lock and tag may remove them.
- CH2M HILL authorized employees shall complete the LO/TO training module on the VO and either the electrical safety training module on the VO or 10-hour construction training. The authorized employee must also be trained and qualified on the system they are working on (e.g., qualified electrician for working on electrical components of a system).
- When equipment-specific LO/TO procedures are not available or when existing procedures are determined to be insufficient, CH2M HILL authorized employees shall also complete the Equipment-Specific LO/TO Procedure Development Form, provided as an attachment to this HSP, to create an equipment-specific lockout/tagout procedure.

9.13 Methylene Chloride

(Reference CH2M HILL SOP HSE-509, *Methylene Chloride*)

Methylene chloride has a faint, sweet odor which is not noticeable at dangerous concentrations. Methylene chloride is shipped as liquefied compressed gas and will cause frostbite on contact.

CH2M HILL is required to control employee workplace exposure to methylene chloride when personal exposures are at or above 12.5 parts per million (ppm) as an 8-hour time-weighted average (TWA) or above 125 ppm short-term exposure limit (STEL) by implementing a program that meets the requirements of the OSHA Methylene Chloride standard, 29 *Code of Federal Regulations* (CFR) 1910.1052. The elements of the CH2M HILL methylene chloride program include the following:

- Exposure monitoring;
- Methods of control, including personal protective equipment (PPE) and respirators;
- Medical surveillance;
- Training on hazards of methylene chloride and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Methylene Chloride)* and*;*
- Recordkeeping requirements.

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met;
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas;
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person;
- Appropriate **air-supplied respirators** must be used when methylene chloride exposures exceed PEL or STEL;
- Air supplied to respirators must meet Grade D breathing air requirements; and
- Review the fact sheet included as an attachment to this HSP.

9.14 Portable Generator Hazards

(Reference CH2M HILL SOP HSE-206, Electrical Safety)

- Portable generators are useful when temporary or remote electric power is needed, but they also can be hazardous. The primary hazards to avoid when using a generator are carbon monoxide (CO) poisoning from the toxic engine exhaust, electric shock or electrocution, and fire.
- NEVER use a generator indoors or in similar enclosed or partially-enclosed spaces. Generators can produce high levels of carbon monoxide (CO) very quickly. When you use a portable generator, remember that you cannot smell or see CO. Even if you can't smell exhaust fumes, you may still be exposed to CO.
- If you start to feel sick, dizzy, or weak while using a generator, get to fresh air RIGHT AWAY. DO NOT DELAY. The CO from generators can rapidly lead to full incapacitation and death.
- If you experience serious symptoms, get medical attention immediately. Inform project staff that CO poisoning is suspected. If you experienced symptoms while indoors have someone call the fire department to determine when it is safe to re-enter the building.
- Follow the instructions that come with your generator. Locate the unit outdoors and away from doors, windows, and vents that could allow CO to come indoors.
- Ensure the generator is grounded in accordance with the manufacturer's operation manual.

- Keep the generator dry and do not use in rain or wet conditions. To protect from moisture, operate it on a dry surface under an open, canopy-like structure. Dry your hands if wet before touching the generator.
- Plug appliances directly into the generator. Or, use a heavy duty, outdoor-rated extension cord that is rated (in watts or amps) at least equal to the sum of the connected appliance loads. Check that the entire cord is free of cuts or tears and that the plug has all three prongs, especially a grounding pin.
- Most generators come with Ground Fault Circuit Interrupters (GFCI). Test the GFCIs daily to determine whether they are working
- If the generator is not equipped with GFCI protected circuits plug a portable GFCI into the generator and plug appliances, tools and lights into the portable GFCI.
- Never store fuel near the generator or near any sources of ignition.
- Before refueling the generator, turn it off and let it cool down. Gasoline spilled on hot engine parts could ignite.

9.15 Pressure Line/Vessel Systems

- Operate and maintain pressure vessels, pumps and hosing in accordance with the manufacturer's recommendations.
- Do not exceed the rated pressure of the vessels and hosing of the system.
- The system must be provided with a pressure relief valve/controller that safely reduces the system pressure to within the system rated pressure.
- The pressure relief valve must be rated at no more than 110% the rated pressure of the system and must be tested at regular intervals.
- Each vessel must be equipped with a functioning pressure gauge to monitor pressure.

9.16 Pressure Washing Operations

Below are the hazard controls and safe work practices to follow when working around or performing pressure washing.

- Only trained, authorized personnel may operate the high-pressure washer.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm deadman trigger is fully operational
- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches (1.1 meter) from the trigger to the tip and utilize greater than 10 degree tips.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.

- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.
- Polycoated Tyvek or equivalent, 16-inch-high steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves will be worn, at a minimum.

9.17 Traffic Control

(Reference CH2M HILL SOP HSE-216, *Traffic Control*)

The following precautions must be taken when working around traffic, and in or near an area where traffic controls have been established by a sub contractor. Ensure the requirements in the referenced SOP are followed.

- Exercise caution when exiting traveled way or parking along street – avoid sudden stops, use flashers, etc.
- Park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so that it can serve as a barrier.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic related hazards and required controls – sun glare, rain, wind, flash flooding, limited sight-distance, hills, curves, guardrails, width of shoulder (i.e., breakdown lane), etc.
- Always remain aware of an escape route (e.g., behind an established barrier, parked vehicle, guardrail, etc).
- Always pay attention to moving traffic – never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from traffic, a "buddy system" should be used, where one worker is looking towards traffic.
- When working on highway projects, obtain a copy of the contractor's traffic control plan.
- Work area should be protected by a physical barrier – such as a K-rail or Jersey barrier.
- Review traffic control devices to ensure that they are adequate to protect your work area. Traffic control devices should: 1) convey a clear meaning, 2) command respect of road users, and 3) give adequate time for proper traffic response. The adequacy of these devices are dependent on limited sight distance, proximity to ramps or intersections, restrictive width, duration of job, and traffic volume, speed, and proximity.
- Either a barrier or shadow vehicle should be positioned a considerable distance ahead of the work area. The vehicle should be equipped with a flashing arrow sign and truck-mounted crash cushion (TMCC). All vehicles within 40 feet (12.2 meters) of traffic should have an orange flashing hazard light atop the vehicle.
- Except on highways, flaggers should be used when 1) two-way traffic is reduced to using one common lane, 2) driver visibility is impaired or limited, 3) project vehicles enter or exit traffic in an unexpected manner, or 4) the use of a flagger enhances established traffic warning systems.
- Lookouts should be used when physical barriers are not available or practical. The lookout continually watches approaching traffic for signs of erratic driver behavior and warns workers.

- Vehicles should be parked at least 40 feet (12.2 meters) away from the work zone and traffic. Minimize the amount of time that you will have your back to oncoming traffic.
- Traffic control training module on the VO shall be completed when CH2M HILL workers who work in and around roadways and who exposed to public vehicular traffic.

9.18 Utilities (underground)

An assessment for underground utilities must be conducted where there is a potential to contact underground utilities or similar subsurface obstructions during intrusive activities. Intrusive activities include excavation, trenching, drilling, hand augering, soil sampling, or similar activities.

The assessment must be conducted before any intrusive subsurface activity and must include at least the following elements:

1. A background and records assessment of known utilities or other subsurface obstructions.
2. Contacting and using the designated local utility locating service.
3. Conducting an independent field survey to identify, locate, and mark potential underground utilities or subsurface obstructions. *Note: This is independent of, and in addition to, any utility survey conducted by the designated local utility locating service above.*
4. A visual survey of the area to validate the chosen location.

When any of these steps identifies an underground utility within 5 feet (1.5 meters) of intrusive work, then non-aggressive means must be used to physically locate the utility before a drill rig, backhoe, excavator or other aggressive method is used.

Aggressive methods are never allowed within 2 feet of an identified high risk utility (see paragraph below).

Any deviation from these requirements must be approved by the Responsible HS Manager and the Project Manager.

Background and Records Assessment of Known Utilities

Identify any client- or location-specific permit and/or procedural requirements (e.g., dig permit or intrusive work permit) for subsurface activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Obtain available utility diagrams and/or as-built drawings for the facility.

Review locations of possible subsurface utilities including sanitary and storm sewers, electrical lines, water supply lines, natural gas lines, fuel tanks and lines, communication lines, lighting protection systems, etc. Note: Use caution in relying on as-built drawings as they are rarely 100 percent accurate.

Request that a facility contact with knowledge of utility locations review and approve proposed locations of intrusive work.

Designated Local Utility Locating Service

Contact your designated local utility locating service (e.g., Dig-Safe, Blue Stake, One Call) to identify and mark the location of utilities. Call 811 in the US or go to www.call811.com to identify the appropriate local service group. Contacting the local utility locating service is a legal requirement in most jurisdictions.

Independent Field Survey (Utility Locate)

The organization conducting the intrusive work (CH2M HILL or subcontractor) shall arrange for an independent field survey to identify, locate, and mark any potential subsurface utilities in the work area. This survey is in addition to any utility survey conducted by the designated local utility locating service.

The independent field survey provider shall determine the most appropriate instrumentation/technique or combinations of instrumentation/techniques to identify subsurface utilities based on their experience and expertise, types of utilities anticipated to be present, and specific site conditions.

A CH2M HILL or subcontractor representative must be present during the independent field survey to observe the utility locate and verify that the work area and utilities have been properly identified and marked. If there is any question that the survey was not performed adequately or the individual was not qualified, then arrangements must be made to obtain a qualified utility locate service to re-survey the area. Obtain documentation of the survey and clearances in writing and signed by the party conducting the clearance. Maintain all documentation in the project file.

If the site owner (military installation or client) can provide the independent field survey, CH2M HILL or the subcontractor shall ensure that the survey includes:

- Physically walking the area to verify the work location and identify, locate, and mark underground utility locations:
- Having qualified staff available and instrumentation to conduct the locate;
- Agreeing to document the survey and clearances in writing.
- Should any of the above criteria not be met, CH2M HILL or subcontractor must arrange for an alternate independent utility locate service to perform the survey.
- The markings from utility surveys must be protected and preserved until the markings are no longer required. If the utility location markings are destroyed or removed before intrusive work commences or is completed, the PM, SC, or designee must notify the independent utility locate service or the designated local utility locating service to resurvey and remark the area.

Visual Assessment before and during Intrusive Activities

Perform a "360 degree" assessment. Walk the area and inspect for utility-related items such as valve caps, previous linear cuts, patchwork in pavement, hydrants, manholes, utility vaults, drains, and vent risers in and around the dig area.

The visual survey shall include all surface landmarks, including manholes, previous liner cuts, patchwork in pavement, pad-mounted transformers, utility poles with risers, storm sewer drains, utility vaults, and fire hydrants.

If any unanticipated items are found, conduct further research before initiating intrusive activities and implement any actions needed to avoid striking the utility or obstruction.

Subsurface Activities within 5 feet of an Underground Utility or if there is Uncertainty

When aggressive intrusive activities will be conducted within 5 feet (1.5 meters) of an underground utility or when there is uncertainty about utility locations, locations must be physically verified by non-aggressive means such as air or water knifing, hand digging, or human powered hand augering. Non-conductive tools must be used if electrical hazards may be present. If intrusive activities are within 5 feet (1.5 meters) and parallel to a marked existing utility, the utility location must be exposed and verified by non-aggressive methods every 100 feet (30.5 meters). Check to see if the utility can be isolated during intrusive work.

Intrusive Activities within 2 feet of an Underground Utility

Use non-aggressive methods (hand digging, vacuum excavation, etc.) to perform intrusive activities within 2 feet of a high risk utility (i.e., a utility that cannot be de-energized or would cause significant impacts to repair/replace). Hazardous utilities shall be de-energized whenever possible.

Spotter

A spotter shall be used to monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon, presence of pea gravel or sand in soils, presence of concrete or other debris in soils, refusal of auger or excavating equipment). If any suspicious conditions are encountered stop work immediately and contact the PM or RHSM to evaluate the situation. The spotter must have a method to alert an operator to stop the intrusive activity (e.g., air horn, hand signals).

9.19 Utilities (overhead)

Proximity to Power Lines

No work is to be conducted within 50 feet (15.2 meters) of overhead power lines without first contacting the utility company to determine the voltage of the system. No aspect of any piece of equipment is to be operated within 50 feet (15.2 meters) of overhead power lines without first making this determination.

Operations adjacent to overhead power lines are PROHIBITED unless one of the following conditions is satisfied:

- Power has been shut off, positive means (such as lockout) have been taken to prevent the lines from being energized, lines have been tested to confirm the outage, and the utility company has provided a signed certification of the outage.
- The minimum clearance from energized overhead lines is as shown in the table below, or the equipment will be repositioned and blocked to ensure that no part, including cables, can come within the minimum clearances shown in the table.

MINIMUM DISTANCES FROM POWERLINES

Powerlines Nominal System Kv	Minimum Required Distance, Feet (Meters)
0-50	10 (3.0)
50-200	15 (4.6)
201-350	20 (6.1)
351-500	25 (7.6)
501-750	35 (10.7)
751-1000	45 (13.7)
Over 1000	Established by utility owner/operator or by a professional engineer in electrical power transmission/distribution

(These distances have been determined to eliminate the potential for arcing based on the line voltage.)

- The power line(s) has been isolated through the use of insulating blankets which have been properly placed by the utility. If insulating blankets are used, the utility will determine the minimum safe operating distance; get this determination in writing with the utility representative's signature.
- All inquiries regarding electric utilities must be made in writing and a written confirmation of the outage/isolation must be received by the PM prior to the start of work.

9.20 Vinyl Chloride

(Reference CH2M HILL, SOP HSE-512, *Vinyl Chloride*)

Vinyl Chloride is considered a "Confirmed Human Carcinogen." Vinyl Chloride has a mild, sweet, chloroform-like odor.

CH2M HILL is required to control employee workplace exposure to vinyl chloride when personal exposures are at or above 1.0 ppm as an 8-hour time-weighted average (TWA) or above 5.0 ppm short term exposure limit (STEL), by implementing a program that meets the requirements of the Occupational Safety and Health Administration (OSHA) Vinyl Chloride standard, 29 CFR 1910.1017. The elements of the CH2M HILL vinyl chloride program include the following:

- Exposure monitoring
- Methods of control, including personal protective equipment (PPE) and respirators
- Medical surveillance
- Training on hazards of vinyl chloride and control measures (includes project-specific training and the computer-based training on CH2M HILL's Virtual Office, *Vinyl Chloride)*
- Record keeping requirements

If air monitoring indicates there is potential exposure at the action level concentrations above, notify the RHSM to ensure the above have been adequately addressed. Other exposure control measures include:

- Do not enter regulated work areas unless training, medical monitoring, and PPE requirements established by the competent person have been met.
- Do not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in regulated areas.
- Respiratory protection and other exposure controls selection shall be based on the most recent exposure monitoring results obtained from the competent person.
- Review the fact sheet included as an attachment to this HSP.

9.21 Working Around Material Handling Equipment

When CH2M HILL personnel are exposed to material handling equipment, the following safe work practices/hazard controls shall be implemented:

- Never approach operating equipment from the rear. Always make positive contact with the operator, and confirm that the operator has stopped the motion of the equipment.
- Never approach the side of operating equipment; remain outside of the swing and turning radius.
- Maintain distance from pinch points of operating equipment.
- Never turn your back on any operating equipment.
- Never climb onto operating equipment or operate contractor/subcontractor equipment.
- Never ride contractor/subcontractor equipment unless it is designed to accommodate passengers and equipped with firmly attached passenger seat.

- Never work or walk under a suspended load.
- Never use equipment as a personnel lift; do not ride excavator buckets or crane hooks.
- Always stay alert and maintain a safe distance from operating equipment, especially equipment on cross slopes and unstable terrain.
- Wear a high visibility safety vest or high visibility clothing

9.22 Working Alone

(Reference CH2M HILL Core Standard, *Working Alone*)

Personnel can only be tasked to work alone by the Project Manager who shall assess potential hazards and appropriate control measures, with assistance from the Responsible Health and Safety Manager (RHSM).

"Lone workers" with an accountability system in place is permitted, depending on the hazards presented during the execution of the task. Reference the "Lone Worker Protocol" included as an attachment to this HSP.

Only limited operations task are permitted to be performed alone. Activities that are not permitted to be performed by a lone worker include the following:

- Working at heights (e.g., on ladders, lifts, scaffolding);
- Energy isolation (e.g., lockout/tagout);
- Any entry into a confined space; and
- Work involving electricity or other hazardous equipment (e.g., chainsaws);
- Work over or near water; and
- Working in an area where there is an increased potential for violence.

An AHA shall be developed that shall include:

- Type or nature of work to be conducted by the lone worker;
- Location of the work
- Length of time the worker will be working alone; and
- Any characteristics of the individual working alone which may increase the risk to the worker (e.g., medical conditions).

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at pre-determined times. For some work, a satellite-based communication system may be appropriate (i.e., a "SPOT" device).

Satellite-Based Communication System for Lone Worker Accountability

Call-In System for Lone Worker Accountability

The employee working alone shall at all times be equipped with a working voice communication device such as a cellular phone, satellite phone, personal alarms, or two-way radio to check-in to their project contact (s) at pre-determined times.

Each time before going into the field, the “Call in contact Form” attached to this HSP shall be completed by the lone worker and given to the call-in office worker contact prior to going into the field.

During field work, a copy of “The Lone Worker Call-In Contact Form” should be maintained by both the “Office Contact Worker” and the field-worker (“Lone Worker”). Lone Worker and Office Contact Worker must both have cell phones and each others’ phone number, plus one other alternate phone number.

Lone worker shall call the office contact worker when he/she has arrived on-site, before exiting his/her vehicle. On this phone call, a time shall be arranged for a “check-in” call to be made by the field worker, based on duration of task. On each “check-in” call a time should be arranged for the next “check-in” call. Document these times on the form.

Lone Worker shall carry his or her cell-phone throughout the field event and put the ringer on its loudest setting as wind or other noise can muffle the sound. If, for any reason the cell-phone becomes inoperable, the field-worker shall immediately stop work, leave the site and find an alternative method of contacting the Office Contact Worker to verify their safety and to inform them of the issue.

Work shall not proceed in the field until the Lone Worker has a working device that provides communication with the Office Contact Worker.

Upon completion of work activities, Lone Worker should pack up all materials and prepare to leave site. Then, before starting the engine of the vehicle to leave site, the Lone Worker should contact the office-worker and inform him or her that work is complete and that he or she is leaving the site. A final call shall be made by the lone work to the office worker to confirm he/she has reached their destination.

If at any time, the Office Contact Worker does not receive a “check-in” call at the scheduled time he/she should attempt to contact Lone Worker. If no contact is made then the Office Contact Worker should contact the facility contact person to check on the Lone Worker.

If no contact is made with the Lone Worker, then the Office Contact Worker shall contact the PM and/or RHSM to let them know they are going to inform emergency services inform that there is a possible emergency and instruct them to go to the field location and assist the Lone Worker. The Office Contact Worker will provide to emergency services the Lone Worker’s name, their last known location, vehicle description and their contact information.

Call in contact Form shall be completed by lone worker and given to call in contact prior to going into the field. Refer to the “Lone Worker Protocol” attached to this HSP.

10.0 Physical Hazards and Controls

Physical hazards include exposure to temperature extremes, sun, noise, and radiation. If you encounter a physical hazard that has not been identified in this plan, contact the RHSM so that a revision to this plan can be made.

10.1 Noise

(Reference CH2M HILL SOP HSE-108, *Hearing Conservation*)

CH2M HILL is required to control employee exposure to occupational noise levels of 85 decibels, A-weighted, (dBA) and above by implementing a hearing conservation program that meets the requirements of the OSHA Occupational Noise Exposure standard, 29 CFR 1910.95. A noise assessment may be conducted by the RHSM or designee based on potential to emit noise above 85 dBA and also considering the frequency and duration of the task.

- Areas or equipment emitting noise at or above 90dBA shall be evaluated to determine feasible engineering controls. When engineering controls are not feasible, administrative controls can be developed and appropriate hearing protection will be provided.
- Areas or equipment emitting noise levels at or above 85 dBA, hearing protection must be worn.
- Employees exposed to 85 dBA or a noise dose of 50% must participate in the Hearing Conservation program including initial and annual (as required) audiograms.
- The RHSM will evaluate appropriate controls measures and work practices for employees who have experienced a standard threshold shift (STS) in their hearing.
- Employees who are exposed at or above the action level of 85 dBA are required to complete the online Noise Training Module located on CH2M HILL's virtual office.
- Hearing protection will be maintained in a clean and reliable condition, inspected prior to use and after any occurrence to identify any deterioration or damage, and damaged or deteriorated hearing protection repaired or discarded.
- In work areas where actual or potential high noise levels are present at any time, hearing protection must be worn by employees working or walking through the area.
- Areas where tasks requiring hearing protection are taking place may become hearing protection required areas as long as that specific task is taking place.
- High noise areas requiring hearing protection should be posted or employees must be informed of the requirements in an equivalent manner and a copy of the OSHA standard 29 CFR 1910.95 shall be posted in the workplace.

10.2 Ultraviolet Radiation (sun exposure)

Health effects regarding ultraviolet (UV) radiation are confined to the skin and eyes. Overexposure can result in many skin conditions, including erythema (redness or sunburn), photoallergy (skin rash), phototoxicity (extreme sunburn acquired during short exposures to UV radiation while on certain medications), premature skin aging, and numerous types of skin cancer. Implement the following controls to avoid sunburn.

Limit Exposure Time

- Rotate staff so the same personnel are not exposed all of the time.

- Limit exposure time when UV radiation is at peak levels (approximately 2 hours before and after the sun is at its highest point in the sky).
- Avoid exposure to the sun, or take extra precautions when the UV index rating is high.

Provide Shade

- Take lunch and breaks in shaded areas.
- Create shade or shelter through the use of umbrellas, tents, and canopies.
- Fabrics such as canvas, sailcloth, awning material and synthetic shade cloth create good UV radiation protection.
- Check the UV protection of the materials before buying them. Seek protection levels of 95 percent or greater, and check the protection levels for different colors.

Clothing

- Reduce UV radiation damage by wearing proper clothing; for example, long sleeved shirts with collars, and long pants. The fabric should be closely woven and should not let light through.
- Head protection should be worn to protect the face, ears, and neck. Wide-brimmed hats with a neck flap or "Foreign Legion" style caps offer added protection.
- Wear UV-protective sunglasses or safety glasses. These should fit closely to the face. Wrap-around style glasses provide the best protection.

Sunscreen

- Apply sunscreen generously to all exposed skin surfaces at least 20 minutes before exposure, allowing time for it to adhere to the skin.
- Re-apply sunscreen at least every 2 hours, and more frequently when sweating or performing activities where sunscreen may be wiped off.
- Choose a sunscreen with a high sun protection factor (SPF). Most dermatologists advocate SPF 30 or higher for significant sun exposure.
- Waterproof sunscreens should be selected for use in or near water, and by those who perspire sufficiently to wash off non-waterproof products.
- Check for expiration dates, because most sunscreens are only good for about 3 years. Store in a cool place out of the sun.
- No sunscreen provides 100 percent protection against UV radiation. Other precautions must be taken to avoid overexposure.

10.3 Temperature Extremes

(Reference CH2M HILL SOP HSE-211, *Heat and Cold Stress*)

Each employee is responsible for the following:

- Recognizing the symptoms of heat or cold stress;
- Taking appropriate precautionary measures to minimize their risk of exposure to temperature extremes (see following sections); and
- Communicating any concerns regarding heat and cold stress to their supervisor or SC.

10.3.1 Heat

Heat-related illnesses are caused by more than just temperature and humidity factors.

Physical fitness influences a person's ability to perform work under heat loads. At a given level of work, the more fit a person is, the less the physiological strain, the lower the heart rate, the lower the body temperature (indicates less retrained body heat—a rise in internal temperature precipitates heat injury), and the more efficient the sweating mechanism.

Acclimatization is a gradual physiological adaptation that improves an individual's ability to tolerate heat stress. Acclimatization requires physical activity under heat-stress conditions similar to those anticipated for the work. With a recent history of heat-stress exposures of at least two continuous hours per day for 5 of the last 7 days to 10 of the last 14 days, a worker can be considered acclimatized. Its loss begins when the activity under those heat-stress conditions is discontinued, and a noticeable loss occurs after 4 days and may be completely lost in three to four weeks. Because acclimatization is to the level of the heat-stress exposure, a person will not be fully acclimatized to a sudden higher level; such as during a heat wave.

Dehydration reduces body water volume. This reduces the body's sweating capacity and directly affects its ability to dissipate excess heat.

The ability of a body to dissipate heat depends on the ratio of its surface area to its mass (surface area/weight). **Heat dissipation** is a function of surface area, while heat production depends on body mass. Therefore, overweight individuals (those with a low ratio) are more susceptible to heat-related illnesses because they produce more heat per unit of surface area than if they were thinner. Monitor these persons carefully if heat stress is likely.

When wearing **impermeable clothing**, the weight of an individual is not as important in determining the ability to dissipate excess heat because the primary heat dissipation mechanism, evaporation of sweat, is ineffective.

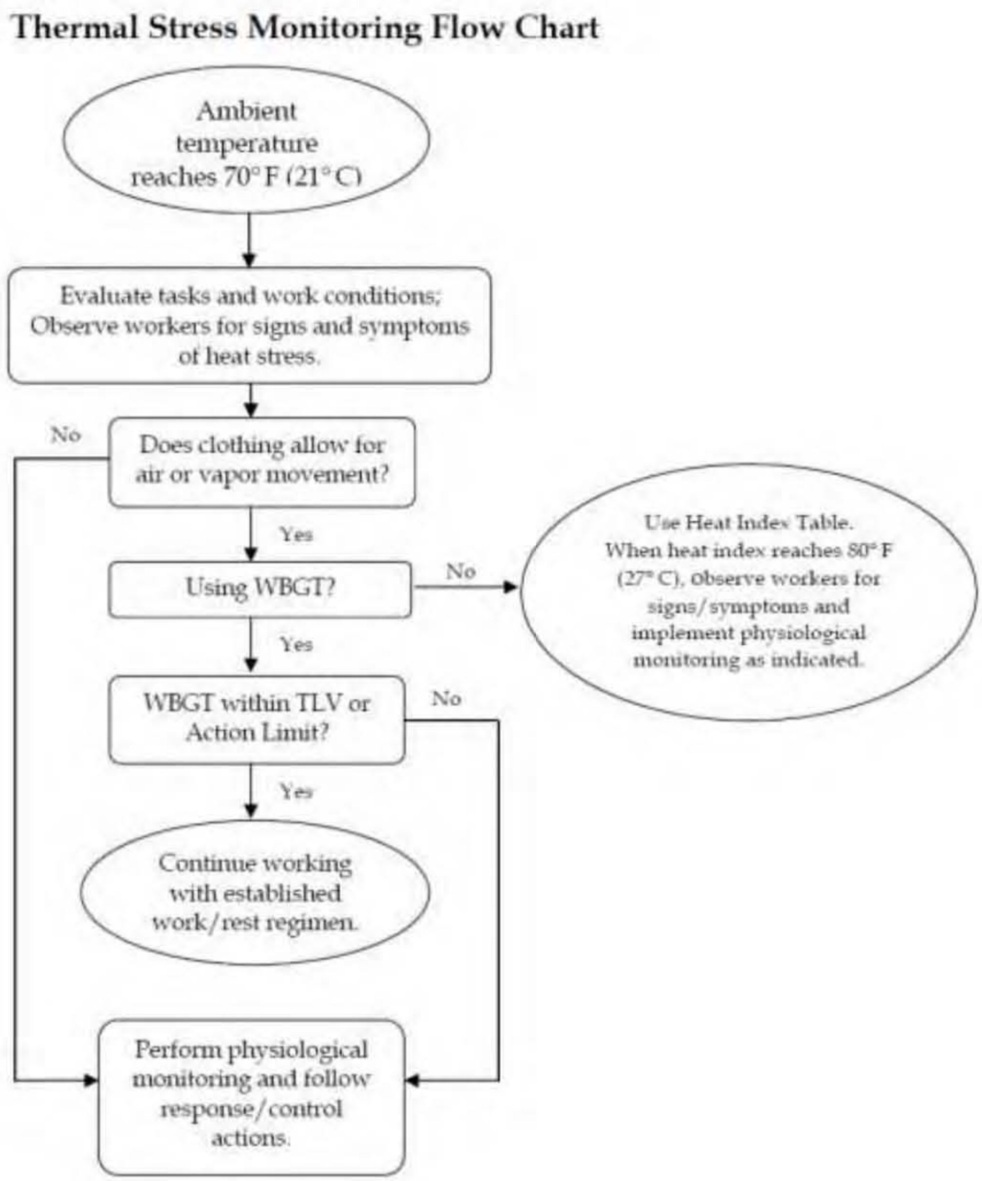
SYMPTOMS AND TREATMENT OF HEAT STRESS					
	Heat Syncope	**Heat Rash**	**Heat Cramps**	**Heat Exhaustion**	**Heat Stroke**
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

Precautions

- Drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50°Fahrenheit (10 degrees Celsius [C]) to 60°Fahrenheit (F) (15.6 degrees C) should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons (7.5 liters) per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.

- Acclimate yourself by slowly increasing workloads (do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Avoid direct sun whenever possible, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. PREVENTION and communication is key.

Thermal Stress Monitoring



Permeable Clothing – Monitoring Using WBGT

A Wet Bulb Globe Thermometer (WBGT) is the established and preferred means of measuring the environmental factors associated with heat stress and for providing indication of when physiological monitoring or rest regimens should be incorporated into the work schedule. The WBGT is the composite temperature used to estimate the effect of temperature, humidity, wind speed, and solar radiation on the human body.

When permeable work clothes are worn (street clothes or clothing ensembles over modesty clothes), physiological monitoring may be required based on the outcome of the WBGT measurements, taking into account the clothing adjustment factors. Use of the WBGT should generally begin when the heat index reaches 80° F (27° C) as indicated in the Heat Index Table below, or when workers exhibit symptoms of heat stress as indicated in Attachment 1.

If the WBGT is within the TLV (acclimatized workers) or Action Limit (unacclimatized workers) per the tables below, then work may continue while maintaining the established work/rest regimen. If the

WBGT reading meets or exceeds either the TLV or Action Level for a work/rest regimen of 15 minutes work and 45 minutes rest, then physiological monitoring will be implemented.

Screening Criteria for TLV and Action Limit for Heat Stress Exposure								
Allocation of work in a cycle of work and recovery	TLV (WBGT Values in ˚F/C˚) (Acclimatized Workers)				Action Limit (WBGT Values in ˚F/˚C˚) (Unacclimatized Workers)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75-100%	88/31	82/28	--	--	82/28	77/25	--	--
50-75%	88/31	84/29	82/28	--	83/29	79/26	75/24	--
25-50%	90/32	86/30	84/29	82/28	85/30	81/27	78/26	76/25
0-25%	91/33	89/32	87/31	86/30	86/30	84/29	82/28	81/27
Work Category Descriptions:								
Light	Sitting or standing with light manual work using hands or arms; occasional walking.							
Moderate	Sustained moderate hand, arm, and leg work; light pushing and pulling; normal walking.							
Heavy	Intense arm and trunk work, carrying, shoveling, manually sawing, pushing and pulling heavy loads, walking at a fast pace.							
Very Heavy	Very intense activity at fast to maximum pace.							
Notes: WBGT values are expressed to the nearest degree. "—"Dashes indicate the need for physiological monitoring because screening criteria are not recommended for this type of work.								

Clothing Adjustment Factors for Some Clothing Ensembles*	
Clothing Type	Addition to WBGT ˚F/˚C˚
Work Clothes (sleeved shirt and pants)	0/0
Cloth (woven material) coveralls	0/0
Double-layer woven clothing	5.4/3
Polypropylene coveralls	0.9/0.5
Limited Use Vapor barrier coveralls	19.8/11
* These values must not be used for completely encapsulating (impermeable) coveralls/suits. Coveralls assume that only modesty clothing is worn beneath.	

Thermal Stress Monitoring – Permeable or Impermeable Clothing

When permeable work clothes are worn (street clothes or clothing ensembles over street clothes), regularly observe workers for signs and symptoms of heat stress and implement physiological monitoring as indicated below. This should start when the heat index reaches 80° F (27° C) [see Heat Index Table below], or sooner if workers exhibit symptoms of heat stress indicated in the table above. These heat index values were devised for shady, light wind conditions; exposure to full sunshine can increase the values by up to 15°F (8°C). Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.

When wearing **impermeable clothing** (e.g., clothing doesn't allow for air or water vapor movement such as Tyvek), physiological monitoring as described below shall be conducted when the ambient temperature reaches 70° F (21° C) or at a lower temperature when workers begin to exhibit signs and symptoms of heat stress.

Heat Index	Possible Heat Disorders	Minimum Frequency of Physiological Monitoring
80°F - 90°F (27°C - 32°C)	Fatigue possible with prolonged exposure and/or physical activity	Observe Workers for signs of heat stress and implement physiological monitoring if warranted.
90°F - 105°F (32°C - 41°C)	Sunstroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity	Every 2 hours, or sooner, if signs of heat stress are observed.
105°F - 130°F (41°C - 54°C)	Sunstroke, heat cramps, or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity.	Every 60 minutes or sooner if signs of heat stress are observed.
130°F or Higher (54°C or Higher)	Heat/Sunstroke highly likely with continued exposure.	Every 30 minutes or sooner if signs of heat stress are observed.
Source: National Weather Service		

Physiological Monitoring and Associated Actions

The following physiological monitoring protocol below, using either radial pulse or aural temperature, will occur when the heat index is 80 degrees F or greater (or when personnel exhibit signs of heat stress), the following will be performed:

- The sustained heart rate during the work cycle should remain below 180 beats per minute (bpm) minus the individual's age (e.g. 180 – 35 year old person = 145 bpm). The sustained heart rate can be estimated by measuring the heart rate at the radial pulse for 30 seconds as quickly as possible prior to starting the rest period.
- The heart rate after one minute rest period should not exceed 120 beats per minute (bpm).
- If the heart rate is higher than 120 bpm, the next work period should be shortened by 33 percent, while the length of the rest period stays the same.
- If the pulse rate still exceeds 120 bpm at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent.
- Continue this procedure until the rate is maintained below 120 bpm.
- Alternately, the body temperature can be measured, either oral or aural (ear), before the workers have something to drink.
- If the oral or aural temperature exceeds 99.6° F (37.6 ° F) at the beginning of the rest period, the following work cycle should be shortened by 33 percent.
- Continue this procedure until the oral or aural (ear) temperature is maintained below 99.6 ° F (37.6° C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field, however, a digital aural (aural) thermometer is easy to obtain and inexpensive to purchase.
- Use the form attached to this HSP to track workers' measurements and actions taken.

Procedures for when Heat Illness Symptoms are Experienced

- **Always** contact the RHSM when any heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.

- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M HILL worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.
- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow precautions under the emergency medical treatment of this HSP.
- Follow the Incident Notification, Reporting, and Investigation section of this HSP.

10.3.2 Cold

General

Low ambient temperatures increase the heat lost from the body to the environment by radiation and convection. In cases where the worker is standing on frozen ground, the heat loss is also due to conduction.

Wet skin and clothing, whether because of water or perspiration, may conduct heat away from the body through evaporative heat loss and conduction. Thus, the body cools suddenly when chemical protective clothing is removed if the clothing underneath is perspiration soaked.

Movement of air across the skin reduces the insulating layer of still air just at the skin's surface. Reducing this insulating layer of air increases heat loss by convection.

Non-insulating materials in contact or near-contact with the skin, such as boots constructed with a metal toe or shank, conduct heat rapidly away from the body.

Certain common drugs, such as alcohol, caffeine, or nicotine, may exacerbate the effects of cold, especially on the extremities. These chemicals reduce the blood flow to peripheral parts of the body, which are already high-risk areas because of their large surface area to volume ratios. These substances may also aggravate an already hypothermic condition.

Precautions

- Be aware of the symptoms of cold-related disorders, and wear proper, layered clothing for the anticipated fieldwork. Appropriate rain gear is a must in wet weather.
- Consider monitoring the work conditions and adjusting the work schedule using guidelines developed by the U.S. Army (wind-chill index) and the National Safety Council (NSC).
- Wind-Chill Index (below) is used to estimate the combined effect of wind and low air temperatures on exposed skin. The wind-chill index does not take into account the body part that is exposed, the level of activity, or the amount or type of clothing worn. For those reasons, it should only be used as a guideline to warn workers when they are in a situation that can cause cold-related illnesses.
- Persons who experience initial signs of immersion foot, frostbite, and/or hypothermia should report it immediately to their supervisor/PM to avoid progression of cold-related illness.
- Observe one another for initial signs of cold-related disorders.
- Obtain and review weather forecast – be aware of predicted weather systems along with sudden drops in temperature, increase in winds, and precipitation.

SYMPTOMS AND TREATMENT OF COLD STRESS			
	Immersion (Trench) Foot	**Frostbite**	**Hypothermia**
Signs and Symptoms	Feet discolored and painful; infection and swelling present.	Blanched, white, waxy skin, but tissue resilient; tissue cold and pale.	Shivering, apathy, sleepiness; rapid drop in body temperature; glassy stare; slow pulse; slow respiration.
Treatment	Seek medical treatment immediately.	Remove victim to a warm place. Re-warm area quickly in warm–but **not** hot–water. Have victim drink warm fluids, but **not** coffee or alcohol. Do not break blisters. Elevate the injured area, and get medical attention.	Remove victim to a warm place. Have victim drink warm fluids, but **not** coffee or alcohol. Get medical attention.

Wind Chill Chart

Temperature (°F)

Wind (mph) / Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes / 10 minutes / 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

10.4 Radiological Hazards

Refer to CH2M HILL's Core Standard, Radiological Control and Radiological Controls Manual for additional requirements.

Hazards	Controls
None Known	None Required

11.0 Biological Hazards and Controls

Biological hazards are everywhere and change with the region and season. If you encounter a biological hazard that has not been identified in this plan, contact the RHSM so that a revision to this plan can be made. Whether it is contact with a poisonous plant, a poisonous snake, or a bug bite, do not take bites or stings lightly. If there is a chance of an allergic reaction or infection, or to seek medical advice on how to properly care for the injury, contact the occupational nurse at 1-866-893-2514.

11.1 Bees and Other Stinging Insects

Bees and other stinging insects may be encountered almost anywhere and may present a serious hazard, particularly to people who are allergic. Watch for and avoid nests. Keep exposed skin to a minimum. Carry a kit if you have had allergic reactions in the past, and inform your supervisor and/or a buddy. If you are stung, contact the occupational nurse at 1-866-893-2514. If a stinger is present, remove it as soon as possible using something with a thin, hard edge (e.g., credit card) to scrape the stinger out. Be sure to sanitize the object first with hand sanitizer, alcohol or soap and water. Wash and disinfect the wound, cover it, and apply ice. Watch for an allergic reaction if you have never been stung before. Call 911 if the reaction is severe.

11.2 Feral Dogs

Avoid all dogs – both leashed and stray. Do not disturb a dog while it is sleeping, eating, or caring for puppies. If a dog approaches to sniff you, stay still. An aggressive dog has a tight mouth, flattened ears and a direct stare. If you are threatened by a dog, remain calm, do not scream and avoid eye contact. If you say anything, speak calmly and firmly. Do not turn and run, try to stay still until the dog leaves, or back away slowly until the dog is out of sight or you have reached safety (e.g. vehicle). If attacked, retreat to vehicle or attempt to place something between you and the dog. If you fall or are knocked to the ground, curl into a ball with your hands over your head and neck and protect your face. If bitten, contact the occupational nurse at 1-866-893-2514. Report the incident to the local authorities.

11.3 Fire Ants

There are several types of fire ants in the United States that can cause painful bites and allergic reactions. Fire ants aggressively defend their nests by stinging several times after climbing on their victims. Large ant mounds are easily visible, but there can be smaller mounds or nests with little "worked" soil that can be stepped on inadvertently. They can also be under rocks, wood or other debris. Implement the following when fire ants are observed:

- Be aware of fire ants and take care not to stand on ant nests;
- Use insect repellents on clothing and footwear to temporarily discourage ants from climbing; and
- Tuck pants into socks.

If stung, get away from the area you are standing on, briskly brush off ants—wash affected area with soap. Call the occupational nurse.

11.4 Mosquito Bites

Due to the recent detection of the West Nile Virus in the southwestern United States it is recommended that preventative measures be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent:

- Stay indoors at dawn, dusk, and in the early evening;
- Wear long-sleeved shirts and long pants whenever you are outdoors;
- Spray clothing with repellents containing permethrin or N,N-diethyl-meta-toluamide (DEET) since mosquitoes may bite through thin clothing;
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35% DEET. Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands; and
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile Virus incubation period is from 3 to 15 days.

Contact the project RHSM with questions, and immediately report any suspicious symptoms to your supervisor, PM, and contact the occupational nurse at 1-866-893-2514.

11.5 Poison Ivy, Poison Oak, and Poison Sumac

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in spring and summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in fall, but plants lose its (yellowed, then brown) leaves in winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons. These plants contain urushiol a colorless or pale yellow oil that oozes from any cut or crushed part of the plant, including the roots, stems and leaves and causes allergic skin reactions when contacted. The oil is active year round.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

Contamination with poison ivy, sumac or oak can happen through several pathways, including:

- Direct skin contact with any part of the plant (even roots once above ground foliage has been removed).
- Contact with clothing that has been contaminated with the oil.
- Contact from removing shoes that have been contaminated (shoes are coated with urishol oil).
- Sitting in a vehicle that has become contaminated.
- Contact with any objects or tools that have become contaminated.
- Inhalation of particles generated by weed whacking, chipping, vegetation clearing.

If you must work on a site with poison ivy, sumac or oak the following precautions are necessary:

- Do not drive vehicles onto the site where it will come into contact with poison ivy, sumac or oak. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed as soon as possible after leaving the site.
- All tools used in the poison ivy, sumac or oak area, including those used to cut back poison oak, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated.
- Personal protective equipment, including Tyvek coveralls, gloves, and boot covers must be worn. PPE must be placed into plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- As soon as possible following the work, shower to remove any potential contamination. Any body part with suspected or actual exposure should be washed with Zanfel, Tecnu or other product designed for removing urishiol. If you do not have Zanfel or Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Tecnu may also be used to decontaminate equipment.
- Use IvyBlock or similar products to prevent poison oak, ivy and sumac contamination. Check with the closest CH2M HILL warehouse to see if these products are available. Follow all directions for application.

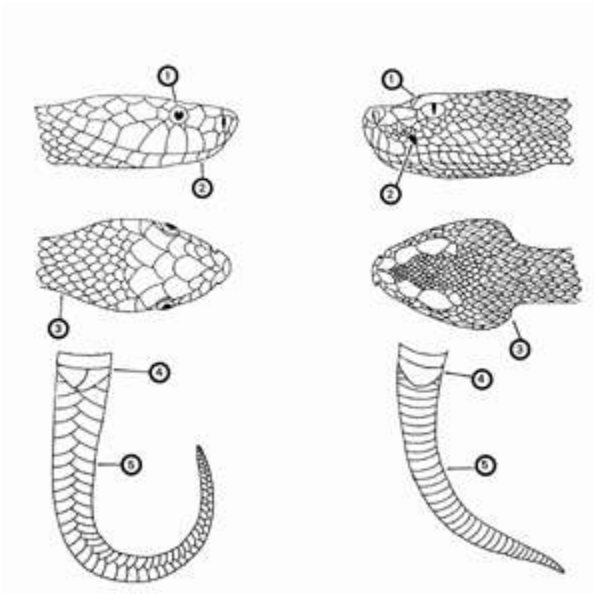
If you do come into contact with one of these poisonous plants and a reaction develops, contact your supervisor and the occupational nurse 1-866-893-2514.

11.6 Snakes

Snakes typically are found in underbrush and tall grassy areas. If you encounter a snake, stay calm and look around; there may be other snakes. Turn around and walk away on the same path you used to approach the area. If bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Call the occupational nurse at 1-866-893-2514 immediately. Do not apply ice, cut the wound, or apply a tourniquet. Try to identify the type of snake: note color, size, patterns, and markings. Below is a guide to identifying poisonous snakes from non-poisonous snakes.

Identification of Poisonous Snakes

Major Identification Features Non-venomous Snake	Major Identification Features Venomous Snake
1. Round pupils	1. Elliptical pupils
2. No sensing pit	2. Sensing pit between eye and nostril
3. Head slightly wider than neck	3. Head much wider than neck
4. Divided anal plate	4. Single anal plate
5. Double row of scales on the underside of the tail	5. Single scales on the underside of the tail



11.7 Spiders - Brown Recluse and Widow

The Brown Recluse spider can be found most anywhere in the United States. It varies in size in shape, but the distinguishing mark is the violin shape on its body. They are typically non-aggressive. Keep an eye out for irregular, pattern-less webs that sometimes appear almost tubular built in a protected area such as in a crevice or between two rocks. The spider will retreat to this area of the web when threatened.

The Black Widow, Red Widow and the Brown Widow are all poisonous. Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day.

Hazard Controls

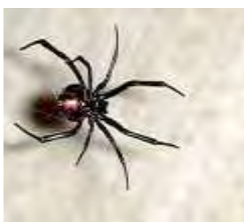
- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.

- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.
- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

If you think you have been bit by a poisonous spider, immediately call the occupational nurse at 1-866-893-2514 and follow the guidance below:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood;
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite;
- Elevate the bitten area, if possible;
- Do not apply a tourniquet, do not try to remove venom; and
- Try to positively identify the spider to confirm its type. If the spider has been killed, collect it in a plastic bag or jar for identification purposes. Do not try to capture a live spider—especially if you think it is a poisonous spider.

Black Widow | Red Widow | Brown Widow | Brown Recluse




If you are stung by a scorpion, call the occupational nurse 1-866-893-2514 and try to note the description of the scorpion. Cleanse the sting area and apply ice.

11.8 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch (6.4 mm) in size.

In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray only outside of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions (vegetation above knee height, tick endemic area) or when tasks (having to sit or kneel in vegetation) diminish the effectiveness of the other controls mentioned above, bug-out suits (check with your local or regional warehouse) or Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Avoid habitats where possible, reduce the abundance through habitat disruption or application of acracide. If these controls aren't feasible, contact your local or regional warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet attached to this HSP for further precautions and controls to implement when ticks are present. If bitten by a tick, follow the removal procedures found in the tick fact sheet, and call the occupational nurse at 1-866-893-2514.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme disease is a rash that might appear that looks like a bull's eye with a small welt in the center. RMSF is a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact the occupational nurse at 1-866-893-2514.

Be sure to complete an Incident Report (either use the Hours and Incident Tracking System [HITS] system on the VO) if you do come in contact with a tick.

12.0 Contaminants of Concern

The table below summarizes the potential contaminants of concern (COC) and their occupational exposure limit and signs and symptoms of exposure. The table also includes the maximum concentration of each COC and the associated location and media that was sampled (groundwater, soil boring, surface soil). These concentrations were used to determine engineering and administrative controls described in the "Project-Specific Hazard Controls" section of this HSP, as well as PPE and site monitoring requirements.

Contaminants of Concern					
Contaminant	**Location and Maximum[a] Concentration (ppm)**	**Exposure Limit[b]**	**IDLH[c]**	**Symptoms and Effects of Exposure**	**PIP[d] (eV)**
Benzene	GW: SB: SS:	0.5 ppm	500 Ca	Eye, nose, skin, and respiratory irritation; headache; nausea; dermatitis; fatigue; giddiness; staggered gait; bone marrow depression	9.24
1,1-Dichloroethane	GW: SB: SS:	100 ppm	3,000	CNS depression, skin irritation; liver, kidney, and lung damage	11.06
1,2-Dichloroethane (Ethylene Dichloride)	GW: SB: SS:	1 ppm	50 Ca	CNS depression, nausea, vomiting, dermatitis, eye irritation, liver, kidney, and CNS damage; corneal opacity	11.05
Dichloromethane (Methylene Chloride)	GW: SB: SS:	25 ppm	2,300 Ca	Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numbness, tingle limbs; nausea	11.32
Methylene Chloride	GW: SB: SS:	25 ppm	2300 Ca	Irritation eyes, skin; lassitude (weakness, exhaustion), drowsiness, dizziness; numbness, tingle limbs; nausea; [potential occupational carcinogen]	11.32
Trichloroethylene (TCE)	GW: SB: SS:	10 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	9.45
Vinyl Chloride	GW: SB: SS:	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	9.99

Footnotes:

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water).
[b] Appropriate value of permissible exposure limit (PEL), recommended exposure limit (REL), or threshold limit value (TLV) listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable; UK = Unknown.

eV = electron volt
mg/kg = milligram per kilogram
mg/m^3 = milligrams per cubic meter
ug/m^3 = micrograms per cubic meter

Potential Routes of Exposure		
Dermal: Contact with contaminated media. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of PPE.	**Inhalation:** Vapors and contaminated particulates. This route of exposure is minimized through use of engineering controls, administrative controls and proper use of respiratory protection when other forms of control do not reduce the potential for exposure.	**Other:** Inadvertent ingestion of contaminated media. This route should not present a concern if good hygiene practices are followed (e.g., wash hands and face before drinking or smoking).

13.0 Site Monitoring

(Reference CH2M HILL SOP HSE-207, *Exposure Monitoring for Airborne Chemical Hazards*)

When performing site monitoring, record all the information, such as in a field logbook. Note date and time, describe monitoring location (for example, in breathing zone, at source and site location), and what the reading is. If any action levels are reached, note it in the field logbook and note the action taken.

Exposure records (air sampling) must be preserved for the duration of employment plus thirty years. Ensure that copies of the field log book are maintained in the project file.

Copies of all project exposure records (e.g., copies of field logbook pages where air monitoring readings are recorded and associated calibration) shall be sent to the regional SPA for retention and maintained in the project files.

13.1 Direct Reading Monitoring Specifications

Instrument	Tasks	Action Levels[a]	Action to be Taken when Action Level reached	Frequency [b]	Calibration
Toxic Gas Monitor: MultiRAE Plus with 11.7 eV lamp (VOCs, O_2, LEL, CO,, H_2S)	All Intrusive Activities	<1 ppm 1-5 ppm 5> ppm	Level D Level C, Level C- Use Detector Tube to rule out Vinyl Chloride but Not Expected. Level B, Not authorized, stopw work/Contact HSM	Initially and periodically during task	Daily
	All Intrusive Activities	0-10% : 10-25% LEL: >25% LEL:	No explosion hazard Potential explosion hazard Explosion hazard; evacuate or vent	Initially and periodically during task	Daily
	All Intrusive Activities	>25%[c] O_2: 20.9%[c] O_2: <19.5%[c] O_2:	Explosion hazard; evacuate or vent Normal O_2 O_2 deficient; vent or use SCBA	Initially and periodically during task	Daily
Dust Monitor: Visual	Intrusive Activties	Dust is visible→	Initiate Engineering controls (Apply water, position upwind etc)	Initially and periodically during tasks	Not Applicable
Detector Tube for Vinyl Chloride	If PID indicates ≥ 0.5 ppm	0.5 ppm -10 ppm	Notify HSM	Initially and periodically during task	Daily
Noise-Level Monitor [d]	Drilling Geoprobe	<85 dB(A) 85-120 dB(A) 120 dB(A)	No action required Hearing protection required Stop; re-evaluate	Initially and periodically during task	Daily

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SC; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate.
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d] Noise monitoring and audiometric testing also required.

13.2 Calibration Specifications

(Refer to the respective manufacturer's instructions for proper instrument-maintenance procedures)

Instrument	Gas	Span	Reading	Method
PID:MultiRae (5 Gas Meter), OVM, 11.7 eV bulb	100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing
	H2S	CF = 25	25 ppm	0.5 lpm reg
	CO	CF = 50	50 ppm	T-tubing
	LEL	CF = 50	50 %	
	O2	CF = 20.9	20.9 %	
	100 ppm isobutylene	CF = 100	100 ppm	

Calibrate air monitoring equipment daily (or prior to use) in accordance with the instrument's instructions. Document the calibration in the field logbook (or equivalent) and include the following information:

- Instrument name
- Serial Number
- Owner of instrument (for example, CH2M HILL, HAZCO)
- Calibration gas (including type and lot number)
- Type of regulator (for example, 1.5 lpm)
- Type of tubing (for example, direct or T-tubing)
- Ambient weather condition (for example, temperature and wind direction)
- Calibration/instrument readings
- Operator's name and signature
- Date and time

13.3 Integrated Personal Air Sampling

Sampling, in addition to real-time monitoring, may be required by other OSHA regulations where there may be exposure to certain contaminants. Air sampling typically is required when site contaminants include lead, cadmium, arsenic, asbestos, and certain volatile organic compounds. Contact the RHSM immediately if these contaminants are encountered.

Method Description

Not currently needed based on site characterization

Personal Breathing Zone and Area Samples

Personal breathing zone and area sampling results must be sent immediately to the RHSM.

Employees potentially exposed to the substances for which air sampling is being performed shall be given the opportunity to observe the exposure measurements, and records shall be made available to all affected employees upon request or when they are required to be provided by a specific regulation. Employees may also receive a copy of their exposure records from the Medical Surveillance Program Administrator (MSPA).

14.0 Personal Protective Equipment

(Reference CH2M HILL- SOP HSE-117, *Personal Protective Equipment*)

14.1 Required Personal Protective Equipment

PPE must be worn by employees when actual or potential hazards exist and engineering controls or administrative practices cannot adequately control those hazards.

A PPE assessment has been conducted by the RHSM based on project tasks (see PPE specifications below). Verification and certification of assigned PPE by task is completed by the RHSM that approved this plan. Below are items that need to be followed when using any form of PPE:

- Employees must be trained to properly wear and maintain the PPE;
- Employees must be trained in the limitations of the PPE;
- In work areas where actual or potential hazards are present at any time, PPE must be worn by employees working or walking through the area;
- Areas requiring PPE should be posted or employees must be informed of the requirements in an equivalent manner;
- PPE must be inspected prior to use and after any occurrence to identify any deterioration or damage;
- PPE must be maintained in a clean and reliable condition;
- Damaged PPE shall not be used and must either be repaired or discarded; and
- PPE shall not be modified, tampered with, or repaired beyond routine maintenance.

The table below outlines PPE to be used according to task based on project-specific hazard assessment. If a task other than the tasks described in this table needs to be performed, contact the RHSM so this table can be updated.

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
-General site entry -Surveying -Observation of material loading for offsite disposal -Oversight of remediation and construction	D	Work clothes; safety toed leather work boots and gloves	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required
-Groundwater Monitoring/Sampling -IDW Mgmt. (Sampling/Disposal) -Hand Augering -Monitoring Well Install -Drilling (Sonic) PRB Install (Trencher)	Modified D	Work clothes or cotton coveralls **Boots:** Safety-toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves. OR Work Clothes or Coveralls. SC to determine body protection based on potential contact with site contaminants. If outer layer of personal clothing cannot be kept clean, then outer cotton coveralls or uncoated Tyvek coveralls shall be worn. (Polycoated Tyvek when there is potential to contact contaminated groundwater or free liquids from drums.)	Hardhat [c] Safety glasses with side shields Ear protection [d]	None required

Project-Specific Personal Protective Equipment Requirements[a]

Task	Level	Body	Head	Respirator [b]
	Modified D	**Coveralls:** Uncoated Tyvek® **Boots:** Safety -toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Safety glasses with side shields Ear protection [d]	None required.
Work near vehicular traffic ways or earth moving equipment.	All	Appropriate level of ANSI/ISEA 107-2010 high-visibility safety vests.	Work near vehicular traffic ways or earth moving equipment.	
Equipment decontamination if using pressure washer	Modified D with splash protection	**Coveralls:** Polycoated Tyvek® **Boots:** 16-inch-high steel-toed rubber boots **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] over safety glasses with side shields or splash goggles Ear protection [d]	None required.
Tasks requiring upgrade -Not Expected	C	**Coveralls:** Polycoated Tyvek® **Boots:** Safety -toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	APR, full face, MSA Ultratwin or equivalent; with GME-H cartridges or equivalent[e].
Tasks requiring upgrade -Not Authorized/Contact HSM	B	**Coveralls:** Polycoated Tyvek® **Boots:** Safety -toe, chemical-resistant boots OR Safety -toe, leather work boots with outer rubber boot covers **Gloves:** Inner surgical-style nitrile & outer chemical-resistant nitrile gloves.	Hardhat [c] Splash shield [c] Ear protection [d] Spectacle inserts	Positive-pressure demand self-contained breathing apparatus (SCBA); MSA Ultralite, or equivalent.

Reasons for Upgrading or Downgrading Level of Protection (with approval of the RHSM)

Upgrade[f]	Downgrade
• Request from individual performing tasks. • Change in work tasks that will increase contact or potential contact with hazardous materials. • Occurrence or likely occurrence of gas or vapor emission. • Known or suspected presence of dermal hazards. • Instrument action levels in the “Site Monitoring” section exceeded.	• New information indicating that situation is less hazardous than originally thought. • Change in site conditions that decrease the hazard. • Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SC.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet (1 meter) or less without shouting.
[e] See cartridge change-out schedule.
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level C) is permitted only when the PPE requirements have been approved by the RHSM, and an SC qualified at that level is present.

14.2 Respiratory Protection

(Reference CH2M HILL SOP HSE-121, *Respiratory Protection*)

Implement the following when using respiratory protection:

- Respirator users must have completed appropriate respirator training within the past 12 months. Level C training is required for air-purifying respirators (APR) use and Level B training is required for supplied-air respirators (SAR) and self-contained breathing apparatus (SCBA) use. Specific training is required for the use of powered air-purifying respirators (PAPR);

- Respirator users must complete the respirator medical monitoring protocol and been approved for the specific type of respirator to be used;
- Tight-fitting facepiece respirator (negative or positive pressure) users must have passed an appropriate fit test within past 12 months;
- Respirator use shall be limited to those activities identified in this plan. If site conditions change that alters the effectiveness of the specified respiratory protection, the RHSM shall be notified to amend the written plan;
- Tight-fitting facepiece respirator users shall be clean-shaven and shall perform a user seal check before each use;
- Canisters/cartridges shall be replaced according to the change-out schedule specified in this plan. Respirator users shall notify the SC or RHSM of any detection of vapor or gas breakthrough. The SC shall report any breakthrough events to the RHSM for schedule upgrade;
- Respirators in regular use shall be inspected before each use and during cleaning;
- Respirators in regular use shall be cleaned and disinfected as often as necessary to ensure they are maintained in a clean and sanitary condition;
- Respirators shall be properly stored to protect against contamination and deformation;
- Field repair of respirators shall be limited to routine maintenance. Defective respirators shall be removed from service;
- When breathing air is supplied by cylinder or compressor, the SC or RHSM shall verify the air meets Grade D air specifications; and
- The SC or designee shall complete the Self-Assessment Checklist – Respiratory Protection included in as attachment to this plan to verify compliance with CH2M HILL's respiratory protection program.

Respirator Change-Out Schedule

Contaminant	Change-Out Schedule
Benzene	End-of-service life or end of shift (whichever occurs first)
Vinyl Chloride	End-of-service life or end of shift (whichever occurs first)
Methylene Chloride	Canisters may only be used for emergency escape and must be replaced after use

15.0 Worker Training and Qualification

15.1 CH2M HILL Worker Training

(Reference CH2M HILL SOP HSE-110, *Training*)

15.1.1 Hazardous Waste Operations Training

All employees engaging in hazardous waste operations or emergency response shall receive appropriate training as required by 29 CFR 1910.120 and 29 CFR 1926.65. At a minimum, the training shall have consisted of instruction in the topics outlined in 29 CFR 1910.120 and 29 CFR 1926.65. Personnel who have not met these training requirements shall not be allowed to engage in hazardous waste operations or emergency response activities.

15.1.1.1 Initial Training

General site workers engaged in hazardous waste operations shall, at the time of job assignment, have received a minimum of 40 hours of initial health and safety training for hazardous waste site operations, unless otherwise noted in the above-referenced standards.

Employees who may be exposed to health hazards or hazardous substances at treatment, storage, and disposal (TSD) operations shall receive a minimum of 24 hours of initial training to enable the employee to perform their assigned duties and functions in a safe and healthful manner.

Employees engaged in emergency response operations shall be trained to the level of required competence in accordance with 29 CFR 1910.120.

15.1.1.2 Three-Day Actual Field Experience

General site workers for hazardous waste operations shall have received three days of actual experience (on-the-job training) under the direct supervision of a trained, qualified supervisor and shall be documented. If the field experience has not already been received and documented at a similar site, this supervised experience shall be accomplished and documented at the beginning of the assignment of the project.

15.1.1.3 Refresher Training

General site workers and TSD workers shall receive 8-hours of refresher training annually (within the previous 12-month period) to maintain qualifications for fieldwork. Employees engaged in emergency response operations shall receive annual refresher training of sufficient content and duration to maintain their competencies or shall demonstrate competency in those areas at least annually.

15.1.1.4 Eight-Hour Supervisory Training

On site management or supervisors who will be directly responsible for, or supervise employees engaged in hazardous waste site operations, will have received at least 8 hours of additional specialized training on managing such operations. Employees designated as Safety Coordinator – Hazardous Waste are considered 8-hour HAZWOPER Site Safety Supervisor trained.

15.1.2 First Aid/Cardiopulmonary Resuscitation

First aid and CPR training consistent with the requirements of a nationally recognized organization such as the American Red Cross Association or National Safety Council shall be administered by a certified trainer. A minimum of two personnel per active field operation will have first aid and CPR training. Bloodborne pathogen training located on CH2M HILL's Virtual Office is also required for those designated as first aid/CPR trained.

15.1.3 Safety Coordinator Training

SCs are trained to implement the HSE program on CH2M HILL field projects. A qualified SC is required to be identified in the site-specific HSP for CH2M HILL field projects. SCs must also meet the requirements of the worker category appropriate to the type of field project (construction or hazardous waste). In addition, the SCs shall have completed additional safety training required by the specific work activity on the project that qualifies them to implement the HSE program (for example, fall protection, excavation).

15.1.4 Site-Specific Training

Prior to commencement of field activities, all field personnel assigned to the project will have completed site-specific training that will address the contents of applicable HSPs, including the activities, procedures, monitoring, and equipment used in the site operations. Site-specific training will also include site and facility layout, potential hazards, risks associated with identified emergency response actions, and available emergency services. This training allows field workers to clarify anything they do not understand and to reinforce their responsibilities regarding safety and work operations for their particular activity.

15.1.5 Project-Specific Training Requirements

Project-specific training for this project includes:

- Training on CH2M HILL HSP and AHAs;
- Training on subcontractor AHAs;
- Training in accordance with appropriate Worker Category
    - Excavation Awareness Training
    - Environmental Awareness Training
    - Lockout/Tagout
    - Hand Safety
    - PPE

16.0 Medical Surveillance and Qualification

(Reference CH2M HILL SOP HSE-113, *Medical Surveillance*

All site workers participating in hazardous waste operations or emergency response (HAZWOPER) will maintain an adequate medical surveillance program in accordance with 29 CFR 1910.120 or 29 CFR 1926.65 and other applicable OSHA standards. Documentation of employee medical qualification (e.g., physician's written opinion) will be maintained in the project files and made available for inspection.

16.1 Hazardous Waste Operations and Emergency Response

CH2M HILL personnel expected to participate in on site HAZWOPER tasks are required to have a current medical qualification for performing this work. Medical qualification shall consist of a qualified physician's written opinion regarding fitness for duty at a hazardous waste site, including any recommended limitations on the employee's assigned work. The physician's written opinion shall state whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use.

16.2 Job or Site-Specific Medical Surveillance

Due to the nature of hazards for a particular job or work site, specialized medical surveillance may be necessary. This surveillance could include biological monitoring for specific compounds, or specialized medical examinations.

Site-specific medical surveillance includes:

- N/A

16.3 Respirator User Qualification

Personnel required to wear respirators must have a current medical qualification to wear respirators. Medical qualification shall consist of a qualified physician's written opinion regarding the employee's ability to safely wear a respirator in accordance with 29 CFR 1910.134.

16.4 Hearing Conservation

Personnel working in hazardous waste operations or operations that fall under 29 CFR 1910.95 and exposed to noise levels in excess of the 85dBA time-weighted average shall be included in a hearing conservation program that includes annual audiometric testing.

17.0 Site-Control Plan

17.1 Site-Control Procedures

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations)*

Site control is established to prevent the spread of contamination throughout the site and to ensure that only authorized individuals are permitted into potentially hazardous areas.

The SC will implement site control procedures including the following bulleted items.

- Establish support, contamination reduction, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals;
  - Air horn; and
  - Two-way radio or cellular telephone if available.
- Establish offsite communication.
- Establish and maintain the "buddy system."

17.2 Remediation Work Area Zones

(Reference CH2M HILL SOP HSE-218 Hazardous Waste Operations)

A three-zone approach will be used to control areas where site contaminants exist. Access will be allowed only after verification of appropriate training and medical qualification. The three-zone approach shall include an EZ, Contamination Reduction Zone (CRZ) and a Support Zone (SZ). The three-zone approach is not required for construction work performed outside contaminated areas where control of site contamination is not a concern.

Specific work control zones shall be established as necessary during task planning. Site work zones should be modified in the field as necessary, based on such factors as equipment used, air monitoring results, environmental conditions, or alteration of work plans. The following guidelines shall be used for establishing and revising these preliminary zone designations.

17.2.1 Support Zone

The SZ is an uncontaminated area (trailers, offices, field vehicles, etc.) that will serve as the field support area for most operations. The SZ provides field team communications and staging for emergency response. Appropriate sanitary facilities and safety and emergency response equipment will be located in this zone. Potentially contaminated personnel/materials are not allowed in this zone. The only exception will be appropriately packaged and decontaminated materials, or personnel with medical emergencies that cannot be decontaminated.

17.2.2 Contamination Reduction Zone

The CRZ is established between the EZ and the SZ, upwind of the contaminated area where possible. The CRZ provides an area for decontamination of personnel, portable handheld equipment and tools, and heavy equipment. In addition, the CRZ serves as access for heavy equipment and emergency support services.

17.2.3 Exclusion Zone

The EZ is where activities take place that may involve exposure to site contaminants and/or hazardous materials or conditions. This zone shall be demarcated to prevent unauthorized entry. More than one EZ may be established if there are different levels of protection to be employed or different hazards that exist in the same work area. The EZ shall be large enough to allow adequate space for the activity to be completed, including field personnel and equipment, as well as necessary emergency equipment.

The EZ shall be demarcated with some form of physical barrier or signage. The physical barrier or signage shall be placed so that they are visible to personnel approaching or working in the area. Barriers and boundary markers shall be removed when no longer needed.

17.2.4 Other Controlled Areas

Other work areas may need to be controlled due to the presence of an uncontrolled hazard, to warn workers of requirements, or to prevent unauthorized entry. Examples include general construction work areas, open excavations, high noise areas, vehicle access areas, and similar activities or limited access locations. These areas shall be clearly demarcated with physical barriers (fencing, cones, reinforced caution tape or rope) as necessary and posted with appropriate signage.

18.0 Decontamination

(Reference CH2M HILL SOP HSE-218, *Hazardous Waste Operations*)

Decontamination areas will be established for work in potentially contaminated areas to prevent the spread of contamination. Decontamination areas should be located upwind of the exclusion zone where possible and should consider any adjacent or nearby projects and personnel. The SC must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SC. The SC must ensure that procedures are established for disposing of materials generated on the site.

No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SC should establish areas for eating, drinking, and smoking.

18.1 Contamination Prevention

Preventing or avoiding contamination of personnel, tools, and equipment will be considered in planning work activities at all field locations. Good contamination prevention and avoidance practices will assist in preventing worker exposure and result in a more efficient decontamination process. Procedures for contamination prevention and avoidance include the following:

- Do not walk through areas of obvious or known contamination;
- Do not directly handle or touch contaminated materials;
- Make sure there are no cuts or tears in PPE;
- Fasten all closures in suits and cover them with duct tape, if appropriate;
- Take particular care to protect any skin injuries;
- Stay upwind of airborne contamination, where possible;
- Do not eat or drink in contaminated work areas;
- Do not carry food, beverages, tobacco, or flame-producing equipment into contaminated work areas;
- Minimize the number of personnel and amount of equipment in contaminated areas to that necessary for accomplishing the work;
- Choose tools and equipment with nonporous exterior surfaces that can be easily cleaned and decontaminated;
- Cover monitoring and sampling equipment with clear plastic, leaving openings for the sampling ports, as necessary; and
- Minimize the amount of tools and equipment necessary in contaminated areas.

18.2 Personnel and Equipment Decontamination

Personnel exiting an EZ must ensure that they are not spreading potential contamination into clean areas or increasing their potential for ingesting or inhaling potential contaminants. Personal decontamination may range from removing outer gloves as exiting the EZ, to proceeding through an outer layer doffing station including a boot and glove wash and rinse, washing equipment, etc. Equipment that has come into contact with contaminated media must also be cleaned/decontaminated when it is brought out of the EZ.

18.3 Decontamination During Medical Emergencies

Standard personnel decontamination practices will be followed whenever possible. For emergency life saving first aid and/or medical treatment, normal decontamination procedures may need to be abbreviated or omitted. In this situation, site personnel shall accompany contaminated victims to advise emergency response personnel on potential contamination present and proper decontamination procedures.

Outer garments may be removed if they do not cause delays, interfere with treatment, or aggravate the problem. Protective clothing can be cut away. If the outer garments cannot be safely removed, a plastic barrier between the individual and clean surfaces should be used to help prevent contaminating the inside of ambulances or medical personnel. Outer garments can then be removed at the medical facility.

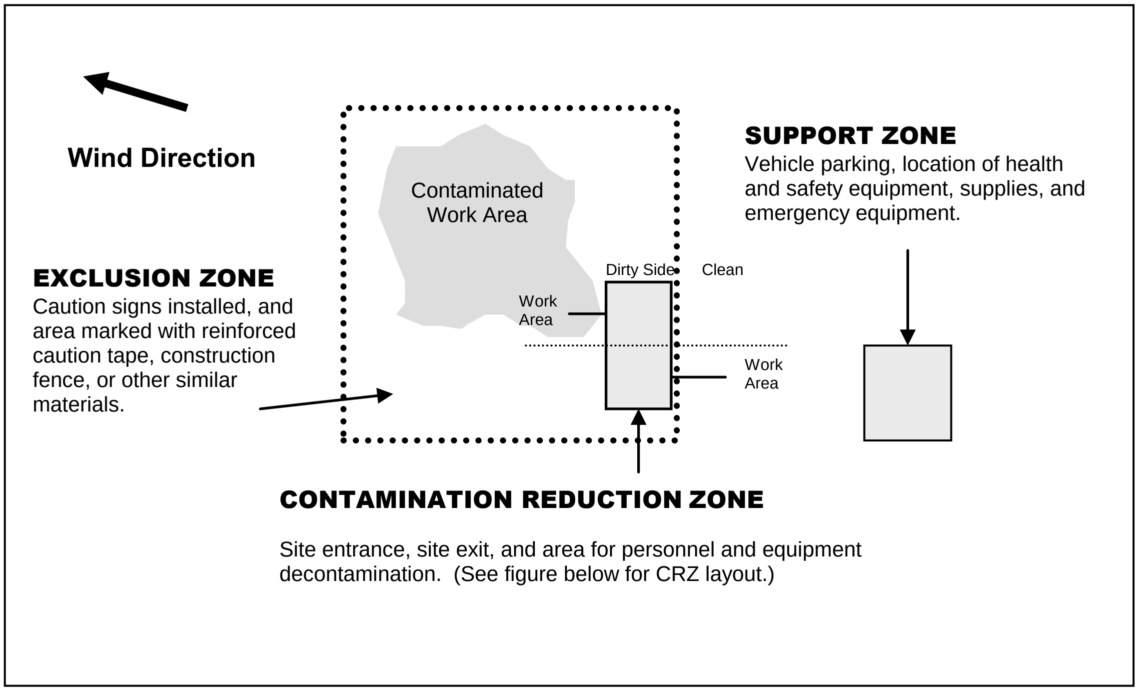
18.4 Waste Collection and Disposal

All contaminated material generated through the personnel and equipment decontamination processes (e.g., contaminated disposable items, gross debris, liquids, sludges) will be properly containerized and labeled, stored at a secure location, and disposed in accordance with the project plans.

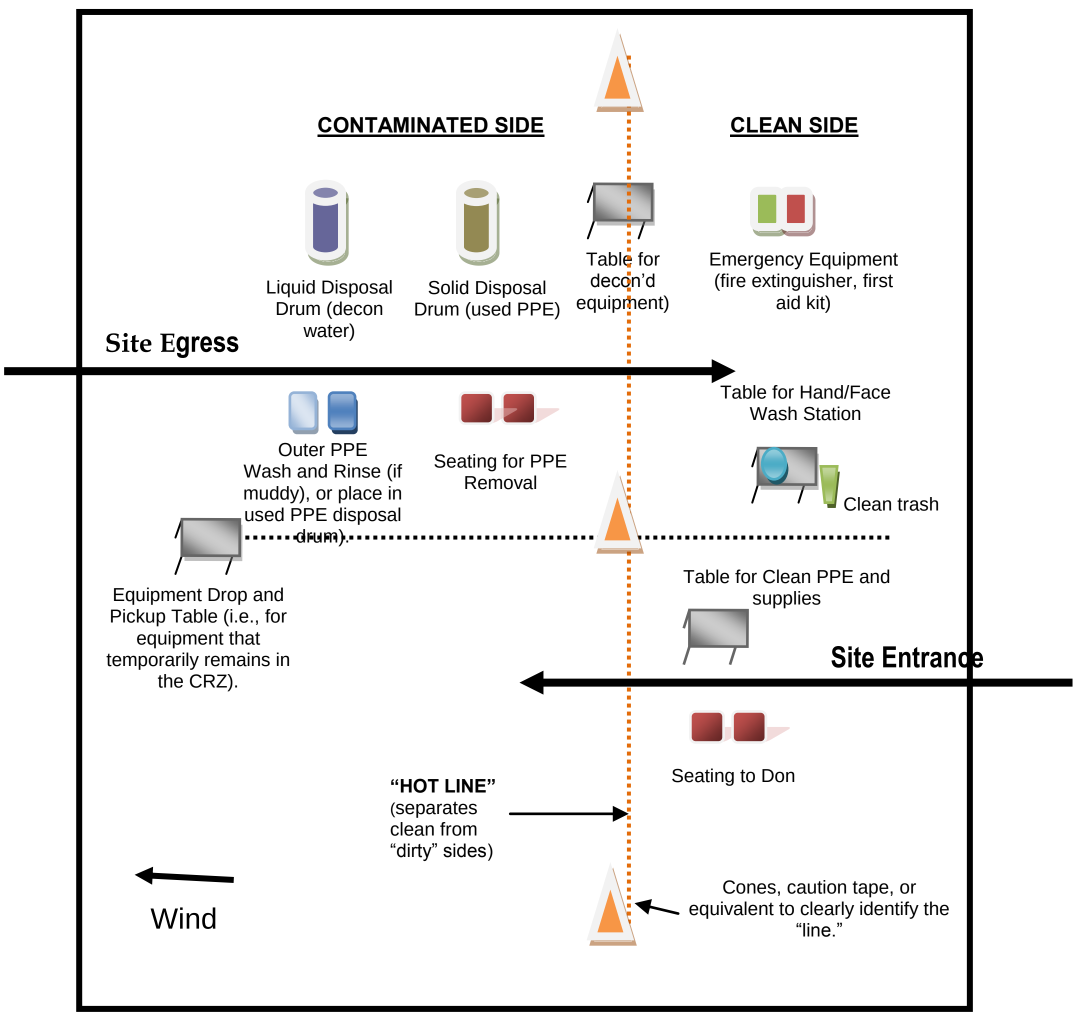
18.5 Diagram of Personnel-Decontamination Line

The following figure illustrates a conceptual establishment of work zones, including the decontamination line. Work zones are to be modified by the SC to accommodate task-specific requirements.

Work Area - Set up appropriately based on wind direction



Typical Contamination Reduction Zone



19.0 Emergency Response Plan

(Reference CH2M HILL SOP HSE-106, *Emergency Planning*)

19.1 Pre-Emergency Planning

The Emergency Response Coordinator (ERC), typically the SC or designee, performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate. Pre-Emergency Planning activities performed by the ERC include:

- Review the facility emergency and contingency plans where applicable;
- Determine what onsite communication equipment is available (two-way radio, air horn);
- Determine what offsite communication equipment is needed (nearest telephone, cell phone);
- Confirm and post the "Emergency Contacts" page and route to the hospital located in this section in project trailer(s) and keep a copy in field vehicles along with evacuation routes and assembly areas. Communicate the information to onsite personnel and keep it updated;
- Field Trailers: Post "Exit" signs above exit doors, and post "Fire Extinguisher" signs above locations of extinguishers. Keep areas near exits and extinguishers clear;
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures;
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies;
- Inventory and check site emergency equipment, supplies, and potable water;
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases;
- Rehearse the emergency response plan before site activities begin. This may include a "tabletop" exercise or an actual drill depending on the nature and complexity of the project. Drills should take place periodically but no less than once a year;
- Brief new workers on the emergency response plan; and
- The ERC will evaluate emergency response actions and initiate appropriate follow-up actions.

19.2 Emergency Equipment and Supplies

The ERC shall ensure the following emergency equipment is on the site. Verify and update the locations of this equipment as needed. The equipment will be inspected in accordance with manufacturer's recommendations. The inspection shall be documented in a field logbook or similar means to be kept in the project files.

Emergency Equipment and Supplies	Location
20 (or two 10) class A,B,C fire extinguisher	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye Wash	Support & Decon Zone/Field Vehicle
Potable water	Support & Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify):Cell Phone	FTL/SSC

19.3 Incident Response

In fires, explosions, or chemical releases, actions to be taken include the following:

- Notify appropriate response personnel;
- Shut down CH2M HILL operations and evacuate the immediate work area;
- Account for personnel at the designated assembly area(s);
- Assess the need for site evacuation, and evacuate the site as warranted;
- Implement HSE-111, Incident Notification, Reporting and Investigation; and
- Notify and submit reports to clients as required in contract.

Small fires or spills posing minimal safety or health hazards may be controlled with onsite spill kits or fire extinguishers without evacuating the site. When in doubt evacuate. Follow the incident reporting procedures in the "Incident Notification, Reporting, and Investigation" section of this HSP.

19.4 Emergency Medical Treatment

Emergency medical treatment is needed when there is a life-threatening injury (such as severe bleeding, loss of consciousness, breathing or heart has stopped). When in doubt if an injury is life-threatening or not, treat it as needing emergency medical treatment.

- Notify 911 or other appropriate emergency response authorities as listed in the "Emergency Contacts" page located in this section.
- The ERC will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury, perform decontamination (if applicable) where feasible; lifesaving and first aid or medical treatment takes priority.
- Initiate first aid and CPR where feasible.
- Notify supervisor and if the injured person is a CH2M HILL employee, the supervisor will call the occupational nurse at 1-866-893-2514 and make other notifications as required by HSE SOP-111, *Incident Notification, Reporting and Investigation*.
- Make certain that the injured person is accompanied to the emergency room.
- Follow the Serious Incident Reporting process in HSE SOP-111, Incident Notification, Reporting and Investigation, and complete incident report using the HITS system on the VO or if not feasible, use the hard copy forms provided as an attachment to this HSP.
- Notify and submit reports to client as required in contract.

19.5 Evacuation

- Evacuation routes, assembly areas, and severe weather shelters (and alternative routes and assembly areas) are to be specified on the site map.
- Evacuation route(s) and assembly area(s) will be designated by the ERC or designee before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The ERC and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The ERC will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s).

- The ERC will follow the incident reporting procedures in the "Incident Notification, Reporting and Investigation" section of this HSP.

19.6 Evacuation Signals

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

19.7 Inclement Weather

Sudden inclement weather can rapidly encroach upon field personnel. Preparedness and caution are the best defenses. Field crew members performing work outdoors should carry clothing appropriate for inclement weather. Personnel are to take heed of the weather forecast for the day and pay attention for signs of changing weather that indicate an impending storm. Signs include towering thunderheads, darkening skies, or a sudden increase in wind. If stormy weather ensues, field personnel should discontinue work and seek shelter until the storm has passed.

Protective measures during a lightning storm include seeking shelter; avoiding projecting above the surrounding landscape (don't stand on a hilltop--seek low areas); staying away from open water, metal equipment, railroad tracks, wire fences, and metal pipes; and positioning people several yards apart. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or vehicle. Do not go into a shed in an open area;
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae, and towers;
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding;
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make yourself less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands; and
- Do not use telephones during electrical storms, except in the case of emergency.

Remember that lightning may strike several miles from the parent cloud, so work should be stopped and restarted accordingly. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap.

High winds can cause unsafe conditions, and activities should be halted until wind dies down. High winds can also knock over trees, so walking through forested areas during high-wind situations should be avoided. If winds increase, seek shelter or evacuate the area. Proper body protection should be worn in case the winds hit suddenly, because body temperature can decrease rapidly.

Emergency Contacts

24-hour CH2M HILL Injury Reporting– 1-866-893-2514 24-hour CH2M HILL Serious Incident Reporting Contact – 720-286-4911	
Medical Emergency – 911 Facility Medical Response #: 911 Local Ambulance #:252/225-7721 (Sealevel **Urgent Care Facility** Craven Regional Medical Center 2000 Neuse Blvd New Bern, NC 28560 **(Base hospital will accept emergencies)** 757-398-2200	**CH2M HILL- Medical Consultant** WorkCare Dr. Peter Greaney M.D. 300 S. Harbor Blvd, Suite 600 Anaheim , CA 92805 800-455-6155/866-893-2514 714-978-7488
Fire/Spill Emergency -- 911 Facility Fire Response #: 911 Local Fire Dept #: 252/225-5751 (Atlantic Fire Dept.)	**CH2M HILL Director – Health, Safety, Security & Environment** Andy Strickland/DEN (720) 480-0685 (cell) or (720) 286-2393 (office)
Security & Police – 911 Facility Security #: 911 Local Police #: 252/504-4800	**CH2M HILL Responsible Health and Safety Manager (RHSM)** Name: Carl Woods Phone: (513) 319-5771
Utilities Emergency Phone Numbers Water: **252/466-4364** Gas: **252/466-4364** Electric: **252/466-4364**	**CH2M HILL Human Resources Department** Phone: Employee Connect toll-free number 1-877-586-4411 (U.S. and Canada)
CH2M HILL Project Manager Name: Keri Halberg Phone: 704-975-9381	**CH2M HILL Worker's Compensation:** Contact Business Group HR dept. to have form completed or contact Jennifer Rindahl after hours: (720)891-5382
CH2M HILL Safety Coordinator (SC) Name: Gerald Couch Phone: 678-530-4077	**Media Inquiries Corporate Strategic Communications** Name: John Corsi Phone: (720) 286-2087
CH2M HILL Project Environmental Manager Name: Hope Wilson Phone: 678-530-4226	**Automobile Accidents** Rental: Jennifer Rindahl/DEN: 720-286-2449 CH2M HILL owned vehicle: Linda George/DEN: 720-286-2057
Federal Express Dangerous Goods Shipping Phone: 800/238-5355	**CHEMTEL (hazardous material spills)** **Phone: 800/255-3924**
Facility Alarms: N/A	Evacuation Assembly Area(s): TBD by SSC
Facility/Site Evacuation Route(s): TBD by SSC	

Directions to Local Hospital

Local Hospital
Craven Regional Medical Center
2000 Neuse Blvd
New Bern, NC 28560
(Base hospital will accept emergencies)
757-398-2200

Directions to Craven RMC:

1. Take Highway 70 West to New Bern
2. Take Glenburnie Road exit (right turn)
3. Take Glenburnie to Neuse Boulevard (turn right)
4. Go two miles, hospital is on the left.

Total 16 miles, 25 minutes

20.0 Spill Containment Procedures

CH2M HILL and subcontractor personnel working at the project site shall be knowledgeable of the potential health, safety and environmental concerns associated with petroleum and other substances that could potentially be released at the project site.

The following is a list of criteria that must be addressed in CH2M HILL's or the subcontractor's plans in the event of a spill or release. In the event of a large quantity spill notify emergency services. Personnel discovering a spill shall (only if safe to do so):

- Stop or contain the spill immediately (if possible) or note source. Shut off the source (e.g., pump, treatment system) if possible. If unsafe conditions exist, then leave the area, call emergency services, inform nearby personnel, notify the site supervisors, and initiate incident reporting process. The SC shall be notified immediately;
- Extinguish sources of ignition (flames, sparks, hot surfaces, cigarettes);
- Clear personnel from the spill location and barricade the area;
- Use available spill control equipment in an effort to ensure that fires, explosions, and releases do not occur, recur, or spread;
- Use sorbent materials to control the spill at the source;
- Construct a temporary containment dike of sorbent materials, cinder blocks, bricks or other suitable materials to help contain the spill;
- Attempt to identify the character, exact source, amount, and extent of the released materials. Identification of the spilled material should be made as soon as possible so that the appropriate cleanup procedure can be identified;
- Assess possible hazards to human health or the environment as a result of the release, fire or explosion; and
- Follow incident notification, reporting, and investigation section of this plan.

21.0 Inspections

21.1 Project Activity Self-Assessment Checklists

In addition to the hazard controls specified in this document, Project Activity Self-Assessment Checklists are contained as an attachment to this HSP. The Project-Activity Self–Assessment Checklists are based upon minimum regulatory compliance and some site-specific requirements may be more stringent. The objective of the self-assessment process is to identify gaps in project safety performance, and prompt for corrective actions in addressing these gaps. The self-assessment checklists, including documented corrective actions, shall be made part of the permanent project records and maintained by the SC.

The self-assessment checklists will also be used by the SC in evaluating the subcontractors and any client contractors' compliance on site.

The self-assessment checklists for the following tasks and exposures are required when the task or exposure is initiated and weekly thereafter while the task or exposure is taking place. The checklists shall be completed by the SC or other CH2M HILL representative and maintained in project files.

- Drilling
- Excavation
- Forklifts
- Hand and Power Tools
- Traffic Control
- Hazardous Materials Handling
- PPE
- Vinyl Chloride

21.2 Safe Behavior Observations

Safe Behavior Observations (SBOs) are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss.

The SC or designee shall perform at least one SBO each week for any field work performed by subcontractors or when there are at least two CH2M HILL personnel performing field work.

The SC or designee shall complete the SBO form (attached to this HSP) for the task/operation being observed and submit them weekly.

For Federal projects, SBOs may be submitted electronically by e-mailing them to the address, "CH2M HILL ES FED Safe Behavior Observations" when connected to the network or at CH2MHILLESFEDSafeBehaviorObservation@ch2m.com.

22.0 Incident Notification, Reporting, and Investigation

(Reference CH2M HILL SOP HSE-111, *Incident Notification, Reporting and Investigation*)

22.1 General Information

This section applies to the following:

- All injuries involving employees, third parties, or members of the public;
- Damage to property or equipment;
- Interruptions to work or public service (hitting a utility);
- Incidents which attract negative media coverage;
- Near misses;
- Spills, leaks, or regulatory violations; and
- Motor vehicle accidents.

Documentation, including incident reports, investigation, analysis and corrective measure taken, shall be kept by the SC and maintained onsite for the duration of the project.

22.2 Section Definitions

Incident: An incident is an event that causes or could have caused undesired consequences. An incident may be caused by natural forces, employees, subcontractors, or third parties in any location associated with CH2M HILL operations, including offices, warehouses, project sites, private property, or public spaces. Incidents include:

- Injury or illness to a CH2M HILL employee or subcontractor employee, or member of the public;
- Property damage;
- Spill or release;
- Environmental requirement or permit violation;
- A "near-miss"; or
- Other (e.g., fire, explosion, bomb threat, workplace violence, threats)**Accident**: an incident involving actual loss through injury, damage to assets, or environmental harm.

Near Miss: A near-miss occurs when an intervening factor prevented an injury or illness, property damage, spill or release, permit violation or other event from occurring. Examples of near-miss situations include: a hard hat or other personal protective equipment (PPE) prevented an injury; secondary containment or emergency shutoff prevented a spill; or an alert co-worker prevented an incident.

Serious Incident:

A Serious Incident must be immediately reported to senior management includes:

- Work related death, or life threatening injury or illness of a CH2M HILL employee;
- subcontractor, or member of the public;
- Kidnap/missing person;
- Acts or threats of terrorism;
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or

- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.3 Reporting Requirements

All employees and subcontractors' employees shall immediately report any incident (including "near misses," as defined in the section above) in which they are involved or witness to their supervisor.

The CH2M HILL or Subcontractor supervisor, upon receiving an incident report, shall inform his immediate superior and the CH2M HILL SC.

The SC shall immediately report the following information to the RHSM and PM by phone and e-mail:

- Project Name and Site Manager;
- Date and time of incident;
- Description of incident;
- Extent of known injuries or damage;
- Level of medical attention; and
- Preliminary root cause/corrective actions

The RHSM shall immediately inform the EM (or available alternate) of spills, potential environmental permit compliance, or any environmental situation that could result in a notice of violation from an agency.

The CH2M HILL team shall comply with all applicable statutory incident reporting requirements such as those to OSHA, the police, or state or Federal environmental agency.

22.4 HITS System and Incident Report Form

CH2M HILL maintains a HITS entry and/or Incident Report Form (IRF) for all work-related injuries and illnesses sustained by its employees in accordance with recordkeeping and insurance requirements. A HITS entry and/or IRF will also be maintained for other incidents (property damage, fire or explosion, spill, release, potential violation, and near misses) as part of our loss prevention and risk reduction initiative.

The SC shall complete an entry into the Hours and Incident Tracking System (HITS) database system located on CH2M HILL's Virtual Office (or if VO not available, use the hard copy Incident Report Form and Root Cause Analysis Form and forward it to the RHSM) within 24 hours and finalize those forms within 3 calendar days.

22.5 Injury Management/Return-to-Work (for US/Puerto Rico based CH2M HILL Staff Only)

(Reference CH2M HILL, SOP HSSE-124, Injury Management/Return-to-Work)

22.5.1 Background

The Injury Management Program has been established to provide orderly, effective and timely medical treatment and return-to-work transition for an employee who sustains a work-related injury or illness. It also provides guidance and assistance with obtaining appropriate treatment to aid recovery, keep supervisors informed of employee status, and to quickly report and investigate work-related injury/illnesses to prevent recurrence.

To implement the Injury Management/Return-to-Work Program successfully, supervisors and/or SC should:

- Ensure employees are informed of the Injury Management/Return-to-Work Program;
- Become familiar with the Notification Process (detailed below); and
- Post the Injury Management/Return-to-Work Notification Poster.

22.5.2 The Injury Management/Return-to-Work Notification Process:

- Employee informs their supervisor.
- Employee calls the Injury Management Program toll free number 1-866-893-2514 immediately and speaks with the Occupational Injury Nurse. This number is operable 24 hours per day, 7 days a week.
- Supervisor ensures employee immediately calls the Injury Management Program number. Supervisor makes the call with the injured worker or for the injured worker, if needed.
- Nurse assists employee with obtaining appropriate medical treatment, as necessary schedules clinic visit for employee (calls ahead, and assists with any necessary follow up treatment). The supervisor or SC accompanies the employee if a clinic visit is necessary to ensure that employees receive appropriate and timely care.
- Supervisor or SC completes the HITS entry or Incident Report Form immediately (within 24 hours) and forwards it to the Project Manager and RHSM.
- Nurse notifies appropriate CH2M HILL staff by e-mail (supervisor, Health & Safety, Human Resources, Workers' Compensation).
- Nurse communicates and coordinates with and for employee on treatment through recovery.
- Supervisor ensures suitable duties are identified and available for injured or ill workers who are determined to be medically fit to return to work on transitional duty (temporary and progressive).
- Supervisor ensures medical limitations prescribed (if any) by physician are followed until the worker is released to full duty.

22.6 Serious Incident Reporting Requirements

(Reference CH2M HILL SOP HSE-111, *Incident Reporting, Notification and Investigation*)

The serious incident reporting requirements ensures timely notification and allows for positive control over flow of information so that the incident is handled effectively, efficiently, and in conjunction with appropriate corporate entities. This standard notification process integrates Health, Safety, Security and Environment and Firm Wide Security Operations requirements for the consistent reporting of and managing of serious events throughout our operations.

22.6.1 Serious Incident Determination

The following are general criteria for determining whether an incident on CH2M HILL owned or managed facilities or program sites is considered serious and must be immediately reported up to Group President level through the reporting/notification process:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public;
- Kidnap or missing person;
- Acts or threats of terrorism;

- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 in damage; or
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

22.6.2 Serious Incident Reporting

If an incident meets the "Serious Incident" criteria, the Project Manager is to immediately contact the Crisis Manager at 720-286-4911, then follow the standard incident reporting procedure.

For all serious incidents this standard reporting process is implemented immediately so as to ultimately achieve notification to the Business Group President within 2 hours of incident onset or discovery, and notification to appropriate corporate Crisis Management Support Team.

ESBG US Operations
Incident Reporting Flow Diagram

Direct Reporting Responsibility

Informational Reporting

Incident:

- Injury or illness
- Hazardous substance exposure
- Damage to property
- Fire or explosion
- Spill, release, potential violation, or permit exceedance
- A "near-miss"

If incident is an **injury** to US or Puerto Rico based CH2M HILL personnel contact the Occupational Health Nurse at 866/893-2514. Outside the US, the supervisor must notify the HR

The Ops Leader is responsible for completing the Incident Report Form (IRF) in **HITS** when there is an injury to a CH2M HILL employee. The PM, CM or SC is responsible for completing the IRF for all other incidents. ***The IRF/HITS must be completed within 24 hours of the incident and does not replace the required immediate PM and RHSM notifications.***

Incident

Ensure that Emergency Responders have been notified as necessary

Employee or Subcontractor

Provide immediate notification.

Supervisor – Construction Manager - Safety Coordinator

Provide immediate notification by phone and email to PM and RHSM. In addition, for spills, NOVs, and permit issues you may also call the EM.

CRISIS MANAGER:

If the incident meets the "**Serious Incident**" criteria, contact the Crisis Manager

(720.286.4911)

Third Party – Incidents outside of our contractual obligations do not need to be communicated, unless they are serious and/or may affect CH2M HILL. The RHSM will determine the level of communication necessary for third party incidents.

Serious Incident:

- Work related death, or life threatening injury or illness of a CH2M HILL employee, subcontractor, or member of the public
- Kidnap/missing person
- Acts or threats of terrorism
- Event that involves a fire, explosion, or property damage that requires a site evacuation or is estimated to result in greater than $ 500,000 US in damage.
- Spill or release of hazardous materials or substances that involves a significant threat of imminent harm to site workers, neighboring facilities, the community or the environment.

Responsible HSM (RHSM)

Immediately notify the Sector OR Client Program HSE Manager, immediately notify the Responsible Environmental Manager (EM) for spills, NOVs, and permit issues, and direct the incident investigation.

Client Program HSE Manager

Notify Sector HSM, and coordinate communication and incident investigations.

Immediate notification to the Sector HSM is not required for some minor incidents. Follow the program or sector protocol.

Sector HSE Manager

Coordinate communication, direct significant incident investigations, notify Sector EM for spills, NOVs, & permit issues.

HSSE Director

Provide decision-making assistance or direction for incident resolution.

Project Manager

Provide notification to the Sector OR Program Project Delivery (PD) or Operations (Ops) Manager or designee. Notification is based on program or sector specific criteria.

Immediate notification to the PD/Ops Manager is not required for some minor incidents. Follow the program or sector protocol.

Sector or Program PD/Ops Manager

Notify Client Program Manager OR Sector Director, provide guidance and follow the incident through to resolution.

Client Program Manager

Notify Sector Director; provide decision-making assistance or direction for incident resolution.

Keep unnecessary communication of serious incidents to a minimum.

Sector Director

Provide decision-making assistance or direction for incident resolution.

ES US Operations Director/ Executive Leadership Team

Provide decision-making assistance, direction for incident resolution, and make higher level notifications as necessary

Post-emergency incident communications regarding serious incidents at a CH2M HILL office or project (regardless of the party involved) shall be considered sensitive in nature and must be controlled in a confidential manner.

22.7 Incident Root Cause Analysis

The accident analysis is essential if all causes of the incident are to be identified for the correct remedial actions to be taken to prevent the same and similar type of incident from recurring. Root Cause Analysis (RCA) shall be completed for all recordable injuries, property damage incidents in excess of $5000.00 (US), environmental permit violations, spills and releases which are required to be reported to regulatory agencies, and any other incident, including near misses where they RHSM or PM determines an RCA is appropriate. The RHSM/REM is responsible for ensuring it is completed and results entered in the incident report form in HITS. RCA's must be completed using a Team that includes, at least the RHSM or designee, the involved party(ies), a responsible operations representative (e.g. PM, construction manager, crew supervisor, etc.) and an independent management representative not associated with the incident.

The Root Cause Analysis Form must be completed for all Loss Incidents and Near Loss Incidents. This form must be submitted to the investigation team for review.

For minor losses or near losses, the information may be gathered by the supervisor or other personnel immediately following the loss. Based on the complexity of the situation, this information may be all that is necessary to enable the investigation team to analyze the loss, determine the root cause, and develop recommendations. More complex situations may require the investigation team to revisit the loss site or re-interview key witnesses to obtain answers to questions that may arise during the investigation process.

Photographs or videotapes of the scene and damaged equipment should be taken from all sides and from various distances. This point is especially important when the investigation team will not be able to review the loss scene.

The investigation team must follow the Root Cause Analysis Flow Chart (see Attachment 4 of the SOP) to assist in identifying the root cause(s) of a loss. Any loss may have one or more root causes and contributing factors. The root cause is the primary or immediate cause of the incident, while a contributing factor is a condition or event that contributes to the incident happening, but is not the primary cause of the incident. Root causes and contributing factors that relate to the person involved in the loss, his or her peers, or the supervisor should be referred to as "personal factors." Causes that pertain to the system within which the loss or injury occurred should be referred to as "job factors."

Personal factors include:

- Lack of skill or knowledge;
- Correct way takes more time and/or requires more effort;
- Short-cutting standard procedures is positively reinforced or tolerated; or
- Person thinks there is no personal benefit to always doing the job according to standards.

Job Factors include:

- Lack of or inadequate operational procedures or work standards;
- Inadequate communication of expectations regarding procedures or standards; or
- Inadequate tools or equipment.

The root cause(s) could be any one or a combination of these seven possibilities or some other uncontrollable factor. In the vast majority of losses, the root cause is very much related to one or more of these seven factors. Uncontrollable factors should be used rarely and only after a thorough review eliminates all seven other factors.

22.7.1 Corrective Actions

Include all corrective actions taken or those that should be taken to prevent recurrence of the incident. Include the specific actions to be taken, the employer and personnel responsible for implementing the actions, and a timeframe for completion. Be sure the corrective actions address the causes.

Once the investigation report has been completed, the PM shall hold a review meeting to discuss the incident and provide recommendations. The responsible supervisors shall be assigned to carry out the recommendations, and shall inform the SC upon successful implementation of all recommended actions.

- Evaluation and follow-up of the IRF will be completed by the type of incident by the RHSM, EM, or FWSO.
- Incident investigations must be initiated and completed as soon as possible but no later than 72 hours after the incident.

23.0 Records and Reports

An organized project filing system is essential for good documentation and recordkeeping. There are many benefits to an organized filing system:

- Other CH2M HILL employees can easily and quickly find documents;
- Records are readily available for review;
- Records may be needed during OSHA investigations, audits, or other legal matters;
- Records may be needed on short notice in case of an accident, illness or other emergency; and
- Systematic recordkeeping aids in overall project organization.

The project filing system shall be established at the beginning of the project and maintained throughout all phases of construction and archived in accordance with CH2M HILL's Records Retention Policy. The information contained in the filing system shall be updated regularly and/or as specified in this document. The PM and SC are responsible for collecting documentation, including subcontractor documentation, and maintaining a complete and organized filing system.

Below are examples of records that must be maintained as the project progresses:

- Exposure records includes air monitoring data (including calibration records), MSDSs, exposure modeling results;
- Physical hazard exposure records include noise, ionizing radiation, non-ionizing radiation, vibration, and lasers exposure assessments and measurements;
- Respiratory fit test records;
- Training records;
- Incident reports, investigations and associated back-up information such as agency notifications, calculations, and corrective actions taken;
- Federal or state agency inspection records;
- Other Records:
    - Ergonomic evaluations;
    - HSE audits and assessments;
    - Project-specific HSE plans;
    - Confined space entry permits;
    - Equipment inspections;
    - Equipment maintenance;
    - Emergency equipment inspection records;
    - SBOs;
    - Self-assessment checklists
- The RHSM shall coordinate with the PM or designee to ensure that final project-specific HSE records described in this section, including negative exposure determinations, are maintained with the project files in accordance with the CH2M HILL records retention schedule, or forwarded to the Medical Surveillance Program Administrator, as appropriate. Records retention requirements are detailed in the Recordkeeping and Access to Records SOP, HSE-119.

Health and Safety Plan Employee Sign-off Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: MCAS Cherry Point OU1, Site 16 ZVI PRB **Project Number:** 424578

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Chemical Inventory/Register Form

CH2MHILL

CHEMICAL INVENTORY/REGISTER FORM

Refer to SOP HSE-107, Attachment 1, for instructions on completing this form.

Location:

HCC:

☐ Office ☐ Warehouse ☐ Laboratory ☐ Project:

Project No.: 424578

Regulated Product	Location	Container labeled (✓if yes)	MSDS available (✓if yes)
Methane	Support Zone		
Isobutylene	Support Zone		
Pentane	Support Zone		
Hydrochloric acid	Support Zone / sample bottles		
Nitric acid	Support Zone / sample bottles		
Sulfuric Acid	Support Zone / sample bottles		
Sodium hydroxide	Support Zone / sample bottles		
Methanol	Support/Decon Zones		
Hexane	Support/Decon Zones		
pH buffers	Support Zone		
MSA Sanitizer	Support/Decon Zones		
Alconox/Liquinox	Support/Decon Zones		

MSDS for the listed products will be maintained at:

CH2M HILL Health and Safety Plan
Attachment 3

Chemical-Specific Training Form

CH2MHILL

CHEMICAL-SPECIFIC TRAINING FORM

Refer to SOP HSE-107 Attachment 1 for instructions on completing this form.

Location: Project # : 424578

HCC: Trainer:

TRAINING PARTICIPANTS:

NAME	SIGNATURE	NAME	SIGNATURE

REGULATED PRODUCTS/TASKS COVERED BY THIS TRAINING:

The HCC shall use the product MSDS to provide the following information concerning each of the products listed above.

☐ Physical and health hazards

☐ Control measures that can be used to provide protection (including appropriate work practices, emergency procedures, and personal protective equipment to be used)

☐ Methods and observations used to detect the presence or release of the regulated product in the workplace (including periodic monitoring, continuous monitoring devices, visual appearance or odor of regulated product when being released, etc.)

Training participants shall have the opportunity to ask questions concerning these products and, upon completion of this training, will understand the product hazards and appropriate control measures available for their protection.

Copies of MSDSs, chemical inventories, and CH2M HILL's written hazard communication program shall be made available for employee review in the facility/project hazard communication file.

CH2M HILL Health and Safety Plan
Attachment 4

Project Activity Self-Assessment Checklists/Permits/Forms

- **Drilling**
- **Excavatation**
- **Forklifts**
- **Hand and Power Tools**
- **Hazardous Materials Handling**
- **Manual Lifting**
- **Personal Protective Equipment**
- **Traffic Control**
- **Vinyl Chloride**

HSE Self-Assessment Checklist - Drilling

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's written safety plan.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to drilling hazards, 2) CH2M HILL staff are providing support function related to drilling activities, and/or 3) CH2M HILL oversight of a drilling subcontractor is required.

Safety Coordinator may consult with drilling subcontractors when completing this checklist, but shall not direct the means and methods of drilling operations nor direct the details of corrective actions. Drilling subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately, or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: __________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to drilling hazards (complete Section 1).
☐ Evaluate CH2M HILL support functions related to drilling activities (complete Section 2)
☐ Evaluate a CH2M HILL subcontractor's compliance with drilling safety requirements (complete entire checklist).
Subcontractors Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the drilling subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in SOP HSE-204.

SECTION 1 - SAFE WORK PRACTICES (5.1)

	Yes	No	N/A	N/O
1. Personnel cleared during rig startup	☐	☐	☐	☐
2. Personnel clear while mast is being raised	☐	☐	☐	☐
3. Personnel clear of rotating parts	☐	☐	☐	☐
4. Personnel not positioned under hoisted loads	☐	☐	☐	☐
5. Loose clothing and jewelry removed	☐	☐	☐	☐
6. Smoking is prohibited around drilling operation	☐	☐	☐	☐
7. Personnel wearing appropriate personal protective equipment (PPE), per written plan	☐	☐	☐	☐
8. Personnel instructed not to approach equipment that has become electrically energized	☐	☐	☐	☐

SECTION 2 - SUPPORT FUNCTIONS (5.2)

AQUIFER DESIGNATIONS (5.2.1)

	Yes	No	N/A	N/O
9. Aquifer designations determined and BGEM consulted when required.	☐	☐	☐	☐

LOCATION OF UTILITIES (5.2.2)

	Yes	No	N/A	N/O
10. Location of underground utilities and structures identified	☐	☐	☐	☐
11. Power lines de-energized and grounded when safe distances cannot be maintained	☐	☐	☐	☐

SECTION 2 (Continued)

WASTE MANAGEMENT (5.2.3)	Yes	No	N/A	N/O
12. Drill cuttings and purge water managed and disposed properly	☐	☐	☐	☐
13. Wastes generated evaluated for proper disposal	☐	☐	☐	☐
14. Appropriate decontamination procedures being followed, per project's written safety plan	☐	☐	☐	☐
DRILLING AT ORDNANCE EXPLOSIVES OR UNEXPLODED ORDNANCE SITES (5.2.4)				
15. MEC plan prepared and approved	☐	☐	☐	☐
16. MEC avoidance provided, routes and boundaries cleared and marked	☐	☐	☐	☐
17. Initial pilot hole established by UXO technician with hand auger	☐	☐	☐	☐
18. Personnel remain inside cleared areas	☐	☐	☐	☐
SECTION 3 - DRILLING SAFETY REQUIREMENTS (5.3)				
GENERAL (5.3.1)				
19. Only authorized personnel operating drill rigs	☐	☐	☐	☐
20. Daily safety briefing/meeting conducted with crew	☐	☐	☐	☐
21. Daily inspection of drill rig and equipment conducted before use	☐	☐	☐	☐
22. Good housekeeping maintained on and around rig	☐	☐	☐	☐
SAFETY EQUIPMENT (5.3.2)				
23. Safety-toed shoes/boots, hardhats, safety glasses, gloves and hearing protection are worn	☐	☐	☐	☐
24. Drill rig equipped with fire extinguisher	☐	☐	☐	☐
25. Air monitoring instruments provided when required	☐	☐	☐	☐
26. PPE for protection from chemical hazards is worn if required				
DRILL RIG PLACEMENT (5.3.3)				
27. Location of underground utilities and structures identified	☐	☐	☐	☐
28. Safe clearance distance maintained from overhead power lines	☐	☐	☐	☐
29. Drilling pad established, when necessary	☐	☐	☐	☐
30. Drill rig leveled and stabilized	☐	☐	☐	☐
31. Additional precautions taken when drilling in confined areas	☐	☐	☐	☐
DRILL RIG TRAVEL (5.3.4)				
28. Rig shut down and mast lowered and secured prior to rig movement	☐	☐	☐	☐
29. Tools and equipment secured prior to rig movement	☐	☐	☐	☐
30. Only personnel seated in cab are riding on rig during movement	☐	☐	☐	☐
31. Backup alarm or spotter used when backing rig	☐	☐	☐	☐
32. Spotter used when backing rig in tight or confined areas or when low clearances exist	☐	☐	☐	☐
33. Safe clearance distance maintained while traveling under overhead power lines	☐	☐	☐	☐
EMERGENCY – CONTACT WITH OVERHEAD OR UNDERGROUND ELECTRICAL LINES (5.3.5)				
34. Personnel understand emergency procedures in the event of contact with overhead or underground electrical lines	☐	☐	☐	☐
DRILL RIG OPERATION (5.3.6)				
35. Kill switch clearly identified and operational	☐	☐	☐	☐
36. All machine guards are in place	☐	☐	☐	☐
37. Rig ropes never wrapped around any part of the body	☐	☐	☐	☐
38. Pressurized lines and hoses secured to prevent whipping hazards	☐	☐	☐	☐
39. Drilling operation stopped during inclement weather	☐	☐	☐	☐
40. Air monitoring conducted per written safety plan for hazardous atmospheres	☐	☐	☐	☐
41. Rig gear boxes placed in neutral when operator not at controls	☐	☐	☐	☐
42. Operator shuts rig engine down prior to leaving the drill rig vicinity	☐	☐	☐	☐

DRILL RIG SITE CLOSURE (5.3.7)

43. Ground openings/holes filled or barricaded ☐ ☐ ☐ ☐
44. Equipment and tools properly stored ☐ ☐ ☐ ☐
45. All vehicles locked and keys removed ☐ ☐ ☐ ☐

DRILL RIG MAINTENANCE (5.3.8)

46. Rig properly maintained per drilling company's maintenance program ☐ ☐ ☐ ☐
47. Defective components repaired immediately ☐ ☐ ☐ ☐
48. Lockout/tagout procedures used prior to maintenance ☐ ☐ ☐ ☐
49. Cathead in clean, sound condition ☐ ☐ ☐ ☐
50. Drill rig ropes in clean, sound condition ☐ ☐ ☐ ☐
51. Fall protection used for fall exposures of 6 feet (U.S.) 1.5 meters (Australia) or greater ☐ ☐ ☐ ☐
52. Rig in neutral and augers stopped rotating before cleaning ☐ ☐ ☐ ☐
53. Good housekeeping maintained on and around rig ☐ ☐ ☐ ☐

FORMS/PERMITS AND CHECKLISTS (7.0)

54. Driller license/certification obtained ☐ ☐ ☐ ☐
55. Well development/abandonment notifications and logs submitted and in project files ☐ ☐ ☐ ☐
56. Groundwater withdrawal permit obtained where required ☐ ☐ ☐ ☐
57. Dig permit obtained where required ☐ ☐ ☐ ☐

SECTION 4

Complete this section for all items checked “No” in previous sections. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

HS&E Self-Assessment Checklist—Excavations

This checklist shall be used by CH2M HILL personnel only and shall be completed at the frequency specified in the project's Health and Safety Plan/Field Safety Instruction (HSP/FSI).

This checklist is to be used at locations where: 1) CH2M HILL employees enter excavations (complete Sections 1 and 3), and/or 2) CH2M HILL oversight of an excavation subcontractor is required (complete entire checklist).

The SSC may consult with excavation subcontractors when completing this checklist, but shall not direct the means and methods of excavation operations nor direct the details of corrective actions. Excavation subcontractors shall determine how to correct deficiencies and we must rely on their expertise. Conditions considered imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazardous area until the situation is corrected.

Project Name: ______________________________ Project No.: ____________________

Location: ______________________________ PM: ______________________________

Auditor: ____________________ Title: ____________________________ Date: ___________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposures to excavation hazards
☐ Evaluate a CH2M HILL subcontractor's compliance with excavation HS&E requirements
Subcontractor Name: ____

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the excavation subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

SECTION 1	Yes	No	N/A	N/O
EXCAVATION ENTRY REQUIREMENTS (4.1)				
1. Personnel have completed excavation safety training	☐	☐	☐	☐
2. Competent person has completed daily inspection and has authorized entry	☐	☐	☐	☐
3. Personnel are aware of entry requirements established by competent person	☐	☐	☐	☐
4. Protective systems are free from damage and in stable condition	☐	☐	☐	☐
5. Surface objects/structures secured from falling into excavation	☐	☐	☐	☐
6. Potential hazardous atmospheres have been tested and found to be at safe levels	☐	☐	☐	☐
7. Precautions have been taken to prevent cave-in from water accumulation in the excavation	☐	☐	☐	☐
8. Personnel wearing appropriate, PPE per HSP/SI	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (4.2.1)				
9. Daily safety briefing/meeting conducted with personnel	☐	☐	☐	☐
10. Excavation and protective systems adequately inspected by competent person	☐	☐	☐	☐
11. Defective protective systems or other unsafe conditions corrected before entry	☐	☐	☐	☐
12. Guardrails provided on walkways over excavation 6 ft (1.8m) or deeper	☐	☐	☐	☐
13. Barriers provided at excavations 6 ft or deeper when excavation not readily visible	☐	☐	☐	☐
14. Barriers or covers provided for wells, pits, shafts, or similar excavation 6 ft (1.8 m) or deeper	☐	☐	☐	☐
15. Earthmoving equipment operated safely (use earthmoving equipment checklist in HSE-306)	☐	☐	☐	☐
PRIOR TO EXCAVATING (4.2.2)				
16. Dig Permit obtained where required by client/facility	☐	☐	☐	☐
17. Location of underground utilities and installations identified	☐	☐	☐	☐
EXCAVATING ACTIVITIES (4.2.3)				
26. Rocks, trees, and other unstable surface objects removed or supported	☐	☐	☐	☐
27. Exposed underground utility lines supported	☐	☐	☐	☐
28. Undermined surface structures supported or determined to be in safe condition	☐	☐	☐	☐
29. Warning system used to remind equipment operators of excavation edge	☐	☐	☐	☐
EXCAVATION ENTRY (4.2.4)				
32. Trenches > 4 ft (1.2 m) deep provided with safe means of egress within 25 ft (7.6 m)	☐	☐	☐	☐
33. Structure ramps designed and approved by competent person	☐	☐	☐	☐
34. Potential hazardous atmospheres tested prior to entry	☐	☐	☐	☐
35. Rescue equipment provided where potential for hazardous atmosphere exists	☐	☐	☐	☐
36. Ventilation used to control hazardous atmosphere and air tested frequently	☐	☐	☐	☐
37. Appropriate respiratory protection used when ventilation does not control hazards	☐	☐	☐	☐
38. Precautions taken to prevent cave-in resulting from water accumulation in excavation	☐	☐	☐	☐
39. Precautions taken to prevent surface water from entering excavation	☐	☐	☐	☐
40. Protection provided from falling/rolling material originating from excavation face	☐	☐	☐	☐
41. Spoil piles, equipment, materials restrained or kept at least 2 ft (61 cm) from excavation edge	☐	☐	☐	☐
EXCAVATION PROTECTIVE SYSTEMS (4.2.5)				
42. Protective systems used for excavations 5 ft (1.5 m) or deeper, unless in stable rock	☐	☐	☐	☐
43. Protective systems for excavation deeper than 20 ft (6.1 m) designed by registered PE	☐	☐	☐	☐
44. If soil unclassified, maximum allowable slope is 34 degrees	☐	☐	☐	☐
45. Protective systems free from damage	☐	☐	☐	☐
46. Protective system used according to manufacturer’s recommendations and not subjected to loads exceeding design limits	☐	☐	☐	☐
47. Protective system components securely connected to prevent movement or failure	☐	☐	☐	☐
48. Cave-in protection provided while entering/exiting shielding systems	☐	☐	☐	☐
49. Personnel removed from shielding systems when installed, removed, or if vertical movement	☐	☐	☐	☐

	Yes	No	N/A	N/O
PROTECTIVE SYSTEM REMOVAL AND BACKFILLING (4.2.6)				
50. Protective system removal starts and progresses from excavation bottom	☐	☐	☐	☐
51. Protective systems removed slowly and cautiously	☐	☐	☐	☐
52. Temporary structure supports used if failure of remaining components observed	☐	☐	☐	☐
53. Backfilling takes place immediately after protective system removal	☐	☐	☐	☐

H&S Self-Assessment Checklist - FORKLIFTS

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: 1) CH2M HILL employees are potentially exposed to hazards associated with forklift operations, 2) CH2M HILL employees are operating forklifts, and/or 3) CH2M HILL provides oversight of a subcontractor operating forklifts.

SC may consult with subcontractors using forklifts when completing this checklist, but shall not direct the means and methods of forklift operations nor direct the details of corrective actions. Subcontractors using forklifts shall determine how to correct deficiencies, and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: ________

This specific checklist has been completed to:

- ☐ Evaluate CH2M HILL employee exposures to forklift hazards (Complete Section 1).
- ☐ Evaluate CH2M HILL employees operating forklifts (Complete entire checklist).
- ☐ Evaluate a CH2M HILL subcontractor's compliance with forklift safety requirements (Complete entire checklist).
  Subcontractor's Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HS-48.

SAFE WORK PRACTICES (5.1) — SECTION 1	Yes	No	N/A	N/O
1. Personnel maintaining safe distance from operating forklifts.	☐	☐	☐	☐
2. Positioning personnel in proximity to operating forklifts is avoided.	☐	☐	☐	☐
3. Personnel wearing high-visibility vests when close to operating forklifts.	☐	☐	☐	☐
4. Personnel approach operating forklifts safely.	☐	☐	☐	☐
5. Personnel only riding in seats equipped with seat belts.	☐	☐	☐	☐
6. Personnel not lifted or lowered by forklift unless approved for such use.	☐	☐	☐	☐
7. Personnel not positioned under elevated loads or forks.	☐	☐	☐	☐
8. Personnel do not place body between mast uprights or outside running lines during operation.	☐	☐	☐	☐
9. Personnel do not touch or approach forklift that has become electrically energized.	☐	☐	☐	☐

FORKLIFT SAFETY REQUIREMENTS SECTION 2	Yes	No	N/A	N/O
PRIOR TO OPERATING FORKLIFT (5.2.1)				
10. Only certified personnel operating forklifts.	☐	☐	☐	☐
11. Daily safety briefing/meeting conducted with forklift operators.	☐	☐	☐	☐
12. Daily inspection of forklift conducted and documented.	☐	☐	☐	☐
13. Rated capacity of forklift visible to operator.	☐	☐	☐	☐
14. Modifications and attachments used approved by forklift manufacturer.	☐	☐	☐	☐
15. High-lift forklifts have load backrest and overhead guard.	☐	☐	☐	☐
16. Seat belts are provided and used.	☐	☐	☐	☐
17. Backup alarm or spotter used when backing forklift.	☐	☐	☐	☐
18. Operational horn provided and used as necessary.	☐	☐	☐	☐
19. Braking system capable of stopping capacity load.	☐	☐	☐	☐
20. Forklifts equipped with lights for low-light operations.	☐	☐	☐	☐
21. Carbon monoxide concentrations below PEL (50 ppm).	☐	☐	☐	☐
22. At least one fire extinguisher available at the forklift operating area.	☐	☐	☐	☐
DESIGNATIONS AND LOCATIONS (5.2.2)				
23. Atmosphere/locations classified as hazardous or non-hazardous.	☐	☐	☐	☐
24. Only properly designated forklifts used in hazardous locations.	☐	☐	☐	☐
FORKLIFT LOADING/UNLOADING (5.2.3)				
25. Operator handles only loads within rated capacity, adjusts for long or tall loads.	☐	☐	☐	☐
26. Loads are stabilized before forklift travel.	☐	☐	☐	☐
27. Operator using proper tilt to stabilize load, uses caution when tilting elevated loads.	☐	☐	☐	☐
28. When two forklifts lift a load in unison, operators stay in close communication.	☐	☐	☐	☐
29. Trucks, trailers, railroad cars secured from movement before entering with forklift.	☐	☐	☐	☐
30. Dockplates/bridgeplates secured before use; capacity not exceeded.	☐	☐	☐	☐
31. Truck, trailer, railroad car flooring checked for weakness before forklift boarding.	☐	☐	☐	☐
32. Personnel platforms secured to forklift and shut off means provided on platform.	☐	☐	☐	☐
FORKLIFT TRAVEL (5.2.4)				
33. Forklift operated on safe roadways and grades.	☐	☐	☐	☐
34. Grades ascended/descended properly.	☐	☐	☐	☐
35. Forklift operated at safe speed, kept under control at all times	☐	☐	☐	☐
36. Operators slow down and use horn at areas with obstructed vision.	☐	☐	☐	☐
37. Forklifts operating in reverse when load obstructs vision.	☐	☐	☐	☐
38. Operator keeping clear view of path of travel.	☐	☐	☐	☐
39. Forklifts do not pass other stopped vehicles at areas with obstructed vision.	☐	☐	☐	☐
40. Operators maintain safe distance from edge of ramps and platforms.	☐	☐	☐	☐
41. Overhead clearance maintained from installations.	☐	☐	☐	☐
42. Forklifts not parked within 8 feet of center of railroad tracks. Tracks crossed diagonally.	☐	☐	☐	☐
43. Forklift parked correctly when operator is dismounted.	☐	☐	☐	☐
FORKLIFT MAINTENANCE (5.2.5)				
44. Forklifts with unsafe conditions removed from service and tagged as such to prevent use.	☐	☐	☐	☐
45. Forklifts repaired in designated, non-hazardous locations by authorized personnel.	☐	☐	☐	☐
46. Battery disconnected when repairing electrical systems.	☐	☐	☐	☐
47. Additions or omissions of parts not performed without manufacturer's approval.	☐	☐	☐	☐
48. Good housekeeping maintained on and around forklift.	☐	☐	☐	☐
49. Water mufflers checked daily, kept at 75% full.	☐	☐	☐	☐
50. Forklifts removed from service if sparks, flames, or elevated operating temperatures occur.	☐	☐	☐	☐
51. Suspended forklifts or components are supported prior to work under or between.	☐	☐	☐	☐
52. Fueling/battery charging conducted in designated, well-ventilated area.	☐	☐	☐	☐
53. Fueling/battery charging areas properly equipped for task.	☐	☐	☐	☐
54. No smoking in fueling/battery charging areas.	☐	☐	☐	☐
55. Spillage of fuel properly cleaned up before starting forklift.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked “No” in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ________________________________ Project Manager: __________________________________

CH2MHILL

HSE Self-Assessment Checklist—HAND AND POWER TOOLS

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where: (1) CH2M HILL employees are exposed to hand and power tool hazards and/or (2) CH2M HILL provides oversight of subcontractor personnel who are exposed to hand and power tool hazards.

SC may consult with subcontractors when completing this checklist, but shall not direct the means and methods of hand and power tool use nor direct the details of corrective actions. Subcontractors shall determine how to correct deficiencies and we must carefully rely on their expertise. Items considered to be imminently dangerous (possibility of serious injury or death) shall be corrected immediately or all exposed personnel shall be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ____________________ Title: ____________________ Date: ________

This specific checklist has been completed to:

☐ Evaluate CH2M HILL employee exposure to hand and power tool hazards.
☐ Evaluate a CH2M HILL subcontractor's compliance with hand and power tool requirements.
Subcontractors Name: ______________________________

- Check "Yes" if an assessment item is complete/correct.
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-210.

SECTION 1

SAFE WORK PRACTICES (5.1)

	Yes	No	N/A	N/O
1. All tools operated according to manufacturer's instructions and design limitations.	☐	☐	☐	☐
2. All hand and power tools maintained in a safe condition and inspected and tested before use.	☐	☐	☐	☐
3. Defective tools are tagged and removed from service until repaired.	☐	☐	☐	☐
4. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
5. Power tools are not carried or lowered by their cord or hose.	☐	☐	☐	☐
6. Tools are disconnected from energy sources when not in use, servicing, cleaning, etc.	☐	☐	☐	☐
7. Safety guards remain installed or are promptly replaced after repair.	☐	☐	☐	☐
8. Tools are stored properly.	☐	☐	☐	☐
9. Cordless tools and recharging units both conform to electrical standards and specifications.	☐	☐	☐	☐
10. Tools used in explosive environments are rated for such use.	☐	☐	☐	☐
11. Knife or blade hand tools are used with the proper precautions.	☐	☐	☐	☐
12. Consider controls to avoid muscular skeletal, repetitive motion, and cumulative trauma stressors.	☐	☐	☐	☐

SECTION 2	Yes	No	N/A	N/O
GENERAL (5.2.2)				
13. PPE is selected and used according to tool-specific hazards anticipated.	☐	☐	☐	☐
14. Tools are tested daily to assure safety devices are operating properly.	☐	☐	☐	☐
15. Damaged tools are removed from service until repaired.	☐	☐	☐	☐
16. Power operated tools designed to accommodate guards have guards installed.	☐	☐	☐	☐
17. Rotating or moving parts on tools are properly guarded.	☐	☐	☐	☐
18. Machines designed for fixed locations are secured or anchored.	☐	☐	☐	☐
19. Floor and bench-mounted grinders are provided with properly positioned work rests.	☐	☐	☐	☐
20. Guards are provided at point of operation, nip points, rotating parts, etc.	☐	☐	☐	☐
21. Fluid used in hydraulic-powered tools is approved fire-resistant fluid.	☐	☐	☐	☐
ELECTRIC-POWERED TOOLS (5.2.3)				
22. Electric tools are approved double insulated or grounded and used according to SOP HSE-206.	☐	☐	☐	☐
23. Electric cords are not used for hoisting or lowering tools.	☐	☐	☐	☐
24. Electric tools are used in damp/ wet locations are approved for such locations or GFCI installed.	☐	☐	☐	☐
25. Hand-held tools are equipped with appropriate on/off controls appropriate for the tool.	☐	☐	☐	☐
26. Portable, power-driven circular saws are equipped with proper guards.	☐	☐	☐	☐
ABRASIVE WHEEL TOOLS (5.2.4)				
27. All employees using abrasive wheel tools are wearing eye protection.	☐	☐	☐	☐
28. All grinding machines are supplied with sufficient power to maintain spindle speed.	☐	☐	☐	☐
29. Abrasive wheels are closely inspected and ring-tested before use.	☐	☐	☐	☐
30. Grinding wheels are properly installed.	☐	☐	☐	☐
31. Cup-type wheels for external grinding are protected by the proper guard or flanges.	☐	☐	☐	☐
32. Portable abrasive wheels used for internal grinding are protected by safety flanges.	☐	☐	☐	☐
33. Safety flanges are used only with wheels designed to fit the flanges.	☐	☐	☐	☐
34. Safety guards on abrasive wheel tools are mounted properly and of sufficient strength.	☐	☐	☐	☐
PNEUMATIC-POWERED TOOLS (5.2.5)				
35. Tools are secured to hoses or whip by positive means to prevent disconnection.	☐	☐	☐	☐
36. Safety clips or retainers are installed to prevent attachments being expelled.	☐	☐	☐	☐
37. Safety devices are installed on automatic fastener feed tools as required.	☐	☐	☐	☐
38. Compressed air is not used for cleaning unless reduced to < 30 psi, with PPE, and guarded.	☐	☐	☐	☐
39. Manufacturer’s safe operating pressure for hoses, pipes, valves, etc. are not exceeded.	☐	☐	☐	☐
40. Hoses are not used for hoisting or lowering tools.	☐	☐	☐	☐
41. All hoses >1/2-inch diameter have safety device at source to reduce pressure upon hose failure.	☐	☐	☐	☐
42. Airless spray guns have required safety devices installed.	☐	☐	☐	☐
43. Blast cleaning nozzles are equipped with operating valves, which are held open manually.	☐	☐	☐	☐
44. Supports are provided for mounting nozzles when not in use.	☐	☐	☐	☐
45. Air receiver drains, handholes, and manholes are easily accessible.	☐	☐	☐	☐
46. Air receivers are equipped with drainpipes and valves for removal of accumulated oil and water.	☐	☐	☐	☐
47. Air receivers are completely drained at required intervals.	☐	☐	☐	☐
48. Air receivers are equipped with indicating pressure gauges.	☐	☐	☐	☐
49. Safety, indicating, and controlling devices are installed as required.	☐	☐	☐	☐
50. Safety valves are tested frequently and at regular intervals to assure good operating condition.	☐	☐	☐	☐

SECTION 2 (continued)

	Yes	No	N/A	N/O
LIQUID FUEL-POWERED TOOLS (5.2.6)				
51. Liquid fuel-powered tools are stopped when refueling, servicing, or maintaining.	☐	☐	☐	☐
52. Liquid fuels are stored, handled, and transported in accordance with SOP HSE-403	☐	☐	☐	☐
53. Liquid fuel-powered tools are used in confined spaces in accordance with SOP HSE-203.	☐	☐	☐	☐
54. Safe operating pressures of hoses, valves, pipes, filters, and other fittings are not exceeded.	☐	☐	☐	☐
POWDER-ACTUATED TOOLS (5.2.7)				
55. Only trained employee operates powder-actuated tools.	☐	☐	☐	☐
56. Powder-actuated tools are not loaded until just prior to intended firing time.	☐	☐	☐	☐
57. Tools are not pointed at any employee at any time.	☐	☐	☐	☐
58. Hands are kept clear of open barrel end.	☐	☐	☐	☐
59. Loaded tools are not left unattended.	☐	☐	☐	☐
60. Fasteners are not driven into very hard or brittle materials.	☐	☐	☐	☐
61. Fasteners are not driven into easily penetrated materials unless suitable backing is provided.	☐	☐	☐	☐
62. Fasteners are not driven into spalled areas.	☐	☐	☐	☐
63. Powder-actuated tools are not used in an explosive or flammable atmosphere.	☐	☐	☐	☐
64. All tools are used with correct shields, guards, or attachments recommended by manufacturer.	☐	☐	☐	☐
JACKING TOOLS (5.2.8)				
65. Rated capacities are legibly marked on jacks and not exceeded.	☐	☐	☐	☐
66. Jacks have a positive stop to prevent over-travel.	☐	☐	☐	☐
67. The base of jacks are blocked or cribbed to provide a firm foundation, when required.	☐	☐	☐	☐
68. Wood blocks are place between the cap and load to prevent slippage, when required.	☐	☐	☐	☐
69. After load is raised, it is cribbed, blocked, or otherwise secured immediately.	☐	☐	☐	☐
70. Antifreeze is used when hydraulic jacks are exposed to freezing temperatures.	☐	☐	☐	☐
71. All jacks are properly lubricated.	☐	☐	☐	☐
72. Jacks are inspected as required.	☐	☐	☐	☐
73. Repair or replacement parts are examined for possible defects.	☐	☐	☐	☐
74. Jacks not working properly are removed from service and repaired or replaced.	☐	☐	☐	☐
HAND TOOLS (5.2.9)				
75. Wrenches are not used when jaws are sprung to the point of slippage.	☐	☐	☐	☐
76. Impact tools are kept free of mushroomed heads.	☐	☐	☐	☐
77. Wooden handles of tools are kept free of splinters or cracks and are tightly fitted in tool.	☐	☐	☐	☐

CHAIN SAWS (5.2.10)	**Yes**	**No**	**N/A**	**N/O**
78. Chainsaw equipped with spark arrestor and fully functioning chain brake	☐	☐	☐	☐
79. Chainsaw operator's manual readily available	☐	☐	☐	☐
80. Fully stocked first aid kit and multipurpose fire extinguisher available	☐	☐	☐	☐
81. Appropriate personal protective equipment available and worn	☐	☐	☐	☐
82. Clothing free of loose edges that could become entangled in the saw	☐	☐	☐	☐
83. Chainsaw handles kept dry, clean, and free of oil or fuel mixture	☐	☐	☐	☐
84. Chainsaws held firmly with both hands and used right-handed	☐	☐	☐	☐
85. Operator standing to the left of the saw out of the plane of the chain	☐	☐	☐	☐
86. Saw used between the waist and mid-chest level	☐	☐	☐	☐
87. Full throttle maintained while cutting	☐	☐	☐	☐
88. Operator aware of position of guide bar tip, does not contact tip with anything being cut	☐	☐	☐	☐
89. Bumper spikes maintained as close to the object as possible	☐	☐	☐	☐
90. Operator aware of what is in the saw's downward path after the cut	☐	☐	☐	☐
91. No attempt to made to cut material that is larger than the guide bar of the saw	☐	☐	☐	☐
92. Cuts avoided that will cause chain to jam	☐	☐	☐	☐
93. Non-metallic wedges used to prevent compression cuts from jamming the blade	☐	☐	☐	☐
94. Bystanders and helpers kept at a safe distance from operation	☐	☐	☐	☐
95. Chainsaw not operated when fatigued	☐	☐	☐	☐
96. Fire extinguisher present when operating the chainsaw in forest or brushy areas	☐	☐	☐	☐

CH2MHILL

HS&E Self-Assessment Checklist: HAZARDOUS MATERIALS

This checklist is provided as a method of verifying compliance with regulations pertaining to the handling of hazardous materials. It shall be used at locations where CH2M HILL employees handle hazardous materials, or are required to perform oversight of subcontractor personnel handling hazardous materials, or both.

CH2M HILL staff shall not direct the means and methods of subcontractor operations nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies, and CH2M HILL staff must carefully rely on the subcontractor's expertise. Items considered imminently dangerous (possibility of serious injury or death) must be corrected immediately, or all exposed personnel must be removed from the hazard until it is corrected.

Completed checklists must be sent to the appropriate regional health and safety program manager for review.

Project Name: ______________________ Project No.: ____________
Location: ______________________ PM: ____________
Auditor: ____________ Title: ____________ Date: ________

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with hazardous material handling requirements (SOP HSE-403)
☐ Evaluate a CH2M HILL subcontractor‟s compliance with hazardous material requirements
Subcontractor‟s Name: ______________________

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-403.

SECTION 1	Yes	No	N/A	N/O
PROCEDURES FOR HAZARDOUS MATERIAL HANDLING (6.0) **GENERAL GUIDELINES (6.1)**				
1. Acids are stored away from bases.	☐	☐	☐	☐
2. Oxidizers and organics are stored away from inorganic reducing agents.	☐	☐	☐	☐
3. Flammables and corrosives are stored in appropriate storage cabinets.	☐	☐	☐	☐
4. Paper and other combustibles are not stored near flammables.	☐	☐	☐	☐
5. Secondary containment and lipped shelving are in place in storage areas.	☐	☐	☐	☐
6. A fire suppression system is available.	☐	☐	☐	☐
SPILL CONTROL/CLEANUP (6.2)				
7. Spill control materials are located on the project site.	☐	☐	☐	☐
HAZARDOUS CHEMICAL INVENTORY REPORTING (6.3)				
8. Reporting is required if the project site handles and stores 10,000 lb or more of a hazardous chemical.	☐	☐	☐	☐
9. Or 500 lb or the threshold planning quantity (TPQ) of an extremely hazardous substance.	☐	☐	☐	☐
10. Regional ECC has been consulted for hazardous chemical inventory reporting.	☐	☐	☐	☐
TOXIC CHEMICAL RELEASE REPORTING				
11. Reporting requirements for toxic chemical release reporting have been followed.	☐	☐	☐	☐

SECTION 1 (continued)	Yes	No	N/A	N/O
FLAMMABLE AND COMBUSTIBLE LIQUIDS (6.5)				
GENERAL STORAGE (6.5.1)				
12. Only approved containers/portable tanks used to store flammable and combustible liquids.	☐	☐	☐	☐
13. Approved safety cans used for handling flammable liquids in quantities 1-5 gallons.	☐	☐	☐	☐
14. For quantities of one gallon or less, the original container must be used for storage.	☐	☐	☐	☐
15. Flammable or combustible liquids are not stored in stairways or personnel passageways.	☐	☐	☐	☐
INDOOR STORAGE (6.5.2)				
16. Quantities of flammable or combustible liquids > 25 gallons stored in approved storage cabinet.	☐	☐	☐	☐
17. No more than 25 gallons of flamm. or comb. liquids can be stored outside an approved cabinet.	☐	☐	☐	☐
18. Cabinets are labeled with "„FLAMMABLE: KEEP FIRE AWAY."	☐	☐	☐	☐
19 No more than 60 gallons of flamm. or 120 gallons of comb. liquids stored in one storage cabinet.	☐	☐	☐	☐
20. Not more than three cabinets located in a single storage area.	☐	☐	☐	☐
OUTSIDE STORAGE (6.5.3)				
21. Storage of containers (not more than 60 gallons each) do not exceed 1,100 gallons in any area.	☐	☐	☐	☐
22. Storage areas are not within 20 feet of any building.	☐	☐	☐	☐
23. Storage areas graded to divert spills away from buildings and surrounded by an earth dike.	☐	☐	☐	☐
24. Storage areas are free from weeds, debris, and other combustible materials.	☐	☐	☐	☐
25. Outdoor portable tanks are provided with emergency vent devices.	☐	☐	☐	☐
26. Outdoor portable tanks are no closer than 20 feet from any building.	☐	☐	☐	☐
27. Signs indicating no smoking are posted around the storage area.	☐	☐	☐	☐
DISPENSING (6.5.4)				
28. Areas where liquids are dispensed in >5-gal quantities are separated from other operations by 25‟.	☐	☐	☐	☐
29. Drainage or other means provided to control spills.	☐	☐	☐	☐
30. Adequate natural or mechanical ventilation provided to maintain concentration of flammable vapor < 10% of the lower flammable limit.	☐	☐	☐	☐
31. Dispensing of flammable liquids from one container to another is done only when containers are electrically interconnected (bonded).	☐	☐	☐	☐
32. Dispensing flammable or combustible liquids by means of air pressure on the container or portable tanks prohibited.	☐	☐	☐	☐
33. Dispensing devices and nozzles for flammable liquids are of an approved type.	☐	☐	☐	☐
USE (6.5.5)				
34. Flammable liquids are kept in closed containers when not in actual use.	☐	☐	☐	☐
35. Leakage or spillage of flammable or combustible liquids is disposed of promptly and safely.	☐	☐	☐	☐
36. Sources of ignition are kept at least 50 feet from flammable liquids.	☐	☐	☐	☐
LIQUID PETROLEUM GAS (6.6)				
37. LPG containers meet DOT requirements.	☐	☐	☐	☐
38. Each container or system has a safety relief device or valve in good working order.	☐	☐	☐	☐
39. Portable heaters using LPG have an automatic shutoff device in the event of flame failure.	☐	☐	☐	☐
40. Storage of LPG within buildings is prohibited.	☐	☐	☐	☐
41. LPG storage location has at least one portable fire extinguisher rated not less than 20-B:C.	☐	☐	☐	☐

SECTION 1 (continued)	Yes	No	N/A	N/O
COMPRESSED GAS CYLINDERS (6.7)				
GENERAL (6.7.1)				
42. Cylinders and apparatus inspected for defects and leakage prior to use. Damaged items not used.	☐	☐	☐	☐
43. Gas distributor notified and subsequent instructions followed for defective cylinders.	☐	☐	☐	☐
44. Leaking cylinders removed from the work area.	☐	☐	☐	☐
45. Cylinder users do not modify, tamper, or attempt repair on cylinders or apparatus.	☐	☐	☐	☐
46. Only cylinder owners or authorized agent refill cylinders or attempt to mix gases in a cylinder.	☐	☐	☐	☐
47. Cylinders labeled with the identity of the contents.	☐	☐	☐	☐
TRANSPORTING (6.7.2)				
48. Cylinders not rolled in the horizontal position or dragged; suitable material-handling device used.	☐	☐	☐	☐
49. Cylinders being transported have valve protection caps installed.	☐	☐	☐	☐
50. Cylinders in vertical position when transported by motor vehicle, hoisted, or carried.	☐	☐	☐	☐
51. Cylinders hoisted by a cradle or pallet designed for such use, and not by magnets, slings, or their valve protection caps.	☐	☐	☐	☐
STORAGE (6.7.3)				
52. Cylinders are stored in the vertical position with valve protection caps installed.	☐	☐	☐	☐
53. Cylinders are secured from being knocked over by a chain or other stabilizing device.	☐	☐	☐	☐
54. Cylinders are stored away from readily ignitable substances.	☐	☐	☐	☐
55. Cylinders are protected from exposure to temperature extremes.	☐	☐	☐	☐
56. Oxygen cylinders in storage are separated from fuel gas cylinders or combustible materials > 20"	☐	☐	☐	☐
or by a ½-hour fire-resistant barrier at least 5" high.	☐	☐	☐	☐
57. Cylinders inside buildings are stored in dry, well-ventilated locations > 20" from comb. materials.	☐	☐	☐	☐
58. Cylinders are stored in definitely assigned places away from elevators, stairs, or gangways.	☐	☐	☐	☐
59. Signs indicating no smoking are provided for storage areas containing flammable gas cylinders.	☐	☐	☐	☐
PLACEMENT FOR USAGE (6.7.4)				
60. Cylinders are located where they will not be knocked over or damaged.	☐	☐	☐	☐
61. Cylinders are secured in the vertical position.	☐	☐	☐	☐
62. Cylinders are not placed where they can become part of an electrical circuit.	☐	☐	☐	☐
63. Cylinders are kept far enough away from welding and cutting operations to prevent sparks, hot slag, or flames from reaching them. When impractical, fire resistant shields are provided.	☐	☐	☐	☐
64. Cylinders are not taken into confined spaces.	☐	☐	☐	☐
CYLINDER CONNECTIONS (6.7.5)				
65. Pressure-controlling apparatus is compatible with the particular gas used.	☐	☐	☐	☐
66. Cylinders and pressure-controlling apparatus are kept free of oil and grease.	☐	☐	☐	☐
67. Pressure-controlling apparatus is kept gastight to prevent leakage.	☐	☐	☐	☐
68. Cylinders not attached to process where backflow could occur unless check valves or traps used.	☐	☐	☐	☐
69. Manifolds designed for product used at the appropriate temperatures, pressures, and flow rates.	☐	☐	☐	☐
70. Manifolds are labeled and placed in well-ventilated and accessible locations.	☐	☐	☐	☐
71. Cylinders are not cross-connected with plant air lines.	☐	☐	☐	☐
72. Flash arrestors or reverse flow check valves are installed on all flammable gas cylinders.	☐	☐	☐	☐
USAGE (6.7.6)				
73. Eye protection (safety glasses or goggles) is worn when using cylinders.	☐	☐	☐	☐
74. Cylinder valve and regulator are inspected for foreign material before connecting.	☐	☐	☐	☐
75. If cylinders are frozen, warm (not boiling) water is used to thaw cylinders.	☐	☐	☐	☐
76. Cylinder valve remains closed except when the cylinder is in use.	☐	☐	☐	☐
77. Fuel gas cylinder valves are not opened more than 1½ turns, for quick closing.	☐	☐	☐	☐
78. If a special wrench is used to open a cylinder valve, it is left in position on the valve.	☐	☐	☐	☐

SECTION 1 (continued)	Yes	No	N/A	N/O
USAGE (continued) (6.7.6)				
79. Acetylene cylinders are used in the vertical position.	☐	☐	☐	☐
80. Acetylene cylinders are not used > 15 psig or > 30 psia.	☐	☐	☐	☐
81. Copper pipe or fittings are not used with acetylene systems.	☐	☐	☐	☐
82. Compressed gas is not used to dust off clothing.	☐	☐	☐	☐
83. Cylinder valve closed and regulator relieved of internal pressure before regulators are removed.	☐	☐	☐	☐
EXPLOSIVES (6.8)				
84. Written authorization provided by Munitions Market Segment Leader designating individuals who can store or use high explosives under the authority of the CH2M HILL BATF Type 33 User of High Explosives License/permit.	☐	☐	☐	☐
85. Written authorization provided by Munitions Market Segment Leader designating individuals who can manufacture high explosives under the authority of the CH2M HILL BATF Type 20 Manufacturer of High Explosives License/permit.	☐	☐	☐	☐
86. Approved Explosive Siting Plan (ESP).	☐	☐	☐	☐
87. Approved Explosive Management Plan (EMP).	☐	☐	☐	☐
88. Sources of ignition are not brought in or near storage magazines, or within 50‟ of an area where explosives are being handled, transported, or used.	☐	☐	☐	☐
89. Radio transmitting or receiving equipment is not brought within 1,000‟ of blasting activities.	☐	☐	☐	☐
90. Transportation and storage of explosives comply with local, state, and federal regulations.	☐	☐	☐	☐
91. Vehicles transporting explosives are placarded and displayed according to DOT regulations.	☐	☐	☐	☐
92. Detonators or blasting caps are not stored with explosive charges.	☐	☐	☐	☐
93. Explosives are stored in storage magazines as required by local, state, and federal regulations.	☐	☐	☐	☐
94. Contact the Munitions Response market Segment Leader for additional instructions	☐	☐	☐	☐
	☐	☐	☐	☐
PROCEDURES FOR HAZARDOUS MATERIALS SHIPPING (7.0)				
1. Only dangerous goods shippers are permitted to ship dangerous goods (CH2M HILL only).	☐	☐	☐	☐
2. Dangerous goods are shipped or transported in accordance with CH2M HILL‟s procedures.	☐	☐	☐	☐
3. All personnel shipping dangerous goods have completed the computer-based training (CH2M HILL only)	☐	☐	☐	☐
4. Dangerous goods are stored only in the equipment warehouse prior to shipping.	☐	☐	☐	☐
5. Written authorization provided by Munitions Market Segment Leader designating individuals who can "offer explosives for shipment" under the authority of the CH2M HILL Department of Transportation Hazardous Materials Certificate of Registration				
SHIPPING BY AIR (7.1)				
5. Shipments for Federal Express meet IATA requirements for dangerous goods.	☐	☐	☐	☐
6. Before shipping, packages are clearly identified, packed, marked, labeled, and documented.	☐	☐	☐	☐
7. The quantity does not exceed IATA regulations.	☐	☐	☐	☐
8. Packaging meets IATA requirements and withstand transport by air.	☐	☐	☐	☐
9. Shipper classifies each item into one of the 9 hazard classes.	☐	☐	☐	☐
10. Inner packages are packed to prevent breaking or leaking during shipping.	☐	☐	☐	☐
11. Absorbent or cushioning material does not react with the contents of the inner package.	☐	☐	☐	☐
12. Outer packages in fiberboard, a plastic case, or other sturdy container.	☐	☐	☐	☐
13. Package is capable of withstanding 4‟ drop test with no damage.	☐	☐	☐	☐
14. Package is marked with: proper shipping name of contents, technical name, UN number, total net. quantity, and the name and address of the shipper and recipient.	☐	☐	☐	☐
15. Irrelevant labels have been removed from package.				
16. Hazard label and handling label are secured in correct locations.	☐	☐	☐	☐
17. Dangerous goods airbill has been completed.	☐	☐	☐	☐
18. Dangerous goods are not shipped via UPS.	☐	☐	☐	☐

SECTION 1 (continued)

SHIPPING BY HIGHWAY (7.2)

	Yes	No	N/A	N/O
19. Use Federal Express packaging and paperwork requirements that comply with DOT regs for ground transportation of dangerous goods.	☐	☐	☐	☐
20. Consult with local state highway police if route includes vehicular tunnels.	☐	☐	☐	☐
21. Inner packaging prevents breakage or leakage under normal conditions of transport.	☐	☐	☐	☐
22. Absorbent/cushioning material does not react with contents of the package.	☐	☐	☐	☐
23. Labels for highway transportation are the same as those for air transportation.	☐	☐	☐	☐
24. Engine turned off, brake set during loading and unloading.	☐	☐	☐	☐

EMERGENCY RESPONSE (7.3)

	Yes	No	N/A	N/O
25. Appropriate emergency response information available not on the package, within reach of driver.	☐	☐	☐	☐
26. Information includes copy of pages from *Emergency Response Guidebook* for each item.	☐	☐	☐	☐
27. An MSDS for each item must also be included.	☐	☐	☐	☐
28. Emergency response information must also include the information found on the shipping papers.	☐	☐	☐	☐
29. CH2M HILL‟s 24-hour EMERGENCY RESPONSE TELEPHONE NUMBER, (800) 255-3954, is included, as required.	☐	☐	☐	☐
30. In the event of an accident, keep other individuals, except response workers, from the vicinity.	☐	☐	☐	☐
31. In case of breakage, spillage, or leakage, use means to prevent spreading and contain the spill.	☐	☐	☐	☐
32. Care taken during the handling of cargo to minimize hazards.	☐	☐	☐	☐
33. MSDS is consulted for safe handling procedures.	☐	☐	☐	☐
34. Wash the area of the vehicle where the dangerous goods may have spilled.	☐	☐	☐	☐
35. Consult your supervisor in the event of a spill.	☐	☐	☐	☐
36. Ask your supervisor to call CHEM-TEL of the local HAZMAT unit if the spill poses a danger.	☐	☐	☐	☐

SECTION 2 Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.		
Item #	**Corrective Action Planned or Taken**	**Date Corrected**

]

Auditor: ________________________________ Project Manager: __________________________________

CH2MHILL

HS&E Self-Assessment Checklist: PPERSONAL PROTECTIVE EQUIPMENT

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI.

This checklist is to be used at locations where CH2M HILL employees are required to wear PPE or are required to perform oversight of a subcontractor using PPE or both.

CH2M HILL staff shall not direct the means and methods of subcontractor use of PPE nor direct the details of corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________

Location: ______________________________ PM: ______________________

Auditor: ________________ Title: ____________________ Date: ________

This specific checklist has been completed to (check only one of the boxes below):

☐ Evaluate CH2M HILL compliance with its PPE program (SOP HSE-117)
☐ Evaluate a CH2M HILL subcontractor's compliance with its PPE program
Subcontractor's Name: ______________________________________

Check the appropriate box, as follows:

- Check "Yes" if an assessment item is complete or correct.
- Check "No" if an item is incomplete or deficient. Section 2 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable.
- Check "N/O" if an item is applicable but was not observed during the assessment.

Numbers in parentheses indicate where a description of this assessment item can be found in Standard of Practice HSE-121.

SECTION 1	Yes	No	N/A	N/O
GENERAL				
1. Required PPE listed in HSP FSI or AHA.	☐	☐	☐	☐
2. PPE available for use by employees.	☐	☐	☐	☐
3. PPE cleaning supplies available for use.	☐	☐	☐	☐
4. PPE stored appropriately to prevent deformation or distortion.	☐	☐	☐	☐
5. PPE written certification has been completed.	☐	☐	☐	☐
EYEWEAR (Glasses/Goggles/Face Shields)				
6 Eyewear cleaning supplies available.	☐	☐	☐	☐
7 Safety glasses in good condition and lenses free of scratches.	☐	☐	☐	☐
8 Goggles adjustment strap not cracked or frayed, not deformed, or lenses not scratched.	☐	☐	☐	☐
9. Face shields in good condition, including adjustment band, and free of scratches or chips.	☐	☐	☐	☐

CH2MHILL

HS&E Self-Assessment Checklist: PERSONAL PROTECTIVE EQUIPMENT

SECTION 1 (Continued)	Yes	No	N/A	N/O
HEAD PROTECTION				
10. Hard hat bill and suspension attached as allowed by manufacturer.	☐	☐	☐	☐
11. Shell is pliable, free of dents, cracks, nicks, or any damage due to impact.	☐	☐	☐	☐
12. Suspension maintained at 1.25 inches from inside of shell.	☐	☐	☐	☐
13. Suspension free of cuts or fraying, torn headband, adjustment strap workable.	☐	☐	☐	☐
14. Electrical hard hat matched to hazard classification.	☐	☐	☐	☐
15. Dated to determine whether within manufacturer's allowable 5-year use time period.	☐	☐	☐	☐
HAND PROTECTION				
16. Available in sizes matched to employee.	☐	☐	☐	☐
17. Gloves free of rips tears, abrasions, or holes.	☐	☐	☐	☐
18. Matched to manufacturer's specification for chemicals used onsite.	☐	☐	☐	☐
19. Electrical gloves matched to hazard and periodically inspected for insulating rating.	☐	☐	☐	☐
20. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
BODY PROTECTION				
21. Available in sizes matched to employee.	☐	☐	☐	☐
22. Maintained in a clean and sanitary condition, decontaminated or disposed properly.	☐	☐	☐	☐
23. Vapor-tight fully encapsulated suits tested at required periodic intervals.	☐	☐	☐	☐
24. Flame-resistant clothing matched to electrical hazard and arc flash rating.	☐	☐	☐	☐
25 Welding gear matched to degree of hazard and free of cuts, tears or burn holes.	☐	☐	☐	☐
26 Flotation gear available for work near or on water and in good condition.	☐	☐	☐	☐
HOT AND COLD BODY PROTECTION				
27 Cooling gear available based on degree of heat stress hazard.	☐	☐	☐	☐
28 Cooling gear in operable, clean, and sanitary condition.	☐	☐	☐	☐
29 Cold-weather gear provided based on needs assessment.	☐	☐	☐	☐
30. Cold-weather gear available in sizes to match employees.	☐	☐	☐	☐
31 Cold-weather gear is in free of tears, rips, or holes and in maintained in a clean condition.	☐	☐	☐	☐
TRAINING				
32 Initial PPE training completed by employees.	☐	☐	☐	☐
33 Training conducted when new types or styles of PPE are issued.	☐	☐	☐	☐
34 PPE selection, use, and maintenance reviewed at daily safety briefings.	☐	☐	☐	☐

SECTION 2

Complete this section for all items checked “No” in Section 1. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned or Taken	Date Corrected

Auditor: _________________________________ Project Manager: ____________________________________

CH2MHILL

HS&E Self-Assessment Checklist -Vinyl Chloride

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI. This checklist is to be used at locations where CH2M HILL employees are exposed to vinyl chloride, or are required to perform oversight of a subcontractor whose personnel are exposed to vinyl chloride.

CH2M HILL staff shall not direct the means and methods of subcontractor vinyl chloride activities nor direct the details of appropriate corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: ______________________________ Project No.: ______________
Location: ______________________________ PM:
Auditor: ____________________ Title: ________________ Date: ________
This specific checklist has been completed to:

☐ Evaluate CH2M HILL compliance with its Vinyl Chloride program (SOP HSE-512)
☐ Evaluate a CH2M HILL subcontractor's compliance with its Vinyl Chloride program

Subcontractors Name: ______________________________________

- Check "Yes" if an assessment item is complete/correct
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable
- Check "N/O" if an item is applicable but was not observed during the assessment

SECTION 1

	Yes	No	N/A	N/O
PERSONNEL SAFE WORK PRACTICES (5.1)				
COMPLIANCE PROGRAM (5.1.1)				
1. A written compliance program is established for work above the PEL.	☐	☐	☐	☐
2. The compliance program includes means of maintaining exposures below the PEL	☐	☐	☐	☐
3. The compliance program is based on the most recent air monitoring results.	☐	☐	☐	☐
4. Written compliance program is available to all affected employees.	☐	☐	☐	☐
5. Waste generated must be determined if considered hazardous waste.	☐	☐	☐	☐
EMPLOYEE INFORMATION (5.1.2)				
6. CH2M HILL personnel have completed the Vinyl Chloride Training Module.	☐	☐	☐	☐
7. Training on the Fact Sheet, HSP/FSI and OSHA standard has been met.	☐	☐	☐	☐
8. The selection of the appropriate respirator is based on the airborne vinyl concentration.	☐	☐	☐	☐
9. Written or verbal notification to owners, contractors or other personnel working in the area of vinyl chloride work activities.	☐	☐	☐	☐
10. Storage, waste or shipping containers have been properly labeled	☐	☐	☐	☐

	Yes	No	N/A	N/O
REGULATED AREAS (5.1.3)				
11. Areas that exceed the PELs (TWA or STEL) have been designated as regulated areas.	☐	☐	☐	☐
12. Personnel do not enter regulated areas unless they meet training, medical and PPE requirements	☐	☐	☐	☐
13. Warning signs have been posted at all entrances to the regulated areas.	☐	☐	☐	☐
Exposure Assessment (5.2)				
14. Initial air monitoring (TWA & STEL) conducted over full shift for each job classification	☐	☐	☐	☐
15. Air monitoring has been repeated when a change in production or controls occurred.	☐	☐	☐	☐
16. Personnel exhibiting signs of exposure have been monitored.	☐	☐	☐	☐
17. EL> AL have been resampled in the last 6 months.	☐	☐	☐	☐
18. EL $\geq$ PEL have been resampled in the 3 months.	☐	☐	☐	☐
19. Air monitoring results above the STEL have been resampled according to frequency established by RHSM.	☐	☐	☐	☐
20. Employees are given opportunities to observe monitoring	☐	☐	☐	☐
21. Relevant employees are notified within 15 days in writing of the results of monitoring.	☐	☐	☐	☐
CONTROL METHODS (5.3)				
ENGINEERING AND WORK PRACTICE CONTROLS (5.3.1)				
22. Engineering controls and work practices are implemented to reduce exposures to below the PEL.	☐	☐	☐	☐
23. Engineering and work practices are implemented to achieve the lowest feasible exposures.	☐	☐	☐	☐
24. Employees are not allowed to eat, drink or smoke in regulated areas.	☐	☐	☐	☐
25. Action plans have been developed to respond to spills.	☐	☐	☐	☐
26. Employees responding to spills have been trained and supplied with PPE	☐	☐	☐	☐
27. Vinyl chloride-contaminated waste is properly handled.	☐	☐	☐	☐
RESPIRATORY PROTECTION (5.3.2)				
28. Respirators are used in areas where EL $\geq$ PEL.	☐	☐	☐	☐
29. A written respiratory protection program is in place where respirators are used.	☐	☐	☐	☐
30. Cartridges changed based on change schedule or at the beginning of each shift.	☐	☐	☐	☐
Personal Protective Equipment (5.3.3)				
31. PPE is provided by the employer at no cost to employees.	☐	☐	☐	☐
32. PPE is selected based on the materials, conditions, and hazards present.	☐	☐	☐	☐
33. PPE is provided clean and dry for each use	☐	☐	☐	☐
34. Personnel who clean or launder protective clothing are informed in writing of the hazards.	☐	☐	☐	☐

SECTION 3

Complete this section for all items checked "No' in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ______________________________ Project Manager: ___________________________

HEAT STRESS PHYSIOLOGICAL MONITORING FORM

Project	Company

1. Take and record measurement of temperature and pulse at the following times:
   a. before beginning shift
   b. at each break
   c. at the end of the day

2. Shorten the work cycle by one third if measurements exceed:
   Pulse – 110 beats per minute
   Temperature – 99.6° F/37.6° C

3. Never continue work if your body temperature is more than 100.4° F/38° C, or if you are experiencing sudden and severe fatigue, nausea, dizziness, or lightheadedness.

Employee: ______________________________
Date: ____________________ Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee: ______________________________
Date: ____________________ Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee: ______________________________
Date: ____________________ Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Employee: ______________________________
Date: ____________________ Describe action taken below if measurements are exceeded:

Time								
Temp								
Pulse								

Thermal Stress Monitoring

The following procedures should be implemented when personnel are wearing protective clothing that limits the cooling process (e.g., use of Tyvek, multiple layers of clothing, thermally insulating clothing) and the **heat index** (takes into account temperature and humidity) exceeds 70° F (21 degrees C), or when the workers exhibit symptoms of heat stress:

- The heart rate should be measured by the radial pulse for 30 seconds, as early as possible in the resting period;
- The heart rate at the beginning of the rest period should not exceed 110 beats per minute, or 20 beats per minute above resting pulse;
- If the heart rate is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same;
- If the pulse rate still exceeds 110 beats per minute at the beginning of the next rest period, the following work cycle should be further shortened by 33 percent;
- Continue this procedure until the rate is maintained below 110 beats per minute, or 20 beats per minute above resting pulse;
- Alternately, the oral temperature can be measured before the workers have something to drink;
- If the oral temperature exceeds 99.6 degrees F (37.6 degrees C) at the beginning of the rest period, the following work cycle should be shortened by 33 percent; and
- Continue this procedure until the oral temperature is maintained below 99.6 degrees F (37.6 degrees C). While an accurate indication of heat stress, oral temperature is difficult to measure in the field.

Procedures for when Heat Illness Symptoms are Experienced

- **Always** contact the RHSM when **any** heat illness related symptom is experienced so that controls can be evaluated and modified, if needed.
- In the case of cramps, reduce activity, increase fluid intake, move to shade until recovered.
- In the case of all other heat-related symptoms (fainting, heat rash, heat exhaustion), and if the worker is a CH2M HILL worker, contact the occupational physician at 1-866-893-2514 and immediate supervisor.
- In the case of heat stroke symptoms, call 911, have a designee give location and directions to ambulance service if needed, follow precautions under the emergency medical treatment of this HSP.
- Follow the Incident Notification, Reporting, and Investigation section of this HSP.

CH2M HILL Health and Safety Plan

Attachment 5

Key Target Zero Program Elements

(blank forms for field use)

Activity Hazard Analysis

Pre-Task Safety Plans

Safe Behavior Observation

Incident Report and Investigation
(use electronic form when possible)
HITS

Lessons Learned Template

ACTIVITY HAZARD ANALYSIS

Activity:	**Date**:
	Project Name:
Description of the work:	**Site Supervisor**:
	Site Safety Officer:
	Review for latest use: Before the job is performed

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)

ACTIVITY HAZARD ANALYSIS

Work Activity Sequence (Identify the principal steps involved and the sequence of work activities)	**Potential Health and Safety Hazards** (Analyze each principal step for potential hazards)	**Hazard Controls** (Develop specific controls for each potential hazard)

Equipment to be used (List equipment to be used in the work activity)	**Inspection Requirements** (List inspection requirements for the work activity)	**Training Requirements** (List training requirements including hazard communication)

ACTIVITY HAZARD ANALYSIS

	PRINT NAME	SIGNATURE	
Supervisor Name:	______________________	______________________	Date/Time:____________________
Safety Officer Name:	______________________	______________________	Date/Time:____________________
Employee Name(s):	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________
	______________________	______________________	Date/Time:____________________

CH2MHILL

Pre-Task Safety Plan (PTSP) and Safety Meeting Sign-in Sheet

Project:____________________________ Location: ________________ Date:_________________

Supervisor: __________________________________ Job Activity:____

____

Attendees: Print Name Sign Name

List Tasks and verify that applicable AHAs have been reviewed:

Tools/Equipment Required for Tasks (ladders, scaffolds, fall protection, cranes/rigging, heavy equipment, power tools):

Potential H&S Hazards, including chemical, physical, safety, biological and environmental (check all that apply):

__ Chemical burns/contact	__ Trench, excavations, cave-ins	__ Ergonomics
__ Pressurized lines/equipment	__ Overexertion	__ Chemical splash
__ Thermal burns	__ Pinch points	__ Poisonous plants/insects
__ Electrical	__ Cuts/abrasions	__ Eye hazards/flying projectile
__ Weather conditions	__ Spills	__ Inhalation hazard
__ Heights/fall > 6 feet	__ Overhead Electrical hazards	__ Heat/cold stress
__ Noise	__ Elevated loads	__ Water/drowning hazard
__ Explosion/fire	__ Slips, trip and falls	__ Heavy equipment
__ Radiation	__ Manual lifting	__ Aerial lifts/platforms
__ Confined space entry	__ Welding/cutting	__ Demolition
__Underground Utilities	__ Security	__ Poor communications

Other Potential Hazards (Describe):

Hazard Control Measures (Check All That Apply):			
PPE __ Thermal/lined __ Eye __ Dermal/hand __ Hearing __ Respiratory __ Reflective vests __ Flotation device __ Hard Hat	Protective Systems __ Sloping __ Shoring __ Trench box __ Barricades __ Competent person __ Locate buried utilities __ Daily inspections __ Entry Permits/notification	Fire Protection __ Fire extinguishers __ Fire watch __ Non-spark tools __ Grounding/bonding __ Intrinsically safe equipment	Electrical __ Lockout/tagout __ Grounded __ Panels covered __ GFCI/extension cords __ Power tools/cord inspected __ Overhead line clearance __ Underground utils ID'd
Fall Protection __ Harness/lanyards __ Adequate anchorage __ Guardrail system __ Covered opening __ Fixed barricades __ Warning system	Air Monitoring __ PID/FID __ Detector tubes __ Radiation __ Personnel sampling __ LEL/O2 __ No visible dust __ Other	Proper Equipment __ Aerial lift/ladders/scaffolds __ Forklift/heavy equipment __ Backup alarms __ Hand/power tools __ Crane with current inspection __ Proper rigging __ Operator qualified	Welding & Cutting __ Cylinders secured/capped __ Cylinders separated/upright __ Flash-back arrestors __ No cylinders in CSE __ Flame retardant clothing __ Appropriate goggles
Confined Space Entry __ Isolation __ Air monitoring __ Trained personnel __ Permit completed __ Rescue	Medical/ER __ First-aid kit __ Eye wash __ FA-CPR trained personnel __ Route to hospital	Heat/Cold Stress __ Work/rest regime __ Rest area __ Liquids available __ Monitoring __ Training	Vehicle/Traffic __ Traffic control __ Barricades __ Flags __ Signs
Permits __ Hot work __ Confined space __ Lockout/tagout __ Excavation __ Demolition __ Energized work	Demolition __ Pre-demolition survey __ Structure condition __ Isolate area/utilities __ Competent person __ Hazmat present	Inspections: __ Ladders/aerial lifts __ Lanyards/harness __ Scaffolds __ Heavy equipment __ Drill rigs/geoprobe rigs __ Cranes and rigging __ Utilities marked	Training: __ Hazwaste (current) __ Construction __ Competent person __ Task-specific __ FA/CPR __ Confined Space __ Hazcom
Underground Utilities __Dig alert called __3rd Party locater __As-builts reviewed __Interview site staff __Client review __soft locate necessary?	Incident Communications __Work stops until cleared by TM/CM __Immediate calls to TM/CM __Client notification __24 hour notification setup __Clear communications	AHA' s __reviewed and approved by HSM __on site and current __applicable for this day's work __Communication and incident processes included?	
Field Notes (including observations from prior day, etc.): ____ ____ ____			

Name (Print): ______________________________

Signature:______________________________ Date:________________

CH2MHILL

Safe Behavior Observation Form		
☐Federal or ☐Commercial Sector (check one)	☐Construction or ☐Consulting (check one)	
Project Number:	Client/Program:	
Project Name:	Observer:	Date:
Position/Title of worker observed:	Background Information/ comments:	
Task/Observation Observed:		

- ❖ Identify and reinforce safe work practices/behaviors
- ❖ Identify and improve on at-risk practices/acts
- ❖ Identify and improve on practices, conditions, controls, and compliance that eliminate or reduce hazards
- ❖ Proactive PM support facilitates eliminating/reducing hazards (do you have what you need?)
- ❖ Positive, corrective, cooperative, collaborative feedback/recommendations

Actions & Behaviors	Safe	At-Risk	Observations/Comments
Current & accurate Pre-Task Planning/Briefing (Project safety plan, STAC, AHA, PTSP, tailgate briefing, etc., as needed)			**Positive Observations/Safe Work Practices:**
Properly trained/qualified/experienced			
Tools/equipment available and adequate			
Proper use of tools			**Questionable Activity/Unsafe Condition Observed:**
Barricades/work zone control			
Housekeeping			
Communication			
Work Approach/Habits			
Attitude			
Focus/attentiveness			**Observer's Corrective Actions/Comments:**
Pace			
Uncomfortable/unsafe position			
Inconvenient/unsafe location			
Position/Line of fire			
Apparel (hair, loose clothing, jewelry)			
Repetitive motion			**Observed Worker's Corrective Actions/Comments:**
Other…			

For ES Federal Sector projects please email completed forms to: CH2M HILL ES FED Safe Behavior Observation
For ES Commercial Sector projects please email completed forms to: CH2M HILL ES COM Safe Behavior Observation
For CNR ES staff please email completed forms to: cnressafe@ch2m.com

HITS Incident Report Hardcopy (Phase 1 – Initial Entry)

Phase 1 – Initial Entry

Type of Incident (May select more than one)

☐ Injury/Illness ☐ Spill/Release ☐ Near Miss
☐ Property Damage ☐ Environment/Permit ☐ Other

General Information Section

Preparer's Name: ______________________ **Preparer's Phone Number:** ______________________

Date of Incident: ______________ **Time of Incident:** ____________ AM / PM

What Business Group is accountable for this incident: ______________________

What Business Group SubGroup is accountable for this incident: ______________________

What CH2M HILL Company is accountable for this incident: ______________________

Where did the Incident occur?

- ☐ United States, Geographic Region: ______________________
- ☐ Canada, Province/Territory: ______________________
- ☐ International, County: ______________________

Location of Incident?

- ☐ Company Premises, CH2M HILL Office (use 3 letter office code if available): ______________________
- ☐ Project, Project name: ______________________
- ☐ In Transit
  - Traveling from: ______________________
  - Traveling to: ______________________
- ☐ At Home
- ☐ Other, Specify: ______________________

Describe the incident: ______________________

____

____

Describe how this event could have been prevented: ______________________

____

Provide Witness Information:

Name: ______________________ Phone: ______________________
Name: ______________________ Phone: ______________________
Name: ______________________ Phone: ______________________

Personnel Notified of Incident (Provide name, date and time):

CH2M HILL Personnel: ______________________
Client Personnel: ______________________

Additional Comments:

____

____

Injury/Illness Section **[Complete only if Injury/Illness Incident type selected]**

Who was injured?

- ☐ CH2M HILL Employee or CH2M HILL Temp Employee
- ☐ Subcontractor to CH2M HILL (Non-LLC Joint Venture Project)
- ☐ LLC Joint Venture Partner Employee
- ☐ LLC Joint Venture Project Subcontractor/Contractor
- ☐ Other

Name of Injured: ______________________ **Job Title:** ______________________

Employer Name: ______________________ **Supervisor of Employee:** ______________________

Complete for CH2M HILL Employee Injuries

Business Group of Injured Employee: ______________________

Has the employee called the Injury Management Administrator (1-800-756-1130)?

☐ Yes ☐ No ☐ Not Sure

Has the injured employee's supervisor been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Complete for Non-CH2M HILL Employee Injuries

Has the project safety coordinator been notified of this incident?

☐ Yes ☐ No ☐ Not Sure

Project Safety Coordinator: ______________________________

Body Part Affected: ______________________________

Injury/Illness (Result): ______________________________

Describe treatment provided (if medication provided, identify whether over-the-counter or prescription): ______________________________

____

Describe any work restriction prescribed (include dates and number of days): ______________________________

____

Physician/Health Care Provider Information

Name: ______________________________ Phone: ______________

Was treatment provided away from the worksite?

☐ No

☐ Yes

Facility Name: ______________________________

Address: ______________________________

City: ______________________________ Phone Number: ______________

Was injured treated in an emergency room?

☐ No ☐ Yes

Was injured hospitalized overnight as an in-patient?

☐ No ☐ Yes

General Information Environmental Section **[Complete only if Environment/Permit or Spill/Release Incident type selected]**

Who had control of the area during the incident?

☐ CH2M HILL, Company: ______________________________

☐ Subcontractor, Company: ______________________________

☐ Joint Venture Partner/Contractor/Subcontractor, Company: ______________________________

☐ Other, Company: ______________________________

Relationship to CH2M HILL: ______________________________

Property Damage Section **[Complete only if Property Damage Incident type selected]**

Property Damaged: ______________________________

Property Owner: ______________________________

Damage Description: ______________________________

Estimated US Dollar Amount: ______________________________

Spill or Release Section **[Complete only if Spill/Release Incident type selected]**

Substance: ______________________________

Estimated Quantity: ______________________________

Did the spill/release move off the property?: ______________________________

Spill/Release From: ______________________________

Spill/Release To: ______________________________

Environment/Permit Section **[Complete only if Environment/Permit Incident type selected]**

Describe Environmental or Permit Issue: ______________________________

Permit Type: ______________________________

Permitted Level or Criteria (e.g., discharge limit): ______________________________

Permit Name and Number (e.g., NPDES No. ST1234): ______________________________

Substance and Estimated Quantity: ______________________________

Duration of Permit Exceedence: ______________________________

HSSE	Lessons Learned [Date] ESBG LL-11-xx
Subject	**[Insert Descriptive Name of Lessons Learned]**
CH2M HILL Project?	[Yes or No]
Situation	[Describe incident or situation that occurred in general terms. Try to be brief and avoid unnecessary details such as names of people or projects, business groups, divisions, dates, location, etc.]
Lessons Learned ***(Recommendations and Comments)***	• Bullet out any lessons learned, recommendations or other important "take away" information that would benefit others. Tie the recommendations to the incident or event, and avoid including information that is not directly tied to the event.
Submitted By	[Name/Office Location/Phone]
Additional Information Contact	[Name/Office Location/Phone]
Keywords/Categories	[Insert any keywords or incident categories that would aid in a search for this lessons learned]

Send completed Lessons Learned to the ESBG HSSE Director for posting and distribution. Please include a recommended distribution list.

CH2M HILL Health and Safety Plan

Attachment 6

Fact Sheets

Tick Fact Sheet

Vehicle Accident Guidance

Working Alone

CH2MHILL

Enterprise Standard Operating Procedure HSE-512

Vinyl Chloride Fact Sheet

Uses and Occurrences—Polyvinyl chloride and copolymers, organic synthesis, adhesives for plastics, and as a precursor in the production of the common plastic polyvinyl chloride (PVC). It is often a degradation product of a number of chlorinated compounds, including tetra-chloroethylene and trichloroethylene, at hazardous waste sites in soils and groundwater. It can also be a breakdown product of the combustion of PVC or other chlorinated compounds.

Physical Characteristics

Appearance:	Colorless gas
Odor:	Sweet; Odor threshold: 3,000 ppm
Flammable:	Class IA Flammable Liquid Gas; NFPA Rating: 4
Flash Point:	-78 °C (-108°F)
Flammable Limits:	3.6% - 33.0% (% by volume in air)
Specific gravity:	0.91; (water = 1.0)
Stability:	Stable under ordinary conditions of use and storage
Vapor Pressure:	2300 mm Hg (at 20 °C)
Incompatibilities:	Atmospheric oxygen and strong oxidizers may react to produce peroxide, which can initiate a violent polymerization reaction
Melting Point:	-155.7 °C (-248°F)
Boiling Point:	-14 °C (7°F)

Signs and Symptoms of Exposure

Inhalation:	<u>Short Term</u>: Dizziness, light-headedness, nausea, dullness of visual and auditory responses, drowsiness, and unconsciousness <u>Long Term</u>: Thickening of skin, contact and allergic dermatitis, fatigue, coughing and sneezing, abdominal pain, gastrointestinal bleeding, nausea, vomiting, indigestion, diarrhea, jaundice, weight loss, anorexia, and cold and tingling sensations of the hands and feet, carcinogen.
Skin contact:	<u>Short Term</u>: Skin contact with liquid can cause frostbite. <u>Long Term</u>: Dermatitis
Eye contact:	Vapors can cause eye irritation. Contact can produce pain, inflammation and temporal eye damage.

Modes of Exposure

Inhalation:	Vapor
Absorption:	Liquid causes frostbite
Ingestion:	Ingestion of contaminated water

Exposure Limits

Action level	0.5 ppm
PEL	1 ppm
STEL	None
PEL-C	5 ppm
TLV	1 ppm

Exposure Level vs. Regulatory Requirements

EXPOSURE LEVEL (EL)	REGULATORY REQUIREMENTS
EL < AL	Maintain exposure as low as reasonably achievable
EL > AL, EL < PEL	Implement portions of the OSHA Vinyl chloride standard and Training
EL > PEL	Implement all portions of the OSHA Vinyl Chloride Standard including training, medical surveillance, engineering controls, establishment of work areas, etc.

PPE

Eye:	Safety glasses, chemical goggles, face shield
Skin:	Tychem SL or other full-body clothing, depending on the exposure. Nitrile, Viton or laminated film gloves.
Respiratory:	Air purifying respirators and supplied air respirators, depending on the exposure.

First Aid

Inhalation:	Move to fresh air, begin rescue breathing if breathing has stopped and CPR if heart action has stopped, transfer promptly to a medical facility.
Skin:	Immerse affected part in warm water. Seek medical attention.
Eyes	Flush with large amounts of water for at least 15 minutes. Seek medical attention immediately.
Ingestion:	Contact a physician.

Tick-Borne Pathogens — A Fact Sheet

Most of us have heard of Lyme disease or Rocky Mountain Spotted Fever (RMSF), but there are actually six notifiable tick-borne pathogens that present a significant field hazard. In some areas, these account for more than half of our serious field incidents. The following procedures should be applied during any field activity—even in places that are predominantly paved with bordering vegetation.

Hazard Recognition

An important step in controlling tick related hazards is understanding how to identify ticks, their habitats, their geographical locations, and signs and symptoms of tick-borne illnesses.

Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These include:

- Deer (Black Legged) Tick (eastern and pacific varieties)
- Lone Star Tick
- Dog Tick
- Rocky Mountain Wood Tick

These varieties and their geographical locations are illustrated on the following page.

Tick Habitat

In eastern states, ticks are associated with deciduous forest and habitat containing leaf litter. Leaf litter provides a moist cover from wind, snow, and other elements. In the north-central states, is generally found in heavily wooded areas often surrounded by broad tracts of land cleared for agriculture.

On the Pacific Coast, the bacteria are transmitted to humans by the western black-legged (deer) tick and habitats are more diverse. For this region, ticks have been found in habitats with forest, north coastal scrub, high brush, and open grasslands. Coastal tick populations thrive in areas of high rainfall, but ticks are also found at inland locations.

Illnesses and Signs & Symptoms

There are six notifiable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite—normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

- Lyme (bacteria)
- RMSF (bacteria)
- Ehrlichiosis (bacteria)
- STARI (Southern Tick-Associated Rash Illness) (bacteria)
- Tularemia (Rabbit Fever) (bacteria)
- Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or may develop only mild symptoms. These illnesses present with some or all of the following signs & symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. For Lyme disease, the bite area will sometimes resemble a target pattern. A variety of long-term symptoms may result if the illness is left untreated, including debilitating effects and death.

Deer Tick

Distribution of Deer Tick (dark green)

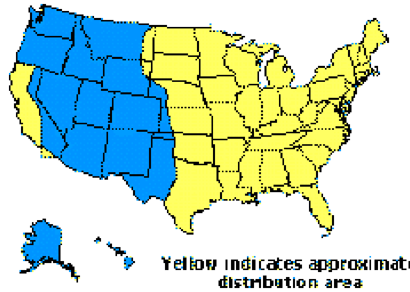
From Left: adult female, adult male, nymph, and larvae Deer Tick (cm scale)

Distribution of Pacific Deer Tick (dark green)

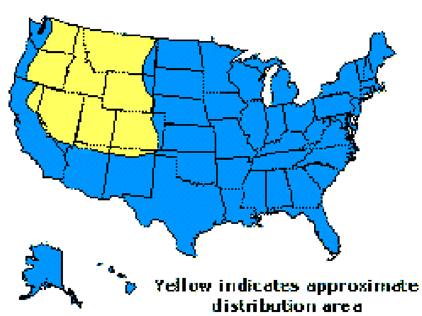
Lone Star Tick

Distribution of Lone Star Tick (Green)

Dog Tick



Rocky Mountain Wood Tick



Hazard Control

The methods for controlling exposure to ticks include, in order of most- to least-preferred:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventative antibiotic treatment after a bite is generally not recommended.

Avoidance and Reduction of Ticks

To the extent practical, tick habitats should be avoided. In areas with significant tick infestation, consider stopping work and withdrawing from area until adequate tick population control can be achieved. Stopping and withdrawing should be considered as seriously as entering an area without proper energy control or with elevated airborne contaminants—tick-borne pathogens present risk of serious illness!

In areas where significant population density or infestation exists, tick reduction should be considered. Tick reduction can be achieved by disrupting tick habitats and/or direct population reduction through the use of tick-toxic pesticides (Damminix, Dursban, Sevin, etc.).

Habitat disruption may include only simple vegetative maintenance such as removing leaf litter and trimming grass and brush. Tick populations can be reduced by between 72 and 100 percent when leaf litter alone is removed. In more heavily infested areas, habitat disruption may include grubbing, tree trimming or removal, and pesticide application (Damminix, Dursban, Sevin, etc.). This approach is practical in smaller, localized areas or perimeter areas that require occasional access. Habitat controls are to be implemented with appropriate health and safety controls, in compliance with applicable environmental requirements, and may be best left to the property owner or tenant or to a licensed pesticide vendor. Caution should be exercised when using chemical repellents or pesticides in or around areas where environmental or industrial media samples will be collected for analysis.

Personal Protection

After other prevention and controls are implemented, personal protection is still necessary to control exposure to ticks. Personal protection must include all of the following steps:

- So that ticks may be easily seen, wear light-colored clothing. Full-body New Tyvek (paper-like disposable coveralls) may also be used
- To prevent ticks from getting underneath clothing tuck pant legs into socks or tape to boots
- Wear long-sleeved shirts, a hat, and high boots
- Apply DEET repellent to exposed skin or clothing per product label
- Apply permethrin repellent to the outside of boots and clothing before wearing, per product label
- Frequently check for ticks and remove from clothing
- At the end of the day, search your entire body for ticks (particularly groin, armpits, neck, and head) and shower
- To prevent pathogen transmission through mucous membranes or broken/cut skin, wash or disinfect hands and/or wear surgical-style nitrile gloves any time ticks are handled

Pregnant individuals and individuals using prescription medications should consult with their physician and/or pharmacists before using chemical repellents. Because human health effects may not be fully known, use of chemical repellents should be kept to a minimum frequency and quantity. Always follow manufacturers' use instructions and precautions. Wash hands after handling, applying, or removing protective gear and clothing. Avoid situations such as hand-to-face contact, eating, drinking, and smoking when applying or using repellents.

Remove and wash clothes per repellent product label. Chemical repellents should not be used on infants and children.

Vaccinations are generally not available for tick-borne pathogens. Although production of the LYMErix™ Lyme disease vaccination has been ceased, vaccination may still be considered under specific circumstances and with concurrence from the consulting physician.

Tick Check

A tick check should be performed after field survey before entering the field vehicle (you do not want to infest your field vehicle with ticks). Have your field partner check your back; the backs of your legs, arms, and neck; and your hairline. Shake off clothing as thorough as possible before entering the vehicle. Once the field day is complete, repeat this procedure and perform a thorough self check.

If a tick has embedded itself into the skin, remove the tick as described below.

Tick Removal

1. Use the tick removal kit obtained through the CH2M HILL Milwaukee warehouse, or a fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.

2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.

3. Avoid squeezing, crushing or puncturing the body of the tick because its fluids (saliva, hemolymph, gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.

4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.

5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.

6. Should you wish to save the tick for identification, place it in a plastic bag, with the date of the tick bite, and place in your freezer. It may be used at a later date to assist a physician with making an accurate diagnosis (if you become ill).

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Individuals previously infected with Lyme disease does not confer immunity—re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

The employee should contact the Injury Management/Return To Work provider (IMRTW), WorkCare using the toll-free number 866-893-2514 to report the tick bite. WorkCare will follow-up with each CH2M Hill employee who reports a tick bite and is at risk of developing Lyme disease by monitoring for symptoms up to 45 days, and will refer the employee to a medical provider for evaluation and treatment as necessary.

2011 Vehicle Accident Guidance—ESBG

Remember that if you a **renting** a non-CH2M HILL owned vehicle (short-term rental) in the U.S., you should carry the insurance card from the state where your driver's license is issued.

If you operate a **fleet vehicle**, carry the insurance card where the vehicle is registered.

For ALL Vehicles if you are in an accident:

1. If you are injured, call 911 for emergency medical treatment or 1-866-893-2514 to contact the CH2M HILL Occupational Nurse/Physician for minor injuries. If you feel you have not been injured, contact the RHSM for guidance on whether calling the CH2M HILL Occupation Nurse/Physician is applicable.

2. **Call the Police--**For any vehicle accident/damage, it is recommended that the local police (or site security/emergency services if working on a client site that provides such services) be called to determine if a report needs to be filed. In some instances, a report may not be required (during accident alerts, or in public parking lots). Document that the authorities were called and follow up with any guidance they give you. State requirements vary. If a report is filed, obtain a copy.

3. Notify Supervisor, (and PM/RHSM if working on a project site)

4. Complete a HITS report on the VO.

Additional Steps

To report an auto accident, and before a claim can be taken by telephonic reporting, have available your name (the company name alone is no longer accepted, a driver's name must be provided even for fender benders), location of accident and your office address if different than the accident location, business group and project number. A claim cannot be taken without your name, address, business group and your project number. By location the state where the accident occurred, and which office you are aligned to, i.e., accident occurs in Idaho, but you are out of the Denver office. Advise the claim recorder the accident occurred in ID, but that your office location is Denver. This will assist the claim intake person in identifying location coding for the claims.

Auto accidents involve two different sections of an Auto policy:

1) Liability to others due to Bodily Injury and Property Damage
2) Physical Damage - Comprehensive and Collision - damage to the vehicle CH employee is driving

CH2M Hill has Liability coverage for any auto - our policy will respond on either a primary or excess basis.

Refer to the table below for additional notifications to make based on the type of accident experienced and type of vehicle being used.

CH2MHILL

HSSE Target Zero World-Class Performance

Liability - Bodily Injury or Property Damage to Others

Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill - Primary	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill - Primary	Contact Jennifer Rindahl/DEN (720-286-2449)
Client vehicle driven by CH2M Hill employee	Client's auto policy unless client has made CH2M Hill responsible for vehicle	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindahl/DEN (720-286-2449); contact client;
Short term lease (30 days or less)	Rental car company if rented through Enterprise, Budget or Hertz; CH2M Hill excess	Contact Broadspire (1-800-753-6737); Contact local branch of rental car company where vehicle leased (ERAC includes 24 hour roadside assistance) and Jennifer Rindahl/DEN (720-286-2449)
Short term lease (30 days or less)	CH2M Hill - Primary if rented through company other than our national agreements; $100,000 deductible	Contact Broadspire (1-800-753-6737); Contact rental car company and Jennifer Rindahl/DEN (720-286-2449)
Personal vehicle used on business	Employee's personal auto policy; CH2M Hill on an excess basis	Contact personal auto insurance company; contact Jennifer Rindahl/DEN (720-286-2449)

Physical Damage - damage to vehicle CH employee was driving

Scenario	Which Coverage Responds	What to do if in an accident
CH2M Hill fleet, pool or project vehicle - long term lease - lower 48	CH2M Hill ONLY if vehicle is scheduled on policy - $5,000 deductible	Contact Broadspire (1-800-753-6737); Jennifer Rindahl/DEN (720-286-2449); Linda George/DEN (720-286-2057)
CH2M Hill fleet, pool or project vehicle - long term lease - Alaska (North Slope)	CH2M Hill Equipment Schedule if scheduled on policy	Contact Jennifer Rindahl/DEN (720-286-2449)
CH2M Hill fleet, pool or project vehicle - long term lease	ARI if physical damage coverage purchased - $500 deductible	Contact Jennifer Rindahl/DEN 720.286.2449; call ARI at 1-800-221-1645 give them Client Code and ARI fleet vehicle number; and notify Linda George/DEN - Fleet Coordinator - 720-286-2057
Client vehicle CH2M Hill Employee is driving	Client's auto policy unless client has made CH2M Hill contractually responsible for vehicle	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)
Short term lease (30 days or less) using corporate VISA	VISA if corporate credit card used and vehicle is not a pickup, truck, cargo van or used off-road	Contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Short term lease (30 days or less) through Enterprise (ERAC) and vehicle is used off-road and physical damage coverage included when vehicle leased	ERAC up to $3,000 in damage; CH2M Hill's coverage is excess	Notify Rental Car Company; contact Jennifer Rindahl/DEN (720-286-2449) if damage over $5,000
Short term lease (30 days or less) did **not** use corporate VISA	CH2M Hill - $5,000 deductible (project responsibility)	Contact Broadspire (1-800-753-6737); Contact Jennifer Rindhal/DEN 720-286-2449; contact VISA - 1-800-847-2911 or http://www.visa.com/eclaim
Personal vehicle used on business	CH will reimburse the amount of the deductible carried on the employee's policy up to $500 whichever is less	Contact Jennifer Rindahl/DEN (720-286-2449); contact client; contact Broadspire (1-800-753-6737)

Details for reporting a claim on the CH2M Hill VO are accessed by going to the VO home page and clicking:

GLOBAL ENTERPRISE SERVICES/INSURANCE & BONDING/CLAIMS REPORTING

HOW DO I REPORT A CLAIM TAB or access the following URL:

https://www.int.ch2m.com/intrnl/voffice/corp/insurance/claims/report.asp?Menu=menu3h

For Personally Owned Vehicles (POVs):

CH2M HILL does not provide auto insurance for POVs, it is responsibility of the owner. If you are in a vehicle accident conducting company business, contact the police as above, supervisor, and 911 or CH2M HILL's occupational nurse/physician as stated above. Complete a HITS report. Contact Jennifer Rindahl/DEN for assistance for meeting personal insurance deductibles (up to $500) with proof of insurance and deductible.

If using your POV for extended project use, notify the PM to make sure a rental car is not needed. Check your insurance policy for guidance on using the POV for business use.

Additional Resources:

Claims Resource Manual

WORKING ALONE PROTOCOL
CALL – IN CONTACT FORM

Date of site work:_______________ Expected start time:_______________
Name of CH2M HILL employee in the field:_______________________________________
Name of CH2M HILL employee responsible to receive contact:_________________________
Client Emergency Contact (if any): ____
CH2M HILL employee's contact numbers:
Radio #____________________________
Cell Phone #________________________
Address and Location of work:____
Directions/Map:

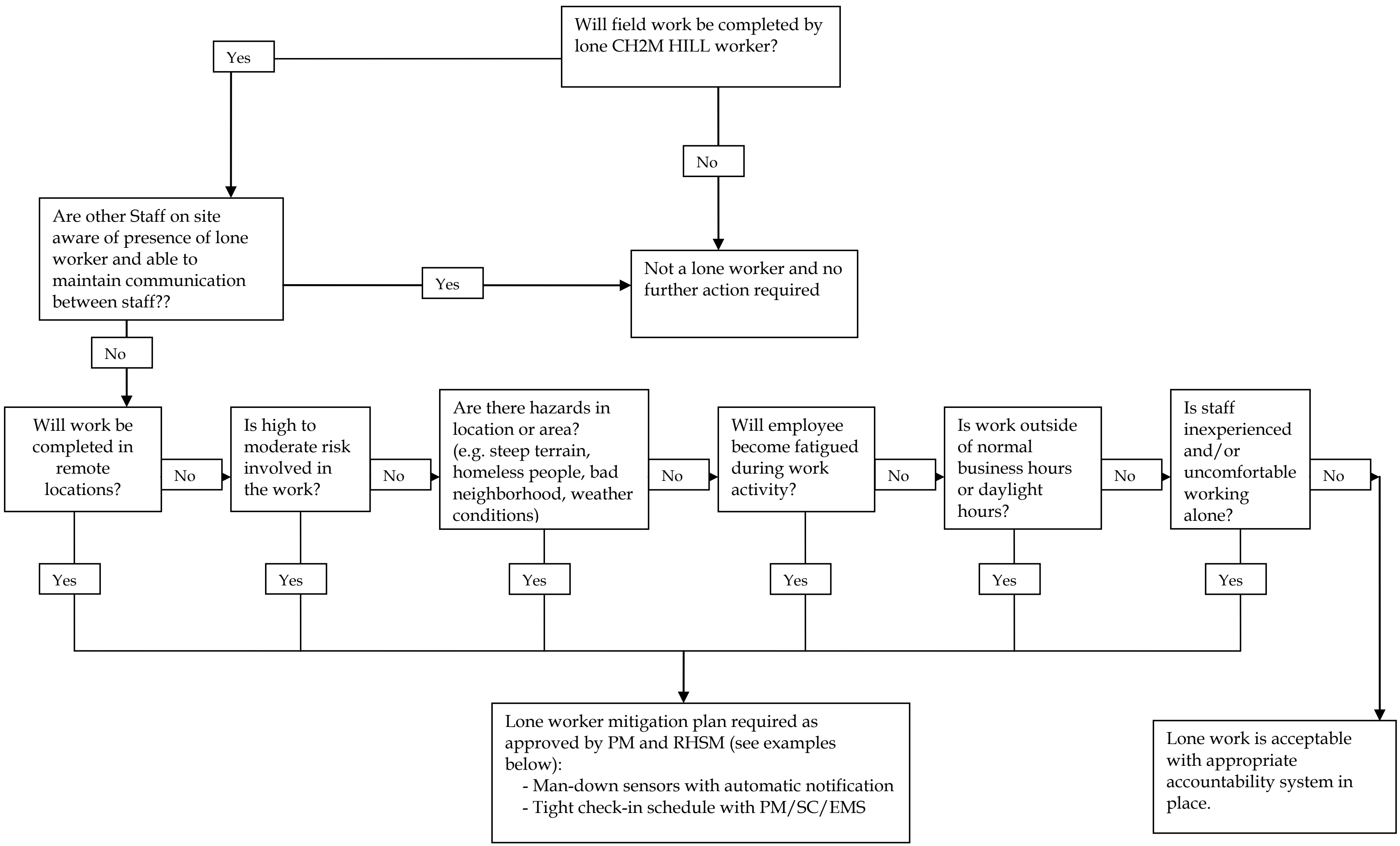
Planned Activity:____
Specified Frequency and time for call in:____

Time	Verified	Location

If lone worker fails to call in at specified frequency/time:

1) Call worker's radio and cell to determine if an emergency exists.
2) If no reply, immediately call Client security/emergency service if there is one at the site.
3) If there is no client security call Emergency Services (911). Inform the dispatcher there is a lone worker that cannot be contacted and there may be an emergency on site. Provide the lone worker's name, their last known location, and your contact information.
4) After Emergency Services have been contacted, call the other emergency contacts, Project Manager, and Responsible Health and Safety Manager.

Lone Worker Protocol



Observed Hazard Form

CH2MHILL

OBSERVED HAZARD FORM

Name/Company of Observer (*optional*):

Date reported: ____________________

Time reported: ______________________

Contractor/s performing unsafe act or creating unsafe condition:

1. ____

2. ____

3. ____

Unsafe Act or Condition:

____
____
____
____
____
____
____
____
____

Location of Unsafe Act or Condition:

Name of CH2M HILL Representative:

____

Corrective Actions Taken: Date: ____________

____
____
____
____
____

Project Safety Committee Evaluation: Date: ____________

____
____
____
____
____

Stop Work Order Form

CH2MHILL

Stop Work Order

REPORT PREPARED BY:

Name:	**Title:**	**Signature:**	**Date:**

ISSUE OF NONPERFORMANCE:

Description:	Date of Nonperformance:

SUBCONTRACTOR SIGNATURE OF NOTIFICATION:

Name:	**Title:**	**Signature:**	**Date:**

**** Corrective action is to be taken immediately. Note below the action taken, sign and return to CCI.* Work may not resume until authorization is granted by CH2M HILL Constructors, Inc. Representative,***

SUBCONTRACTOR'S CORRECTIVE ACTION

Description:	Date of Nonperformance:

SUBCONTRACTOR SIGNATURE OF CORRECTION

Name:	**Title:**	**Signature:**	**Date:**

Agency Inspection Target Zero Bulletin

[illegible]

Subject: HSSE Agency Inspections (OSHA, EPA, DOT, State Health Department)

Do you know what YOU would do if an agency inspector arrived at your site unannounced?

Recently, a State Occupational Safety and Health Administration (OSHA) inspector made an unannounced visit to one of our Federal project sites. OSHA, U.S. Environmental Protection Agency (EPA), and authorized state or local agencies have authority to inspect any facility that is subject to health, safety, and environmental legislation. Inspections may be announced or unannounced. This particular inspector indicated that the project was targeted for an inspection because the work was funded by the American Recovery and Reinvestment Act (ARRA).

Enterprise Standard Operating Procedure (SOP) HSE-201, *Agency Inspections and Communications,* describes the responsibilities, procedures, and requirements associated with inspections conducted by external regulatory agencies, as well as the methods for communicating information to key individuals. This Target Zero Bulletin is a brief summary of what to do in the event of an agency inspection at your site. Refer to the SOP for more specific guidance.

Notification of Inspections

- If the inspection is an announced regulatory agency inspection, the Project Manager (PM) should notify the Responsible Health and Safety Manager (RHSM) and Responsible Environmental Manager (REM) well in advance of the inspection.
- If an unannounced agency inspector visits one of our projects, Field personnel must immediately notify the project Emergency Response Coordinator (ERC). Typically the ERC is the Safety Coordinator (SC).
- The ERC must immediately notify the RHSM/REM, as appropriate, of unannounced inspections, or designate someone to call the RHSM/REM. The RHSM/REMs can provide guidance to the field staff and PM.

Inspector Credential Verification

- Upon arrival, the ERC must request the inspector to provide official credentials. Record the inspector's name and office phone number or obtain the inspector's business card.
- The inspector shall sign the visitors log and be given a site-specific health, safety, and environmental protection briefing.
- The inspector shall meet any site access requirements associated with security clearances, specialized training, and medical monitoring. The CH2M HILL representative shall verify that the inspector possesses these requirements; access will only be granted to those areas where appropriate access requirements are met. Some inspectors have the authority to gain access to any work area at any time, such as an inspector with a search warrant. In these cases, we can stop work operations as necessary to protect the safety of the inspector(s).

Opening Conference

- The CH2M HILL Project Manager, ERC, RHSM, or REM, and the inspector shall determine attendees for the opening conference. The RHSM (for OSHA and other worker health and safety inspections) or REM (for environmental inspections) shall join the opening conference via conference call.
- The inspector shall inform CH2M HILL of the purpose of the inspection and provide a copy of the complaint, if applicable.
- The inspector shall outline the scope of the inspection, including employee interviews conducted in private, physical inspection of the workplace and records, possible referrals, discrimination complaints, and the closing conference(s).

Requests for OSHA Logs

- An OSHA inspector may request to review the project OSHA Injury/Illness log, better known as the OSHA 300 Log. Contact your RHSM for assistance in obtaining the OSHA 300 Log.
- Field projects with a continuous duration of one year or longer are considered to be separate establishments and are required to maintain an OSHA 300 log specific to the project. The project OSHA 300 log should be maintained onsite and kept current.
- Recordable injuries and illnesses sustained on field projects less than one year in duration are maintained on the CH2M HILL office log where the injured employee is based.

The Inspection

- The scope of the inspection shall be limited to that indicated by the inspector in the opening conference. The inspector shall be escorted to relevant areas only. The ERC or other designated by the RHSM or REM must accompany the inspector during the inspection.
- Ensure that the inspection is limited to the scope that the inspector disclosed during the opening conference. The ERC should always take notes which identify: areas inspected, machinery or equipment and materials examined, employees or other persons interviewed, and photographs taken by the inspector.
- The inspector will observe safety, health, and environmental conditions and practices and document the inspection process. The inspector may also take photos and instrument readings, examine records, collect air samples, measure noise levels, survey existing engineering controls, and monitor employee exposure to toxic vapors, gases, and dusts.
- CH2M HILL should gather duplicate information (photographs, readings, samples) in the same manner and condition as the inspector. If the equipment needed to take duplicate samples is not onsite, ask the inspector if the sampling can wait until the equipment is available. If samples are taken, request a description of the tests that the agency intends to perform on the samples and request results as soon as they are available.
- Employees may be questioned during the inspection tour. The employee can refuse to speak to an inspector, can speak to the inspector with a company representative (including management) present, or can speak to the inspector privately. It is CH2M HILL policy that employees who wish to speak to the inspector are not discriminated against, intimidated, or otherwise mistreated for exercising their rights during compliance inspections.
- Copies of documents should not be provided to the inspector without the approval of the RHSM or REM or Legal Insurance Department (LID). **DO NOT** voluntarily release documents. Respond only to inspection team requests.
- During the course of the inspection, the inspector may point out violations. For each violation, the CH2M HILL representative should ask the inspector to discuss possible corrective action. Where possible, violations detected by the inspector should be corrected immediately and noted by the inspector as corrected.
- For those items which cannot be corrected immediately, an action plan shall be formulated for timely correction. In any instance, employees exposed to hazards shall be removed from the area.

Closing Conference

After the inspection, a closing conference is normally held as follows:

- The CH2M HILL PM, ERC, RHSM or REM shall be involved via conference call in the closing conference, at a minimum;
- The inspector shall describe the apparent violations found during the inspection and other pertinent issues as deemed necessary by the inspector. CH2M HILL shall be advised of their rights to participate in any subsequent conferences, meetings or discussions. Any unusual circumstances noted during the closing conference shall be documented by the ERC;
- The inspector shall discuss violations observed during the inspection and indicate for which violations a citation and a proposed penalty may be issued or recommended;
- The ERC shall request receipts for all samples and approved documents photocopied by the inspector, request a photocopy of the inspector's photograph log, and request a copy of the final inspection report; and
- Any documentation from an agency inspection must be transmitted immediately to the RHSM or REM, and LID.

Unannounced regulatory agency inspections may happen at any time on our projects -

Get your RHSM/REM and PM involved immediately if an Inspector arrives.

Completed CH2M HILL AHAs

CH2M HILL HEALTH AND SAFETY PLAN

Attachment 11

Material Safety Data Sheets

1. PRODUCT IDENTIFICATION: Reductive DARAMEND®, D6390Fe40
PRODUCT USE: Bioremediation Product

MANUFACTURER:
Adventus Americas Inc.
2871 W. Forest Rd, Suite 2
61032

EMERGENCY PHONE:
Primary: 1-866-789-6273 ext. 1
Backup: 1-866-789-6273 ext. 2

TRANSPORTATION OF DANGEROUS GOOD CLASSIFICATION:
Not Regulated

WHMIS CLASSIFICATION:
Not Regulated

CONTAINMENT HAZARD:
Any vessel that contains wet DARAMEND or DARAMEND and water must be vented due to potential pressure build up from fermentation gasses.

2. INGREDIENTS

CHEMICAL NAME:	CAS#	TLV(mg/m3)	LD low (mg/Kg)	% by Weight
Organic Amendment	N/D	N/E	N/E	60
Iron	7439-89-6	5	20	40

3. PHYSICAL DATA

Physical state	Solid	Freezing point (Deg.C)	N/A
Odour threshold	N/A	Boiling point (Deg.C)	N/A
Specific gravity	N/A	Vapour pressure	N/A
Density	0.97 Kg/L	Vapour density (air=1)	N/A
pH	6.0	Evaporation rate	N/A
Solubility in water	N/A	Coeff. of water/oil	N/A
Appearance	Tan/Brown Flakes		

4. FIRE AND EXPLOSION HAZARD DATA

CONDITIONS OF FLAMMABILITY:
Non Flammable

EXTINGUISHING MEDIA:	WATER	FOAM	CO_2
	X		

OTHER: Use a fog nozzle to spray water

SPECIAL PROCEDURES:
Firefighters should wear SCBA.

FLASH POINT (Deg. C PMCC): None

	LOWER	UPPER
FLAMMABLE LIMITS IN AIR % BY VOLUME:	N/A	N/A
AUTO IGNITION TEMP (Deg. C):	N/A	
HAZARDOUS COMBUSTION PRODUCTS:	Some metallic oxides	

EXPLOSION DATA:
Sensitivity to Impact........None known
Sensitivity to Static Discharges........Not sensitive (minimum spark ignition energy >8J, determined by analysis of D6386)
Relative Explosion Hazard Rating........Weak

5. REACTIVITY DATA

STABILITY (NORMAL COND.):
Stable: X **Unstable:**

CONDITIONS TO AVOID:	None
CONDITIONS OF REACTIVITY:	None
INCOMPATIBILITY (Materials to Avoid):	None
HAZARDOUS DECOMPOSITION PRODUCTS:	None

6. TOXICOLOGICAL PROPERTIES

Effects of acute exposure: Inhalation: over-exposure by inhalation may cause respiratory irritation.
Eyes: may irritate eyes (conjunctivitis, retinae) upon contact.
Ingestion: not a normal exposure route, but could induce gastric problem.
Effects of chronic exposure: Repeated inhalation of dust can produce respiratory irritation.

LD low (rabit) mg/kg (calc.)	100	Exposure limits	N/D
Irritancy	N/D	Sensitization	N/D
Synergistic Mat	None known	Carcinogenicity	None known
Reproductive Eff	None known	Teratogenicity	None known
Mutaginicity	None known		

7. PREVENTIVE MEASURES

PERSONAL PROTECTIVE EQUIPMENT:
Eye Protection: X **Gloves:** X **Clothing:**

RESPIRATORY PROTECTION:
Use dust mask in severe conditions

VENTILATION REQUIREMENTS:
Not normally required

SPILL AND LEAK PROCEDURES:
Sweep up and return to container

WASTE DISPOSAL:
No special requirements necessary

HANDLING PROCEDURES:
Wear safety glasses for normal use. Avoid generating excessive dust, wear dust mask in severe conditions.

STORAGE REQUIREMENTS:
Keep dry.
Any vessel that contains wet DARAMEND or DARAMEND and water must be vented due to potential pressure build up from fermentation gasses.

SPECIAL HANDLING INFORMATION:
Treat as a nuisance dust

8. FIRST AID MEASURES

Not normally required.
Wash off skin with soap and water.
If inhaled, remove to fresh air, treat symptoms as required.

9. OTHER INFORMATION

None

10. PREPARATION INFORMATION

Prepared By:		Date Prep./Rev.:	1/18/11
	Adventus Remediation Technologies	Print Date:	1/18/11
	1345 Fewster Drive	Phone:	905-273-5374
	Mississauga, Ontario	Fax:	905-273-4367
	L4W 2A5		

Definitions:
N/D - No Data N/A - Not Applicable N/E - Not Established

Appendix E
Environmental Protection Plan

APPENDIX E
Environmental Protection Plan

Purpose

This Environmental Protection Plan (EPP) describes the environmental management requirements and procedures for activities related to Zero Valent Iron (ZVI) Permeable Reactive Barrier (PRB) work being performed by CH2M HILL at MCAS Cherry Point OU1, Site 16. This EPP is intended to be used in conjunction with the project Health and Safety Plan (HASP), construction quality management plan (CQMP), implementation plan (IP), and design specifications and includes the following elements:

- Roles and Responsibilities
- Management of construction spoils, excavated unsuitable material, and potential construction debris.
- Best management practices (BMPs) for sediment and erosion control
- Refueling

Roles and Responsibilities

TABLE 1

Roles and Responsibilities

Role	Responsibility
CH2M HILL Project Manager (PM) Keri Hallberg/CLT 704.543.3260	• Ultimately responsible for project environmental performance • Provides the field crew with instructions concerning environmental management according to this procedure for the wastes being generated • Checks the HandS database to determine that all field staff have had the appropriate training
CH2M HILL Construction Manager/Site Superintendent Gerald Couch/ATL 678.488.8837	• Label and stage waste and materials appropriately; • Follow all procedures specified in the HASP, CQMP, IP, design specs and this EPP • Complete any required training
CH2M HILL Environmental Manager (EM) Hope Wilson/ATL 678.530.4226 678.565.5411	• Provide guidance in following this procedure and complying with regulations • Approve any changes to this Environmental Protection Plan

NCDENR UIC Permitting

This project has been exempt from permitting under the North Carolina Department of Environment and Natural Resources (NCDENR) Aquifer Protection Section (APS) and Underground Injection Control.

- ALL practices and procedures defined in the design shall be followed to the maximum extent practicable.
- Fill and structures shall be properly maintained to ensure public safety.
- All exposed soil and other fills must be stabilized at the earliest practicable date.
- Heavy equipment must be checked for leaks regularly.

- Only suitable materials may be used for construction activities. Construction material may not consist of debris and may not contain toxic pollutants in toxic amounts. Imported fill will have a letter certifying that it is not contaminated.
- Temporary fills must be removed in their entirety and the affected areas returned to their pre-existing elevation
- No special or additional mitigation actions are required for this project

Refueling

Refueling will be conducted onsite using a truck with a ~100 gallon capacity tank. The following management practices will be adhered to during these operations to prevent any release to the environment.

- Secondary containment and/or diversionary structures shall be implemented during ALL refueling activities to prevent any loss of fuel to surface water bodies, ground surfaces, or drainage pathways.
- Nearby storm water drains shall be blocked during refueling activities
- Secondary containment shall be used to capture any dripped or spilled fuel
- Trucks carrying fuel shall not be parked in close proximity to surface water bodies nor shall they traverse unstable terrain
- Spill equipment of the proper number and kind to deal with a petroleum spill equal to 100% of the capacity of the fuel tank will be available in the immediate work area. If this material is used it will be replaced prior to the end of the working day.
- Fueling equipment shall be inspected daily for signs of deterioration and leaks. Inadequate equipment will not be placed into service.
- Any spills of fuel will immediately be reported to the CH2M HILL Site Manager (Gerald Couch/ATL), CH2M HILL Project Manager (Keri Hallberg/CLT), and CH2M HILL Environmental Manager (Hope Wilson/ATL)

Waste and Materials Management

General instructions for managing wastes and materials that are anticipated are provided in this section. If other wastes are generated they will be managed in accordance with the MCAS Cherry Point Waste Management Plan (WMP).

- <u>Construction debris</u> – It is possible that some residual construction debris may be encountered during PRB emplacement. This construction debris is related to an old (since removed) landfill located within the vicinity of the proposed PRB. This material will be staged onsite in a pre-approved area.
- <u>Excavated impacted material</u> – All soil removed during PRB placement will be staged in the approved waste pile staging area. This material will be stockpiled as detailed in the General Guidance section.
- <u>Stockpiles of non-impacted material</u> – Excavated soil from the top five (5) feet will be recycled as backfill to the extent practicable. This material will be stockpiled onsite at a pre-approved location. Stockpiling requirements are provided in the General Guidance section.
- <u>Groundwater and decontamination water</u> – All potentially impacted water will be collected and disposed of at the industrial waste treatment plant (IWTP).

Erosion and Sediment Control BMPs

Erosion and sediment control BMPs will be implemented as specified in the IP to prevent run off from impacting the area. These BMPs will be inspected on a daily basis and the results documented in the field logs. Any observed deficiencies or issues that render these measures ineffective will be repaired immediately. BMPs shall remain in place until the site has been stabilized and the condition accepted by the client.

Transportation/Storage of Soils/Excavated Material

- Trucks will be routinely inspected to ensure that they are in good working condition and do not have any leaks. Trucks failing inspection shall not be used.
- The staging location will be specified by the client prior to the start of work.
- Transfer wastes as specified in the AHA for this work.
- Keri Hallberg/PM will inform Will Potter/MCAS EAD and Nicole Cowand/NAVFAC RPM that the material/waste has been generated and where it is stored.
- Weekly inspections of wastes generated and stockpiles of material onsite will be conducted by CH2M HILL. Inspections will be documented in a log book.

Stockpiles of Suitable Material

The following procedures shall be followed when stockpiling soils

- Obtain approval of the stockpile area from the client.
- Stockpiles shall be placed on minimum 6-mil plastic sheeting and covered to control wind dispersion, erosion, and sedimentation.
- Covers and perimeter berms shall be secured in-place when not in use and at the end of each workday, or as necessary to prevent wind dispersion or run-off from major precipitation events.
- A log documenting accumulation dates and approximate volumes shall be maintained for excavated soils staged onsite in stockpiles.
- Stockpiles will be inspected daily to ensure that the above requirements are met.

Dust Controls and Emissions

Construction activities will be kept under surveillance, management, and control to minimize the discharge of any air pollutants. The following general practices will be implemented to control dust and emissions:

- Construction equipment will be maintained within manufacturer's design limits to ensure minimal discharge of exhaust emissions.
- Dust emissions will be controlled during earth disturbing activities using water truck or hose nozzle spray applications of water.
- Traffic routes will be designated to limit the area that is disturbed.
- Haul paths will be maintained and watered to reduce dust, as necessary.
- Travel speeds over unpaved areas will be limited to reduce dust levels.
- Completed areas will be seeded or otherwise stabilized to reduce dust levels.
- Burning will not be allowed as a means of clearing.
- Equipment will be operated in such a manner as to minimize airborne particulates whenever possible (e.g., the drop height of excavators will be limited).

Spill Containment and Control

Spill control materials will be maintained in the support zone, at fuel storage and dispensing locations, and at waste storage areas. Incidental spills will be contained with sorbent and disposed of properly. Spilled materials must be immediately contained and controlled. Spill response procedures include:

- Immediately warn any nearby workers and notify supervisor;
- Assess the spill area to ensure that it is safe to respond;
- Evacuate area if spill presents an emergency;
- Ensure any nearby ignition sources are immediately eliminated;
- Stop source of spill;
- Establish site control for spill area;
- Contain and control spilled material through use of sorbent booms, pads, or other material; and
- Use proper personal protective equipment in responding to spills.

Spill Clean-up and Removal

All spilled material, contaminated sorbent, and contaminated media will be cleaned up and removed as soon as possible. Contaminated spill material will be drummed, labeled, and properly stored until material is disposed of. Contaminated spill material will be managed as waste (see WMP) and disposed of according to applicable, federal, state, and local requirements. Contact the CH2M HILL Environmental Manager for additional assistance.