Feasibility Study Report
for
Site 11, Solvent Release Area

Former Naval Air Station South Weymouth
Weymouth, Massachusetts

Naval Facilities Engineering Command Mid-Atlantic
Contract Number N62470-08-D-1001
Contract Task Order WE11

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FEASIBILITY STUDY REPORT

FOR

SITE 11, SOLVENT RELEASE AREA

FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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ACRONYMS AND ABBREVIATIONS

AOC	Area of Concern
AS	Air sparging
ARAR	Applicable or Relevant and Appropriate Requirement
AWQC	Ambient Water Quality Criterion
BCT	BRAC Cleanup Team
BEHP	Bis(2-ethylhexyl)phthalate
bgs	Below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cis-1,2-DCE	cis-1,2-Dichloroethene
CLEAN	Comprehensive Long-Term Environmental Action Navy
CO_2e	Carbon dioxide equivalents
COC	Chemicals of Concern
CSF	Cancer Slope Factor
CTO	Contract Task Order
CVOC	Chlorinated volatile organic compound
CVS	Cardiovascular system
CWA	Clean Water Act
DNAPL	Dense non-aqueous-phase liquid
DO	Dissolved oxygen
DoD	Department of Defense
DPT	Direct-push technology
EBS	Environmental Baseline Survey
EFANE	Engineering Field Activity Northeast
EMD	Eastern Mat Ditch
EOS	Emulsified oil substrate
ERH	Electrical Resistance Heating
FS	Feasibility Study
FWENC	Foster Wheeler Environmental Corporation
GC	Gas chromatography
GHG	Greenhouse gas
GRA	General Response Action
HHRA	Human health risk assessment
HQ	Hazard quotient

IR	Installation Restoration
LNR	LNR South Shore LLC
LTM	Long-Term Monitoring
LUC	Land use control
MassDEP	Massachusetts Department of Environmental Protection
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MCP	Massachusetts Contingency Plan
MMBTU	Million British Thermal Units
MSL	Mean sea level
NA	Natural Attenuation
NAS	Naval Air Station
NAVD	North American Vertical Datum
NAVFAC	Naval Facilities Engineering Command
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NERP	Navy Environmental Restoration Program
NHESP	Natural Heritage and Endangered Species Program
NO_x	Nitrogen oxides
NTCRA	Non-Time-Critical Removal Action
O&M	Operation and maintenance
ORC	Oxygen-release compound
ORP	Oxidation-reduction potential
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene (also known as perchloroethene)
PCP	Pentachlorophenol
PMO	Project Management Office
PM_{10}	Particulate matter
PRB	Permeable reactive barrier
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
RI	Remedial Investigation
RIA	Review Item Areas
RME	Reasonable maximum exposure
ROD	Record of Decision

SO_x	Sulfur oxides
SRA	Solvent Release Area
SSTTDC	South Shore Tri-Town Development Corporation
SVOC	Semivolatile organic compound
TACAN	Tactical Air Navigation
TBC	To Be Considered
TCA	1,1,2-Trichlrorethane
TCE	Trichloroethene
TCRA	Time-Critical Removal Action
TOC	Total organic carbon
Tetra Tech	Tetra Tech NUS, Inc.
TTZ	Target Treatment Zone
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
VC	Vinyl chloride
VE	Vapor extraction
VOC	Volatile organic compound
ZVI	Zero-valent iron

1.0 INTRODUCTION

1.1 PURPOSE AND ORGANIZATION OF REPORT

1.1.1 Purpose

This Feasibility Study (FS) Report for the Solvent Release Area (SRA) Site (the Site) at the former Naval Air Station (NAS) South Weymouth, in Weymouth, Massachusetts (the Base), was prepared for the Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic by Tetra Tech under Contract Task Order (CTO) WE11 of the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62470 08-D-1001. The document was prepared to fulfill the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and is consistent with United States Environmental Protection Agency (USEPA) Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (USEPA, 1988) and the Navy Environmental Restoration Program (NERP) Manual, Chapter 8, Remedial Investigation/Feasibility Study (Navy, 2006). This FS Report describes the formulation and evaluation of remedial alternatives for contaminated groundwater at the SRA. The FS establishes Remedial Action Objectives (RAOs) and cleanup goals; screens remedial technologies; and assembles, evaluates, and compares remedial alternatives. The FS is based on data collected during the Remedial Investigation (RI) [Tetra Tech NUS, Inc. (Tetra Tech), 2010].

The purpose of the RI/FS process is to gather and evaluate information sufficient to select an appropriate remedy for a site based on an informed risk management decision-making process. Within an FS report, the results of an RI are used to develop and evaluate potential remedial alternatives that would permanently and significantly reduce the risks to human health and the environment identified at the site. The alternatives should provide cost-effective methods to mitigate the identified risks, and the range of alternatives should be adequate so that consensus can be reached between the Navy and regulators regarding the selected response action.

Subsequent to the FS, the Navy will present the preferred remedial alternative(s) in a Proposed Plan. Following a 30-day public comment period, the Navy and EPA will select the remedial alternative(s) with concurrence from the Massachusetts Department of Environmental Protection (MassDEP). The final remedial alternative(s) will be presented in a Record of Decision (ROD).

1.1.2 Document Organization

This FS Report has been organized with the intent of meeting the general format requirements specified in the RI/FS Guidance Document (USEPA, 1988). This report contains the following five sections:

- Section 1.0, Introduction, summarizes the purpose of the report, provides site background information, summarizes the findings of the RI, and provides the report outline.

- Section 2.0, Remedial Action Objectives and General Response Actions, presents the RAOs, identifies Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria, develops cleanup goals and associated General Response Actions (GRAs), and provides estimates of the volumes of contaminated media to be remediated.

- Section 3.0, Screening of Remediation Technologies and Process Options, provides a two-tiered screening of potentially applicable remediation technologies and identifies the technologies that were assembled into remedial alternatives.

- Section 4.0, Assembly and Detailed Analysis of Remedial Alternatives, assembles the remedial technologies retained from the Section 3.0 screening process into multiple remedial alternatives, describes these alternatives, and performs a detailed analysis of these alternatives in accordance with seven of the nine CERCLA criteria.

- Section 5.0, Comparative Analysis of Remedial Alternatives, compares the remedial alternatives on a criterion-by-criterion basis, for each of the seven CERCLA analysis criteria used in Section 4.

Appendix A contains reference figures and tables from the RI Report. Appendix B contains calculations for the preliminary remediation goals (PRGs). Appendix C contains computations of contaminated media volumes. Appendix D contains remedial alternatives conceptual design calculations. Appendix E contains the sustainable remediation evaluation. Appendix F contains the Biochlor model output. Appendix G contains the cost estimates. Appendix H contains the 2011 time series analysis; Appendix I contains an evaluation of excavation of source area saturated soil.

1.2 BACKGROUND INFORMATION

The following paragraphs provide background information about the Base and the SRA including Base history, study area setting, and site description and history. Figure 1-1 provides the general location map, Figure 1-2 is a site map that shows general features of the Site, and Figure 1-3 shows the main site features.

NAS South Weymouth (Figure 1-1) encompasses an area of approximately 1,442 acres and is located approximately 15 miles southeast of Boston, Massachusetts, primarily in the Town of Weymouth, Norfolk County. Portions of NAS South Weymouth extend into the adjacent Towns of Abington, and Rockland,

Massachusetts. The Town of Hingham forms the northeast boundary. The Base is located in an urban area and is accessed from Route 18 in Weymouth.

The Base is partially developed with wetland and forested areas still remaining. The topography is relatively flat with surface features that include bedrock outcrops, swampy wetlands, and small stream channels. During construction of the airfield, runways, taxiways, and related facilities at the Base, low-lying wetland areas were filled, other areas were re-graded, and surface water was diverted through culverts and drainage ditches. Major surface water features on the Base include Old Swamp River and French Stream (Figure 1-2).

1.2.1 NAS South Weymouth

NAS South Weymouth was commissioned during the 1940s to support dirigible aircraft used to patrol the North Atlantic during World War II. The facility was closed in 1949 and then reopened in 1953 as a naval air station for aviation training. NAS South Weymouth was designated for closure under the Base Realignment and Closure Act of 1990 (BRAC), as part of the BRAC Commission's 1995 Base Closure List (BRAC IV). In September 1996, operational closure of NAS South Weymouth began with the transfer of aircraft to other Navy facilities, and through personnel reduction. Between 1996 and 1997, NAS South Weymouth provided facilities for limited ground training to Marine and Naval reserve units (EA, 1998). NAS South Weymouth was closed administratively under BRAC on September 30, 1997. Because of the closure, the facility was placed in caretaker status under the supervision of NAVFAC Engineering Field Activity Northeast (EFANE) and is currently under the supervision of the NAVFAC BRAC Program Management Office (PMO) Northeast. The majority of the base property has been transferred from the Navy to the local reuse authority. The Navy will transfer the remaining property as environmental work is completed and the property is determined to be suitable to transfer.

As part of the Base closure, the Environmental Baseline Survey (EBS) investigations were conducted to support the Navy's compliance with: the CERCLA Section 120, as amended by Public Law 102-426; the Community Environmental Response Facilitation Act; and state and local real property transfer disclosure notification regulations. In other words, the EBS investigations were conducted to support environmental restoration programs, Base closure, and property transfers/leases. Phase I EBS investigations were conducted in October and November 1995, for those areas of the Base property not already addressed by the DOD Installation Restoration (IR) or Massachusetts Contingency Plan (MCP) programs (MassDEP, 1996). They included visual inspections of all Base property and adjoining property, records reviews, and interviews. The information collected during the Phase I EBS investigations was used to identify specific areas of potential concern and to recommend the level of further investigation required at each of these locations. Areas identified in the Phase I EBS Report (issued in November 1996) as requiring additional investigation were designated as Phase II EBS Review Item Areas (RIAs). Based on

the Phase II EBS investigations, RIAs were designated as Areas of Concern (AOCs) where analytical results of environmental samples indicated concentrations of chemicals exceeding screening criteria. AOCs were then investigated under CERCLA.

1.2.2 Solvent Release Area

The Site is located just north of the East Mat in the eastern portion of the Base (Figure 1-2). The East Mat is an open, flat area which was used for mooring the lighter-than-air aircraft. For the RI Work Plan, the site boundaries were defined approximately by Pidgeon Road to the north, by the Eastern Drainage Ditch to the east, by the East Mat Ditch (EMD) to the south and by the dirt road leading to the former Pistol Range (AOC 35) and tree line on the west (Figure 1-3). Based upon the results of the RI, the boundary of the Site has been expanded slightly to the west and south, to include more of the EMD.

The Site study area is approximately 8 acres and consists of an undeveloped parcel. The Site is vegetated by white pine and red maple trees and has densely vegetated undergrowth. Numerous boulders and fallen trees were noted during a previous investigation (Stone & Webster, 2004b). A wetlands delineation was completed by a consultant to the South Shore Tri-Town Development Corporation (SSTTDC), the local redevelopment authority (see Figure 1-3) (RAI, 2001). The delineation identified approximately 4.0 acres of predominantly forested wetland system and 0.9 acres of intermittent stream consisting predominantly of scrub-shrub vegetation at the Site. The wetland is bordered by a series of dirt roads, the former Pistol Range, and upland forests. The dirt road along the eastern perimeter of the Site provides access to the East Mat. The eastern and southern boundaries consist of drainage ditches. The drainage swale on the eastern edge of the Site was addressed as part of the Tactical Air Navigation (TACAN) outfall drainage system (AOC 61) Non-Time Critical Removal Action (NTCRA). The dirt road along the western boundary provides access to the former Pistol Range. There are no buried gas or electrical utility lines within the site boundary.

1.2.3 Site Investigations

Previous investigations at Site 11, and upgradient of the Site (at the Hobby Shop) are summarized in this section.

Upgradient – Former Hobby Shop (Building 95) - The former Hobby Shop (Building 95) is located immediately north of Pidgeon Road and upgradient of the Site. The Hobby Shop site contained a one-story, corrugated steel building that had been constructed in the 1960's; maintenance and repairs on vehicles were performed inside. Foster Wheeler Environmental Corporation (FWENC), a Navy contractor, conducted four removal actions at Building 95 including: cleaning and removal of an above ground storage tank that stored No. 2 fuel oil for heating Building 95; removal of two floor drain systems;

and removal of two hydraulic lift stations. Soil and groundwater samples collected following the removal actions were evaluated in a decision document. The decision document recommended no further action; the regulators concurred and the site was closed in 2004 (Stone & Webster, 2004a).

AOC 35 (Pistol Range) - The Pistol Range Site (AOC 35) comprised about 2 acres of land in the southern portion of the Site and within the current Site boundary. In 2000, the Navy conducted a CERCLA Time-Critical Removal Action (TCRA) to address soil that contained elevated concentrations of lead (from past Pistol Range operations) through excavation and offsite disposal. Post-excavation soil sampling results confirmed that the cleanup goal of 300 mg/kg lead was achieved. A ROD for AOC 35 was issued in December 2004 and the Pistol Range Site was closed. The No Further Action ROD stated that the soil had been remediated and the groundwater would be addressed as part of the SRA Site.

RIA 108 (Site) - Under the Phase II EBS, the undeveloped parcel of land that constitutes the current Site was selected for background sampling as part of the *Background Data Summary Statistics Report (*Stone & Webster, 2000). In October 1998, one soil boring (BG-05) was advanced at what is now known as the Site and soil samples were collected from three separate depths (0-1 foot, 3-5 feet, 5-7 feet). Tetrachloroethene (PCE) was detected at all three depth intervals at BG-05. Trichloroethene (TCE) and cis-1,2-dichloroethene (cis-1,2-DCE) were detected at the 5- to 7-foot depth interval at BG-05. The highest PCE concentration (870 µg/kg) was measured in the 5- to 7-foot interval sample. Semi-volatile compounds (SVOCs), pesticides and polychlorinated biphenyls (PCBs), were not detected above laboratory reporting limits in the three soil samples. Arsenic, vanadium, iron, and manganese concentrations were elevated in samples from BG-05.

November 2002 – Additional Soil Characterization near BG-05 - In November 2002, additional soil samples were collected near BG-05. One soil boring (SB10-301) was advanced using hollow stem auger drilling techniques. Soil samples were collected from three depth intervals (Stone & Webster, 2004b). PCE was detected at concentrations of 150 µg/kg (0-1 feet), 55 µg/kg (3-5 feet), and 370 µg/kg (5-7 feet). Cis-1,2-DCE was detected at 7.7 µg/kg (3-5 feet) and 65 µg/kg (5-7 feet). TCE was not detected above laboratory reporting limits.

April 2003 – Groundwater Sampling of Downgradient Overburden Well - In April 2003, a groundwater sample was collected from MW10-302, which is located south of the BG-5 location at AOC 35 (the former Pistol Range) for volatile organic compound (VOC) analysis. The sample interval depth was 11 feet below ground surface (bgs). PCE was detected at 270 µg/L; TCE and cis-1,2 DCE were detected at estimated concentrations of 0.35J µg/L, and 0.48J µg/L, respectively.

September-October 2003 – Shallow Groundwater Sampling Program - During September and October 2003, 33 temporary wells (GW10-305 to GW10-337) were installed using direct-push (Geoprobe™) drilling techniques. These wells were installed in the overburden to depths ranging from 8 to 14 feet bgs. Groundwater samples were collected from 30 of the 33 temporary wells and analyzed for VOCs. Chlorinated VOCs (CVOCs) were detected above laboratory reporting limits in several samples located on the Site. The maximum values of the CVOCs were detected just north of BG-5 in GW10-305: PCE (13,000 µg/L), TCE (180 µg/L), cis-1,2-DCE (1,300 µg/L), trans-1,2-DCE (21 µg/L) and 1,1,2-trichloroethane (TCA) (17 µg/L). VOCs were not detected in the seven temporary wells located along Pidgeon Road upgradient from the Site. Petroleum-related VOCs were also detected above laboratory reporting limits in a few samples. The highest concentrations of petroleum-related VOCs were detected in the northern portion of the Site at GW10-309: benzene (7.8 µg/L), ethylbenzene (11 µg/L), toluene (62 µg/L), and total xylenes (43 µg/L).

February 2004 – Additional Monitoring Wells and Groundwater Sampling - In February 2004, five overburden groundwater monitoring wells (MW10-303, MW10-304, MW10-338, MW10-339 and MW10-340) and two shallow bedrock monitoring wells (MW10-302D and MW10-304D) were installed to evaluate the preliminary extent of VOCs in groundwater. PCE concentrations ranged from not detected above laboratory reporting limits to 255 µg/L in the overburden wells, and from 5.4 to 1,600 µg/L in the two bedrock wells. TCE was not detected above laboratory reporting limits in any of the five overburden wells with the exception of MW10-303, where it was detected at 13 µg/L. TCE was detected in one of the two shallow bedrock monitoring wells (MW10-302D) at a concentration of 1.7 µg/L.

2004 – Additional Monitoring Wells and Groundwater Profiling – Eight soil borings (CH-GW108-01 through CH-GW108-08) were advanced to the apparent overburden/bedrock interface and groundwater samples were collected for field gas chromatography (GC) screening and laboratory analysis. Field GC screening results indicated concentrations of PCE ranging from trace up to 96,000 µg/L. Fixed laboratory data confirmed the PCE concentrations (up to 20,000 µg/L). Two of the borings were completed as overburden monitoring wells (CH108-MW01 and CH108-MW02).

November 2004 Shallow Soil Sampling Program – During November 2004, the Navy conducted a shallow soil sampling program to attempt to identify the potential PCE source. Soil samples were collected from 34 locations (SB10-401 to SB10-434) and analyzed by USEPA's mobile laboratory for TCE, PCE, and 1,1,1-TCA. PCE was detected at concentrations between 10 and 285 µg/kg in the shallow soil samples. The highest PCE concentration (1474 µg/kg) was detected in the deep sample collected below the groundwater table at 5 feet bgs (SB10-413). TCE and TCA were not detected in the soil samples.

October 2004 - Geophysical Survey/Refuse Removal – Geophysical surveys (magnetometer, electromagnetics, seismic refraction) were performed to help identify potential buried metallic objects, such as drums, that might be sources of the subsurface VOC contamination (Stone & Webster, 2004c). Significant large anomalies, attributed to the presence of surface scrap and metal debris, were detected to the northern and northwestern portion of AOC 108. Each anomaly was inspected and, if appropriate, removed for offsite disposal. Based on the field observations and the conditions that the debris were found, it is unlikely that materials were buried at depth.

Downgradient - East Mat Ditch - The East Mat is a semi-circular, 50-acre area located in the east-central portion of NAS South Weymouth, just south of the EMD. A stormwater drainage system on the East Mat was investigated as RIA 39 a – h; all components of RIA 39 have been closed out with no action required. The storm drains are connected to the TACAN outfall on the west side of the East Mat and to tributaries of Old Swamp River on the east side. AOC 60 encompasses most of the EMD, with the exception of about 200 linear feet of the western portion of the EMD which were investigated as part of AOC 61 (TACAN Outfall and Associated Areas). The reports listed below summarize the studies which characterized the contamination in the sediments of the EMD and the removal actions subsequently completed.

- *Technical Memorandum, Area of Concern 61, TACAN Outfall, Naval Air Station South Weymouth, Weymouth, Massachusetts, Tetra Tech, August 2008.*

- *Technical Memorandum Area of Concern 60, EMD, Naval Air Station South Weymouth, Weymouth, Massachusetts, Tetra Tech, August 2008.*

Based on the information presented in these two Technical Memoranda, No Further Action RODs were issued for AOC 60 and AOC 61 in December 2008.

1.3 SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

This section summarizes the physical characteristics, nature and extent of contamination, contaminant fate and transport, and human and ecological risks at the Site based on the findings provided in the RI Report (Tetra Tech, 2010).

1.3.1 Topography and Surface Drainage

The topography of the Site is relatively flat. The ground-surface elevations over most of the Site range from approximately 167 to 157 feet, but decrease to approximately 153 feet (North American Vertical Datum [NAVD] 1988) at the Eastern Drainage Ditch and the EMD.

A drainage ditch is also present to the west of the western boundary of the Site. Surface water in the ditches is intermittent, and at times portions of the ditches are dry. Surface drainage over a majority of the Site flows in a southerly direction toward the EMD. A portion of the surface drainage at the Site was noted to flow towards the Western Drainage Ditch. Surface drainage was not noted to flow toward the Eastern Drainage Ditch. The Eastern Drainage Ditch also receives surface water from a culvert that extends north of the Site. Surface water from the Eastern Drainage Ditch and the Western Drainage Ditch discharges to the EMD. At the location where the Eastern Drainage Ditch flows into the EMD, the surface water flow divides. West of the confluence of the ditches, the EMD flows in a westerly/southwesterly direction to a catch basin located at the west end of the ditch. The Western Drainage Ditch joins the EMD upstream of the catch basin and also flows towards the catch basin. The water that enters this catch basin is part of the basewide storm water drainage system that ultimately drains into French Stream. Near the southwestern corner of the former Pistol Range a corrugated drainage pipe drains shallow groundwater into the EMD. East of the confluence of the Eastern Drainage Ditch and the EMD, the EMD flows in an easterly direction and becomes part of the basewide storm water drainage system that ultimately drains into Old Swamp River.

During dry months the Eastern Drainage Ditch has been observed to be dry, mostly dry and/or stagnant. However, during other times of the year, the Eastern Drainage Ditch was observed to be flowing. The EMD was observed to be flowing at highly variable rates during the RI field work. The opposing directions of surface water drainage are consistent with a groundwater divide at the Site.

1.3.2 Ecological Setting

The Site was previously delineated as a predominantly forested wetland system with a saturated water regime under a study performed for the SSTTDC, the local redevelopment authority (RAI, 2001). The area consists of an undeveloped parcel that is dominated by two red maple wetlands which are bordered by white pine-oak forest, one to the east of the pistol range access road (Wetland AAA) and one to the west of the pistol range access road (Wetland BBB). As shown on Figure 1-3, the Wetland AAA area is within the SRA site boundary while other delineated wetland areas lie adjacent to the Site. These wetland areas were verified by a study conducted by Tetra Tech in June 2008 as part of the RI field program. The study verified the wetland areas using both the MassDEP method (used in the SSTTDC delineation) and the U.S. Army Corps of Engineers (USACE) method. Based on the June 2008 study, the eastern wetland within the SRA Site met only the state wetland criteria of >50% of plant species hydrophytes, it did not meet the three parameters needed to be considered a wetland according to the 1987 USACE manual; the western wetland did meet the criteria. A wetland functional assessment conducted on June 22, 2010, at the wetlands within the SRA Site, identified suitability for seven functions and values: groundwater recharge/discharge, floodflow alteration, sediment/toxicant retention, nutrient

removal, production export, sediment/shoreline stabilization, and wildlife habitat. Two of these – floodflow alteration and wildlife habitat – were identified as principal functions.

The Massachusetts Natural Heritage and Endangered Species Program (NHESP) Wildlife Habitat Evaluation Field Data Form, completed during the Ecological Risk Assessment, indicated no rare or unique species or habitats were observed at SRA.

1.3.3 Geology and Hydrogeology

The Site overburden consists of approximately 10 to 30 feet of native unconsolidated materials, underlain by bedrock. Four overburden geologic units have been observed at the Site, including: a fine-to-coarse sand unit ranging from 0 to approximately 16 feet in thickness throughout the Site; a discontinuous fine-to-coarse sand, silty sand, and silt unit ranging from 0 to approximately 6 feet in thickness in a few locations; a sand and gravel unit predominant throughout the Site and ranging in thickness from 0 to 9 feet; and a glacial till unit, ranging from 0 to 18 feet in thickness, and comprised of sand, silt, and gravel with varying amounts of clay and rock fragments on top of bedrock throughout most of the Site with the exception of the area to the west of the former Pistol Range. Cross-sections from the RI Report are included in Appendix A.

The Site is underlain by Dedham Granite, which is weathered, fractured, medium to coarse-grained, and light grayish-pink to greenish-gray in color. Overall, the bedrock surface elevation at the Site ranges from approximately 133 feet to 153 feet mean sea level (MSL) and slopes from the north to south. The bedrock surface dips to the southwest in the northern portion of the Site and southeast in the southern portion of the Site. Over short distances, the seismic survey indicated the bedrock surface is mildly irregular, except for the southeastern corner of the survey area, where the bedrock surface dips steeply to the east.

Generally north-south trending fracture zones with high angle dips were observed at the Site. In addition, northeast-southwest trending fracture zones were also observed. One interpreted, north-south oriented, water-bearing fracture zone passes to the west of the source area and extends to the southern portion of the Site. This fracture zone was found to be dipping steeply to the east and appears to be affecting contaminant transport in the bedrock.

The overburden, shallow bedrock, and deep bedrock contour maps all show a southerly groundwater flow direction beneath the Site. The EMD is the dominant surface or near-surface feature in the area that affects groundwater flow, particularly in the overburden. There is a pipe on the north side of the EMD that discharges surface runoff/shallow groundwater into the EMD. This feature has been characterized and is part of the RI datasets. A stormwater drainage system on the East Mat is the only other engineered

structure in the area. This system was investigated as RIA 39 a – h; all components of RIA 39 have been closed out with no action required. The storm drains are connected to the TACAN outfall on the west side of the East Mat and to tributaries of Old Swamp River on the east side. There are no buried gas or electrical utility lines within the site boundary. The drainage system that is downgradient of the EMD will not have an effect on the plume because utilities are constructed in overburden and the overburden plume at SRA ends at the EMD.

The groundwater flow patterns during both seasonal high and seasonal low conditions were very similar in overburden, shallow bedrock and deep bedrock. The groundwater flow directions and rates in overburden, shallow bedrock and deep bedrock groundwater did not vary significantly between seasonal high and seasonal low water levels. Calculated horizontal gradients in the overburden, shallow bedrock and deep bedrock all ranged from 0.01 to 0.02 ft/ft. Four synoptic groundwater level measurement rounds completed in November 2006, December 2006, April 2007, and November 2009 indicated a consistent depth to groundwater, ranging from 0 to 6 feet below ground surface across the Site.

1.3.4 Nature and Extent of Contamination

VOCs are the predominant contaminants at the Site. The most frequently detected VOC compounds are PCE and its degradation products: TCE, cis-1,2-DCE, and vinyl chloride (VC) (to a more limited extent). These four compounds are also the only VOCs that exceeded their respective Maximum Contaminant Levels (MCLs). VOCs, including PCE and its breakdown products, were detected infrequently in soil, sediment, and surface water. Direct evidence of dense non-aqueous-phase liquid (DNAPL) was not found at the Site. However, indirect evidence for the potential presence of DNAPL exists. Figures 1-4 and 1-5 show the extent of the PCE plume in the overburden and bedrock. The extent of other chemicals of concern (COCs) is depicted on RI Report figures included in Appendix A. A summary of the groundwater sampling results from the RI Report is also included in Appendix A.

The SVOCs, caprolactam and naphthalene, were the most frequently detected SVOCs in groundwater. The SVOC, 3,3'-dichlorobenzidine, was detected in one sample and the concentration exceeded the Region 9 PRG; 2,4,6-trichlorophenol was detected in more than one groundwater sample. Concentrations of pentachlorophenol (PCP) exceeded its Region 9 PRG in two groundwater samples and the MCL was also exceeded in one of these samples. A few additional SVOCs were detected, each in just one subgroup in just one sample, and at concentrations that did not exceed the screening criteria. Polycyclic aromatic hydrocarbons (PAHs) were detected in the surface water location in the western portion of the EMD. Four PAHs and bis(2)ethylhexylphthalate (BEHP) were the only SVOCs that were detected at concentrations greater than their Region 9 PRGs in site soils. Sediment samples exceeded Region 9 PRGs for five SVOCs, all PAHs.

Pesticides were detected in Site soil, groundwater, and sediment, generally infrequently and at low concentrations. Endosulfan I was the only pesticide detected in groundwater; no pesticides were detected in the surface water samples. PCBs (Aroclor-1242 and Aroclor-1260) were detected in surface and subsurface soils. PCBs were not detected in Site groundwater. Aroclor-1242, Aroclor-1248, Aroclor-1252, and Aroclor-1260 were detected in sediment samples.

Five metals (aluminum, arsenic, iron, manganese, and vanadium) were present at concentrations exceeding their respective Region 9 PRGs in soil, groundwater, surface water and sediment. Barium in groundwater exceeded the Region 9 PRG in one location; its MCL was also exceeded in this location.

Because the Site is primarily a wetland with a very high water table, the thickness of unsaturated soil precluded soil vapor sampling over much of the Site. The one soil vapor sample collected contained a very low concentration of toluene.

Evaluation of Groundwater Time Series Data

In response to discussions at a BRAC Cleanup Team (BCT) meeting on October 28, 2010, the Navy proposed collection of additional time series groundwater data at select SRA monitoring wells to support the FS. In December 2010, the Navy proposed two additional groundwater sampling events for spring and fall 2011 to determine whether there are changes in the CVOC plume at SRA. Sixteen monitoring wells were originally selected to provide time series data for use in the FS. Four additional monitoring wells were added to the fall sampling event to provide additional data for modeling purposes. The data from the two 2011 groundwater sampling events have been used to check the limits of the overburden and bedrock groundwater contamination delineated during the RI. The groundwater sampling events were completed during April 2011 (high groundwater) and August (low groundwater). A summary of these two events, including data tables, figures, and plotted time series data, is included as Appendix H. The conclusions of this additional data collection are presented below.

The PCE plume and concentrations in the overburden groundwater are consistent or decreasing (Figure 1-6). The TCE, cis-1,2-DCE, and VC plumes in the overburden groundwater continue to be much more limited in extent than the PCE plume and the detected concentrations are similar to prior events. The analytical data (between 1999 and 2011) indicate a decrease in the extent of the plume on its western flank (MW10-302) and southern edge (MW10-303). The data indicate a slight increase in the extent of the plume on its eastern flank (MW10-304) and near the source area (CH108-MW01). Overall, these are not considered significant changes to the extent of the overburden plume.

The PCE plume and concentrations in the bedrock groundwater are slightly decreasing to the north, variable within the source area, consistent to the southeast and southwest, and increasing or consistent

to the south (Figure 1-7). The TCE, cis-1,2-DCE, and VC plumes in the bedrock groundwater continue to be much more limited in extent than the PCE plume and the detected concentrations are similar. The analytical data (between 2004 and 2011) suggest a slight increase in concentrations of the plume on its eastern flank (MW-304D) and south of the source area (MW10-302D). Concentrations of the bedrock plume are generally consistent south of the East Mat Ditch and contracting north of the source area. It should be noted that these apparent trends may not be statistically significant. The bedrock groundwater results to date indicate that the extent of the plume is generally consistent to the southeast and southwest, slightly expanding to the south and east, and contracting to the north. Within the source area in the bedrock the concentrations are variable. Overall, these data do not suggest a significant shift in the bedrock plume configuration in this time period.

1.3.5 Contaminant Fate and Transport

Two primary sources of contaminants detected in Site soil, groundwater, surface water, and sediment have been identified based on evaluation of the concentrations and distribution of contaminants, contaminant properties, and the physical characteristics of the Site. These two sources include: releases of liquid waste (solvents) adjacent the dirt access road to the former Pistol Range; and historical disposal of debris and fuel in the EMD.

While several hypotheses regarding the origin of the contamination have been advanced, none have been corroborated. The most plausible explanation of the source is that spent solvents were disposed of at the Site. The source of the chlorinated solvent plume is likely direct disposal of chlorinated solvent(s), either PCE or a mixture, on the ground surface. The historical presence of discolored water, solid waste and the report that aircraft fuel tanks were previously drained into the EMD indicated that the source of PCBs, SVOCs, and metals in sediment are attributable to this historical status of the EMD.

Anthropogenic and Natural Background Conditions

Some of the contaminants detected on the Site may be present as a result of background conditions. These are identified below:

- Pesticide presence is likely related to general use of pesticides on the Base.
- The presence of arsenic, manganese, vanadium, iron and other metals in Site media is likely a natural background condition.
- The presence of BEHP and PAHs is likely a result of their ubiquitous presence in the environment.

1.3.6 Baseline Risk Assessments

1.3.6.1 Human Health Risk Assessment

The objective of this risk assessment was to determine whether detected concentrations of chemicals within the study area pose a significant threat to potential human receptors under current and/or future land use. The risk assessment for the Site was based on chemical data for subsurface soil, surface soil, groundwater, soil gas, surface water, and sediment. The potential risks to human receptors were estimated based on the assumption that no actions are taken to control contaminant releases. Five potential receptor groups were evaluated: future maintenance workers, current and future adolescent trespassers, future adult and child recreational users, future adult and child residents, and future construction workers. Note that while the nature and extent evaluation in the RI used Region 9 PRGs, the risk assessment used the EPA RSLs.

Potential unacceptable risks were identified for future residents (adult and child), primarily from use of groundwater as drinking water and in the form of vapor intrusion into buildings, and for future construction workers from ingestion, dermal exposure, and inhalation of vapors in narrow deep trenches.

The major contributor to risk is PCE in groundwater. In addition to use for drinking water purposes, an evaluation of potential risks associated with use of groundwater for irrigation indicated a potential risk to future residents via the dermal exposure pathway (adult only) and the vegetable ingestion exposure pathway (adult and child). Exposures to surface soil, subsurface soil, sediment, and surface water do not contribute significantly to total receptor hazards. Further examination of these results reveals that the organ-specific hazard indices for blood, skin, cardiovascular system (CVS), liver, and kidney, and the individual hazard quotients for cis-1,2-DCE, PCE, arsenic, and barium in groundwater exceed 1 for future child residents under the Reasonable Maximum Exposure (RME) scenario. The organ-specific hazard indices for blood and liver, and the individual hazard quotients for cis-1,2-DCE and PCE in groundwater exceed 1 for future adult residents under the RME scenario.

For future construction workers, exposure to groundwater through ingestion, dermal contact and inhalation of volatiles in trench air are the primary pathways of concern. Exposures to surface soil, subsurface soil, sediment, and surface water do not contribute significantly to total receptor hazards. The organ-specific hazard index for liver and the individual hazard quotient for PCE in groundwater exceed 1 for future construction workers under the RME scenario. The organ-specific hazard index for liver and the individual hazard quotient for PCE in trench air at the study area exceed 1 for construction workers under the RME scenario.

These exceedances of 1 by organ-specific hazard indices and individual contaminants indicate that adverse non-carcinogenic health effects are possible under the conditions established in the exposure assessment for future residents and future construction workers.

The RME cancer risk estimates for the future adult and child residents and future construction workers exceed the USEPA cancer risk range ($1x10^{-4}$ to $1x10^{-6}$). The major contributor to cancer risk at the Site is PCE in groundwater.

Vapor intrusion was quantitatively evaluated for residential and industrial scenarios. Adolescent trespassers were evaluated for exposure to chemicals in groundwater migrating to outdoor air. Residents were evaluated for exposure to groundwater used for irrigation through dermal contact (adult only) and ingestion of home-grown vegetables (child and adult). PCE in groundwater was identified as a risk driver for vapor intrusion in both industrial and residential scenarios. PCE in groundwater used for irrigation exceeded USEPA target cancer and non-cancer risk levels in the RME scenarios via the dermal exposure pathway and via the vegetable ingestion exposure pathway.

Based on the non-cancer and cancer evaluations, the following contaminants with non-cancer hazard quotients greater than 1 or with cancer risks greater than $1x10^{-6}$ in a scenario with total cancer risks greater than $1x10^{-4}$ were identified as COCs: cis-1,2-DCE, PCE, TCE, VC, PCP, 3,3-dichlorobenzidine, arsenic, and barium in groundwater used as drinking water; PCE in vapor intrusion, and PCE in groundwater used for irrigation. PCE in groundwater is the primary COC risk driver in both future residents and future construction workers.

1.3.6.2 Ecological Risk Assessment

Screening level risks to terrestrial plants, invertebrates, and aquatic organisms were present for several chemicals. However, during the detailed risk evaluation it was determined that plants or invertebrates are not likely to be significantly impacted from the chemicals detected in soil at the Site and that risks to aquatic organisms were not great enough for any chemicals to warrant further evaluation at this Site and/or the concentrations in the Site samples were similar to the concentrations in background samples.

Although some slight impacts to sediment invertebrates could occur from PAHs and pesticides in the sediment, the PAHs and pesticides do not appear to be site-related. Some slight impacts to sediment invertebrates could occur from PCBs in the sediment but the maximum potentially impacted area is approximately 150 linear feet. None of the metals detected in the sediment samples are expected to significantly impact sediment invertebrates at the Site.

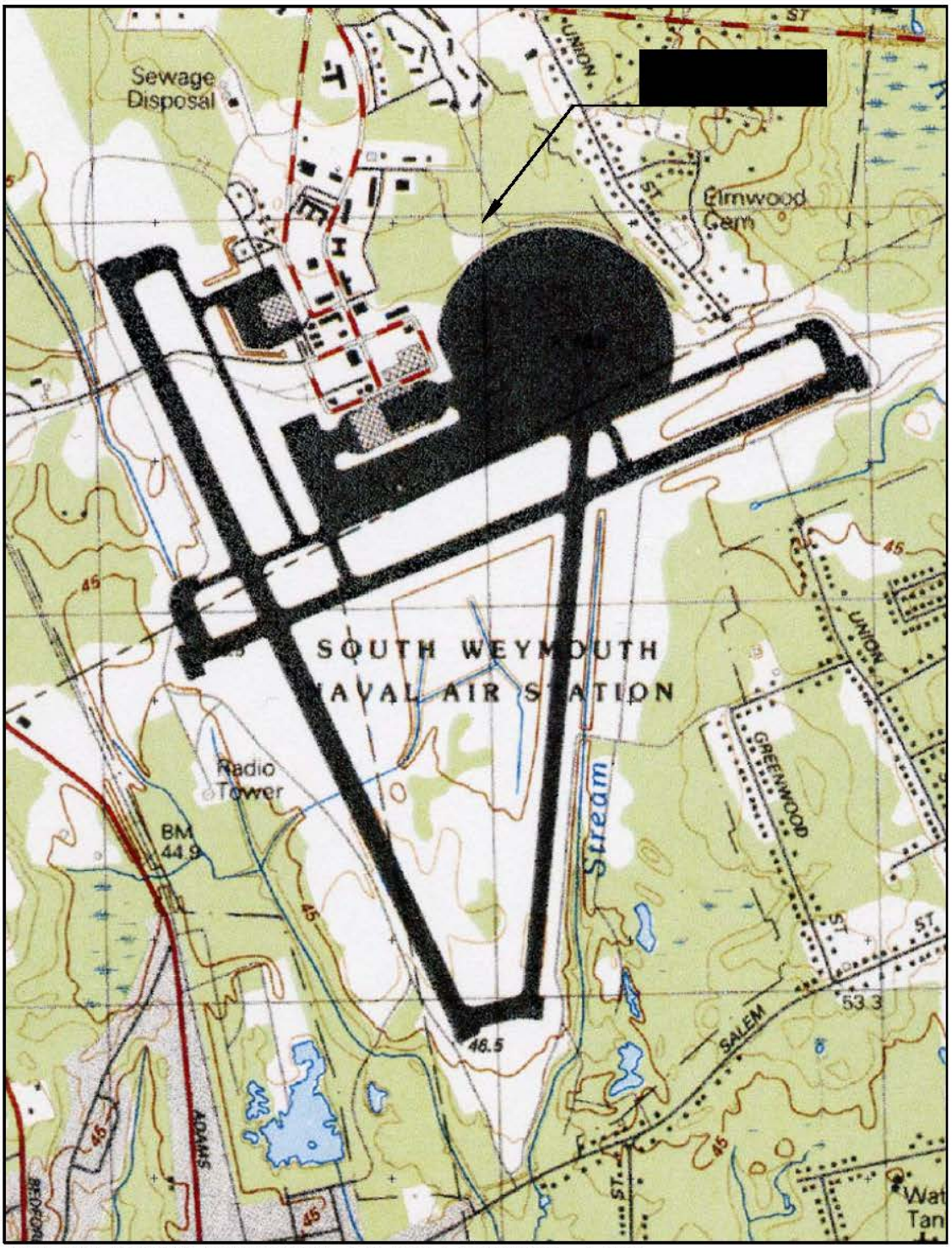
Several chemicals had a hazard quotient (HQ) greater than 1 based on the conservative food chain models for terrestrial receptors. During the detailed risk evaluation, it was determined that risks to wildlife were not great enough for any chemicals to warrant further evaluation at this Site and/or the concentrations in the site samples were similar to the concentrations in background samples.

1.3.6.3 Conclusions

Contaminants in Site media did not pose unacceptable human health or ecological risks under current exposure scenarios. However, groundwater at the Site contained several organic contaminants and metals at concentrations that may pose unacceptable human health risks to future construction workers from exposure to COCs via incidental ingestion, dermal contact, inhalation, and exposure of building occupants to VOCs resulting from vapor intrusion.

Adverse effects to terrestrial receptors, wildlife, aquatic organisms and terrestrial plants and invertebrates were not predicted. There are no significant impacts to sediment invertebrates that could occur from PAHs and pesticides in the sediment, and there are no significant impacts to sediment invertebrates that could occur from PCBs in the sediment.

ACAD:I:\02073\FS.DF.SRA\SRA_LOCUS.DWG 6/21/12 DWM



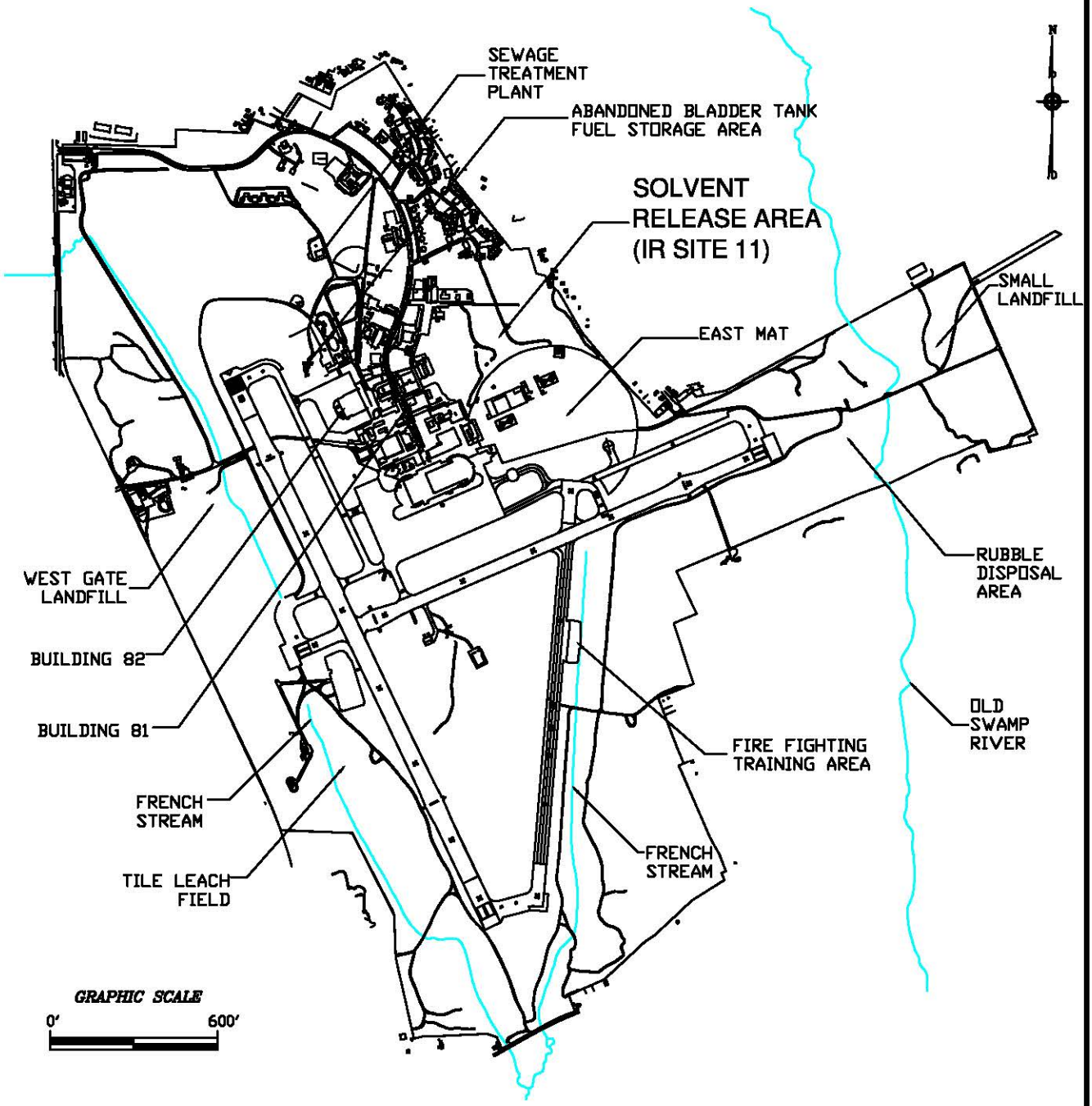
BASE MAP FROM USGS QUADRANGLE SHEET: WEYMOUTH, MASSACHUSETTS, 1984

QUADRANGLE LOCATION

GRAPHIC SCALE
0 0.5 MILE 1 MILE

TETRA TECH	FORMER NAVAL AIR STATION SOUTH WEYMOUTH WEYMOUTH, MASSACHUSETTS SITE LOCUS SOLVENT RELEASE AREA FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA	SCALE AS NOTED FILE \..\SRA_LOCUS.DWG REV 0 DATE 6/21/12 FIGURE NUMBER 1–1

ACAD:I:\02073\FS.DF.SRA\SRA_BASE_MAP.DWG 6/21/12 DWM



TETRA TECH

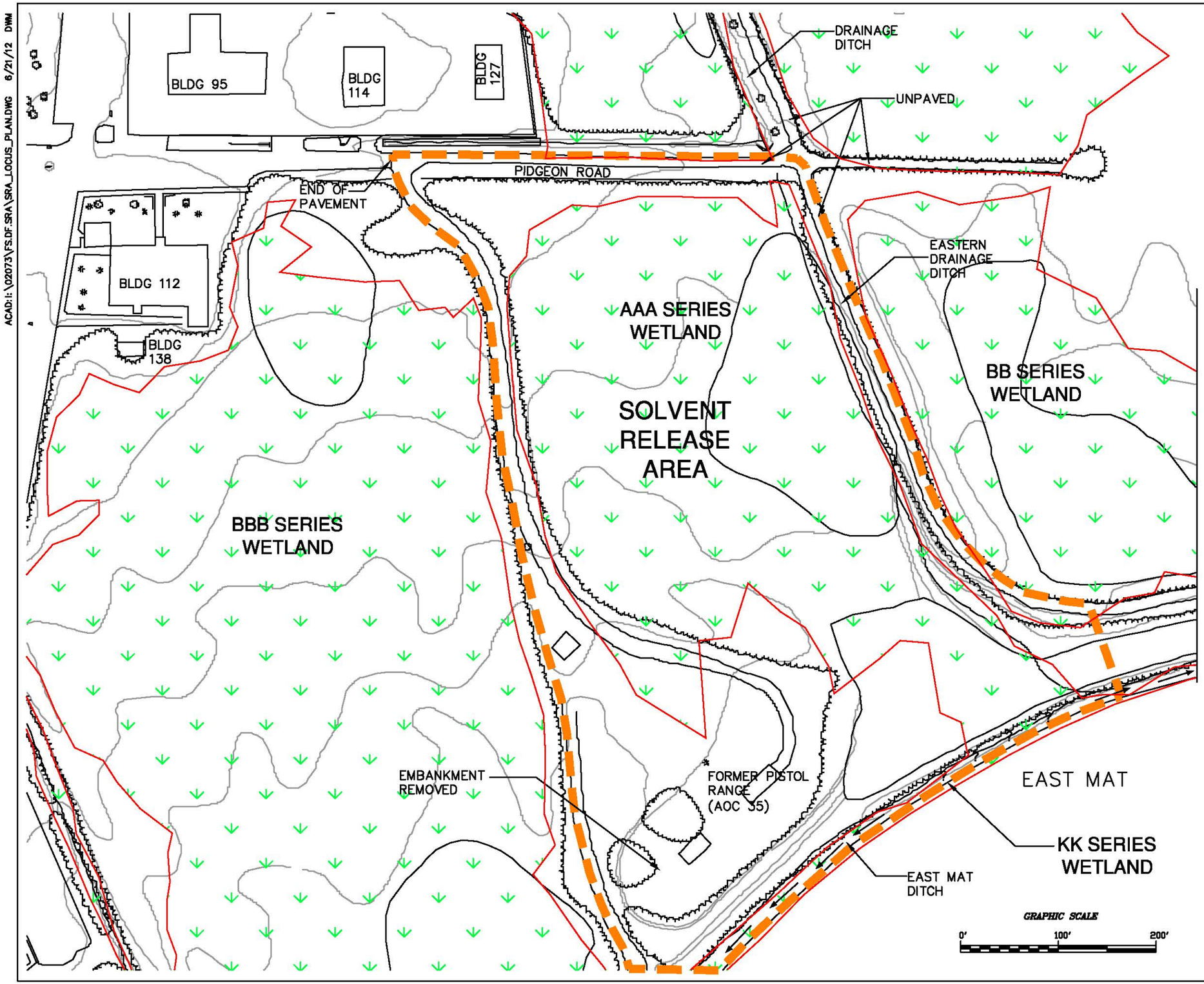
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

MAIN BASE MAP

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

SCALE	PER–BAR SCALE
FILE	\..\SRA_BASE_MAP.DWG
REV	0
DATE	6/21/12
FIGURE NUMBER	1–2

ACAD:I:\02073\FS.DF.SRA\SRA_LOCUS_PLAN.DWG 6/21/12 DWM



SOLVENT RELEASE AREA WORK PLAN BOUNDARY

DELINEATED WETLANDS BOUNDARY

WETLANDS

SOURCES:

1. ENSR DATABASE/GIS DISK:
NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N
SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9)
NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS
PREPARED BY: ENSR INTERNATIONAL
PREPARED FOR: EFA NORTHEAST NAVAL FACILITIES ENGINEERING COMMAND
MARCH 28, 2005

2. S.S.T.T.D.C. / RIZZO ASSOC., INC.– WETLAND DELINEATIONS, JUN. 01, 2001.

TETRA TECH

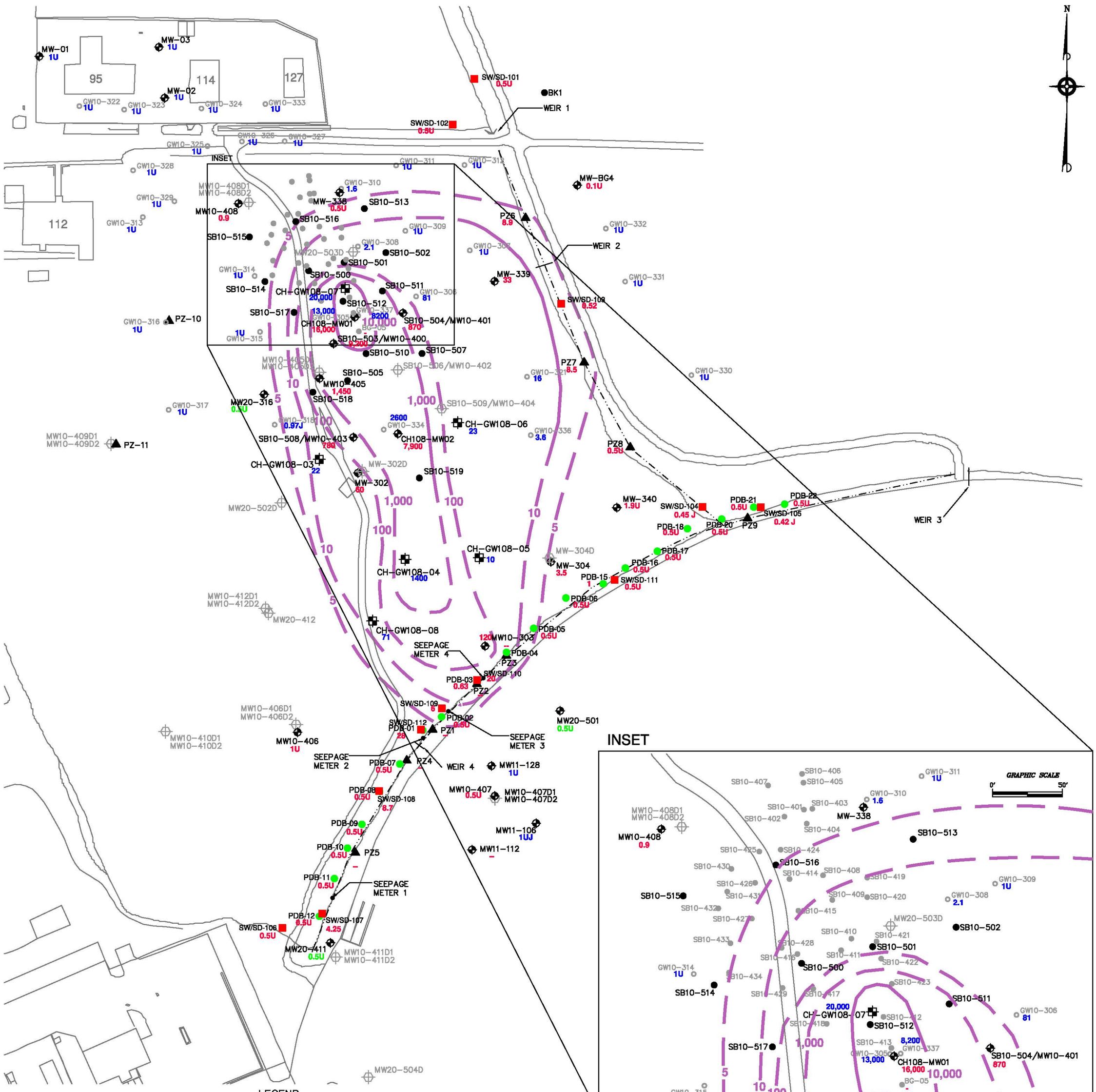
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

LOCUS PLAN

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_LOCUS_PLAN.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
FIGURE 1–3	0	6/21/12


N
MW-01
1U
MW-03
1U
MW-02
1U
95
114
127
112
GW10-322
1U
GW10-323
1U
GW10-324
1U
GW10-333
1U
SW/SD-101
0.5U
BK1
WEIR 1
SW/SD-102
0.5U
GW10-325
1U
GW10-326
1U
GW10-327
1U
INSET
GW10-328
1U
GW10-329
1U
GW10-313
1U
MW10-408D1
MW10-408D2
MW10-408
0.9
GW10-310
1.6
MW-338
0.5U
SB10-513
SB10-516
SB10-515
GW10-311
1U
GW10-312
1U
MW-BG4
0.1U
PZ6
8.9
GW10-332
1U
WEIR 2
GW10-309
1U
GW10-308
2.1
MW20-503D
SB10-502
SB10-501
SB10-500
GW10-314
1U
SB10-514
CH-GW108-07
20,000
SB10-511
SB10-512
GW10-306
81
MW-339
33
GW10-331
1U
SW/SD-109
0.52
SB10-517
13,000
CH108-MW01
16,000
GW10-337
8200
SB10-504/MW10-401
870
10,000
GW10-316
1U
PZ-10
GW10-315
1U
SB10-503/MW10-400
9,200
SB10-510
SB10-507
MW10-405D1
MW10-405D2
SB10-505
SB10-506/MW10-402
MW10-405
1,450
SB10-518
PZ7
8.5
GW10-321
16
GW10-330
1U
MW20-316
0.5U
GW10-317
1U
1,000
SB10-509/MW10-404
2600
GW10-334
CH-GW108-06
23
GW10-336
3.6
GW10-318
0.97J
MW10-409D1
MW10-409D2
PZ-11
SB10-508/MW10-403
780
CH108-MW02
7,900
PZ8
0.5U
CH-GW108-03
22
MW-302D
MW-302
60
SB10-519
MW20-502D
MW-340
1.9U
SW/SD-104
0.45 J
PDB-21
0.5U
PDB-22
0.5U
SW/SD-105
0.42 J
PZ9
PDB-18
0.5U
PDB-20
0.5U
WEIR 3
CH-GW108-05
10
MW-304D
MW-304
3.5
PDB-17
0.5U
PDB-16
0.5U
PDB-15
1
SW/SD-111
0.5U
CH-GW108-04
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PDB-06
0.5U
MW10-412D1
MW10-412D2
MW20-412
CH-GW108-08
71
PDB-05
0.5U
120
MW10-303
SEEPAGE METER 4
PDB-04
PZ3
SW/SD-110
PDB-03
0.63
20
PZ2
SW/SD-109
6
PDB-02
0.5U
MW10-406D1
MW10-406D2
SW/SD-112
PDB-01
28
PZ1
MW20-501
0.5U
MW10-410D1
MW10-410D2
MW10-406
1U
SEEPAGE METER 3
SEEPAGE METER 2
PDB-07
0.5U
PZ4
WEIR 4
MW11-128
1U
PDB-08
0.5U
SW/SD-108
8.7
MW10-407
0.5U
MW10-407D1
MW10-407D2
PDB-09
0.5U
MW11-106
1UJ
PDB-10
0.5U
PZ5
MW11-112
PDB-11
0.5U
SEEPAGE METER 1
PDB-12
0.5U
SW/SD-107
4.25
SW/SD-106
0.5U
MW20-411
0.5U
MW10-411D1
MW10-411D2
MW20-504D
INSET
GRAPHIC SCALE
0'
50'
SB10-407
SB10-406
SB10-405
GW10-311
1U
GW10-310
1.6
MW-338
SB10-401
SB10-403
SB10-402
SB10-404
MW10-408D1
MW10-408D2
MW10-408
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SB10-419
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SB10-515
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SB10-420
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GW10-308
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SB10-432
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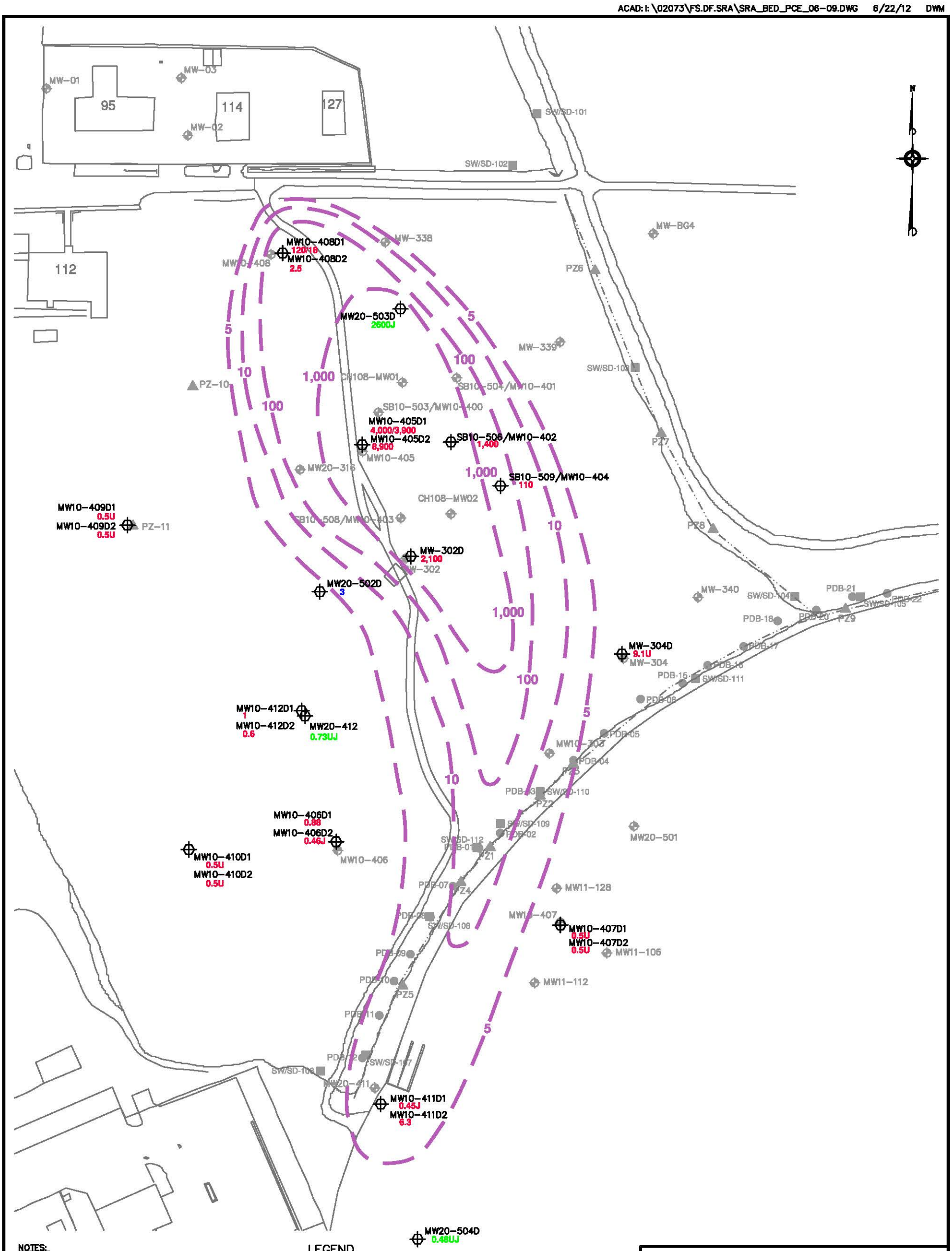
SB10-410
SB10-421
SB10-433
SB10-428
SB10-501
SB10-411
SB10-416
SB10-422
SB10-500
GW10-314
1U
SB10-434
SB10-423
SB10-514
SB10-429
SB10-417
SB10-511
20,000
CH-GW108-07
SB10-412
SB10-512
GW10-306
81
SB10-418
SB10-517
1,000
SB10-413
8,200
GW10-337
13,000
CH108-MW01
16,000
10,000
SB10-504/MW10-401
870
BG-05
GW10-315
1U
9,200
SB10-503/MW10-400
GRAPHIC SCALE
0'
100'
200'
LEGEND
OVERBURDEN MONITORING WELL
BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP
STREAM PIEZOMETER
CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)
RI SURFACE WATER/SEDIMENT SAMPLING LOCATION
RI PASSIVE DIFFUSION BAG LOCATION
PRE-RI TEMPORARY WELL LOCATION (GW10 SERIES)
PRE-RI SOIL BORING LOCATION (SB10-400 SERIES)
RI SOIL BORING LOCATION (SB10-500 SERIES)
TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
22
2003-2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
• SEPTEMBER-OCTOBER 2003 - GW-10 SERIES TEMPORARY WELLS (TOTAL DEPTH 8-13 FEET) VALIDATED LABORATORY DATA
• FEBRUARY 2004 - CH SERIES TEMPORARY WELLS (TOTAL DEPTH 6-12 FEET) UNVALIDATED LABORATORY DATA
9,200
2006 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
• NOVEMBER-DECEMBER 2006 - EXISTING WELLS AND NEW (MW10-400 SERIES) WELLS VALIDATED LABORATORY DATA
0.5U
2009 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
• NOVEMBER 2009 - NEW (MW20 SERIES) WELLS VALIDATED LABORATORY DATA
NOTES:
1. BASE MAP: ENSR DATABASE/GIS DISK: NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. MONITORING WELLS (MW-01, MW-02, AND MW-03) LOCATIONS IN VICINITY OF BUILDING 95 ARE ESTIMATED.
3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
4. PLAN NOT TO BE USED FOR DESIGN.
TETRA TECH
OVERBURDEN GROUNDWATER TETRACHLOROETHENE CONCENTRATIONS - 2003-2009
SOLVENT RELEASE AREA
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS
FILE
\..\SRA_OB_PCE_03-09.DWG
SCALE
PER-SCALE BAR
FIGURE NUMBER
1-4
REV
0
DATE
6/22/12
ACAD: I:\02073\FS.DF.SRA\SRA_OB_PCE_03-09.DWG 6/22/12 DWM

ACAD: I:\02073\FS.DF.SRA\SRA_BED_PCE_06-09.DWG 6/22/12 DWM



NOTES:

1. BASE MAP:
ENSR DATABASE/GIS DISK:
NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
3. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0' 120' 240'

LEGEND

CH108-MW02	OVERBURDEN GROUNDWATER MONITORING WELL
MW10-411D	BEDROCK GROUNDWATER MONITORING WELL
PZ5	STREAM PIEZOMETER
SW/SD-107	SURFACE WATER/SEDIMENT SAMPLING LOCATION
PDB-12	PASSIVE DIFFUSION BAG LOCATION
	TETRACHLOROETHENE CONCENTRATION CONTOUR TAKEN ON NOV. 2006/DEC. 2007/ NOV. 2009, DASHED WHERE INFERRED
120/18	TETRACHLOROETHENE CONCENTRATION (µg/L) IN NOV. 2006/DEC. 2007
3	TETRACHLOROETHENE CONCENTRATION (µg/L) IN NOVEMBER 2009

TETRA TECH

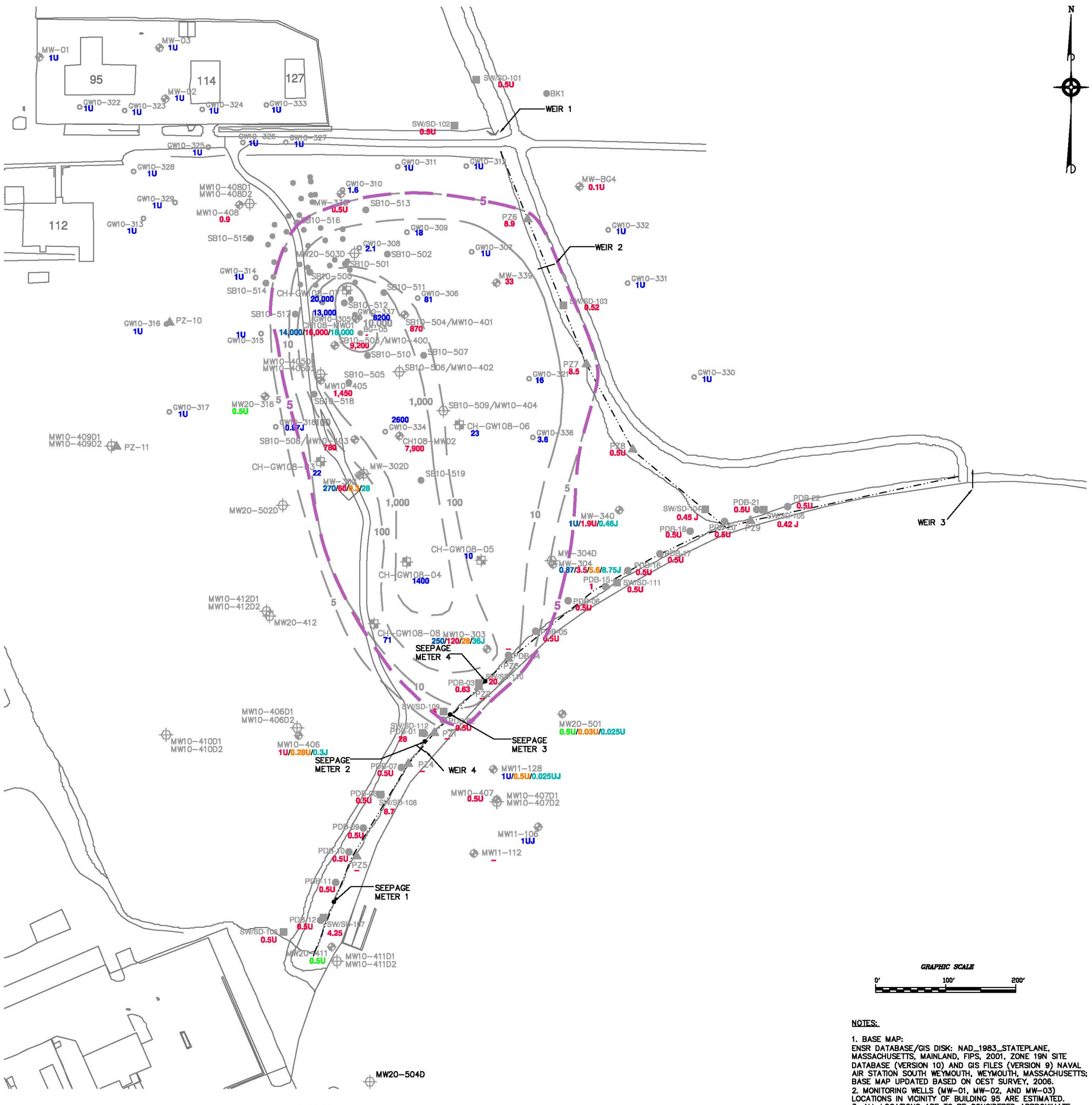
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

SHALLOW AND DEEP BEDROCK GROUNDWATER TETRACHLOROETHENE CONCENTRATIONS - 2006-2009

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_BED_PCE_06-09.DWG	PER-SCALE BAR

FIGURE NUMBER	REV	DATE
1-5	0	6/22/12



NOTES:

1. BASE MAP:
ENSR DATABASE/GIS DISK: NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. MONITORING WELLS (MW-01, MW-02, AND MW-03) LOCATIONS IN VICINITY OF BUILDING 95 ARE ESTIMATED.
3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
4. PLAN NOT TO BE USED FOR DESIGN.

LEGEND

- OVERBURDEN MONITORING WELL
- BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP
- STREAM PIEZOMETER
- CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)
- RI SURFACE WATER/SEDIMENT SAMPLING LOCATION
- RI PASSIVE DIFFUSION BAG LOCATION
- PRE-RI TEMPORARY WELL LOCATION (GW10 SERIES)
- PRE-RI SOIL BORING LOCATION (SB10-400 SERIES)
- RI SOIL BORING LOCATION (SB10-500 SERIES)
- FORMER TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- 22 — 2003-2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
  - SEPTEMBER-OCTOBER 2003 – GW-10 SERIES TEMPORARY WELLS (TOTAL DEPTH 8-13 FEET) VALIDATED LABORATORY DATA
  - FEBRUARY 2004 – CH SERIES TEMPORARY WELLS (TOTAL DEPTH 6-12 FEET) UNVALIDATED LABORATORY DATA
- 270 — 2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- 9,200 — 2006 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
  - NOVEMBER-DECEMBER 2006 – EXISTING WELLS AND NEW (MW10-400 SERIES) WELLS VALIDATED LABORATORY DATA
- 0.5U — 2009 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
  - NOVEMBER 2009 – NEW (MW20 SERIES) WELLS VALIDATED LABORATORY DATA
- 5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
  - APRIL 2011
- 5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
  - AUGUST 2011

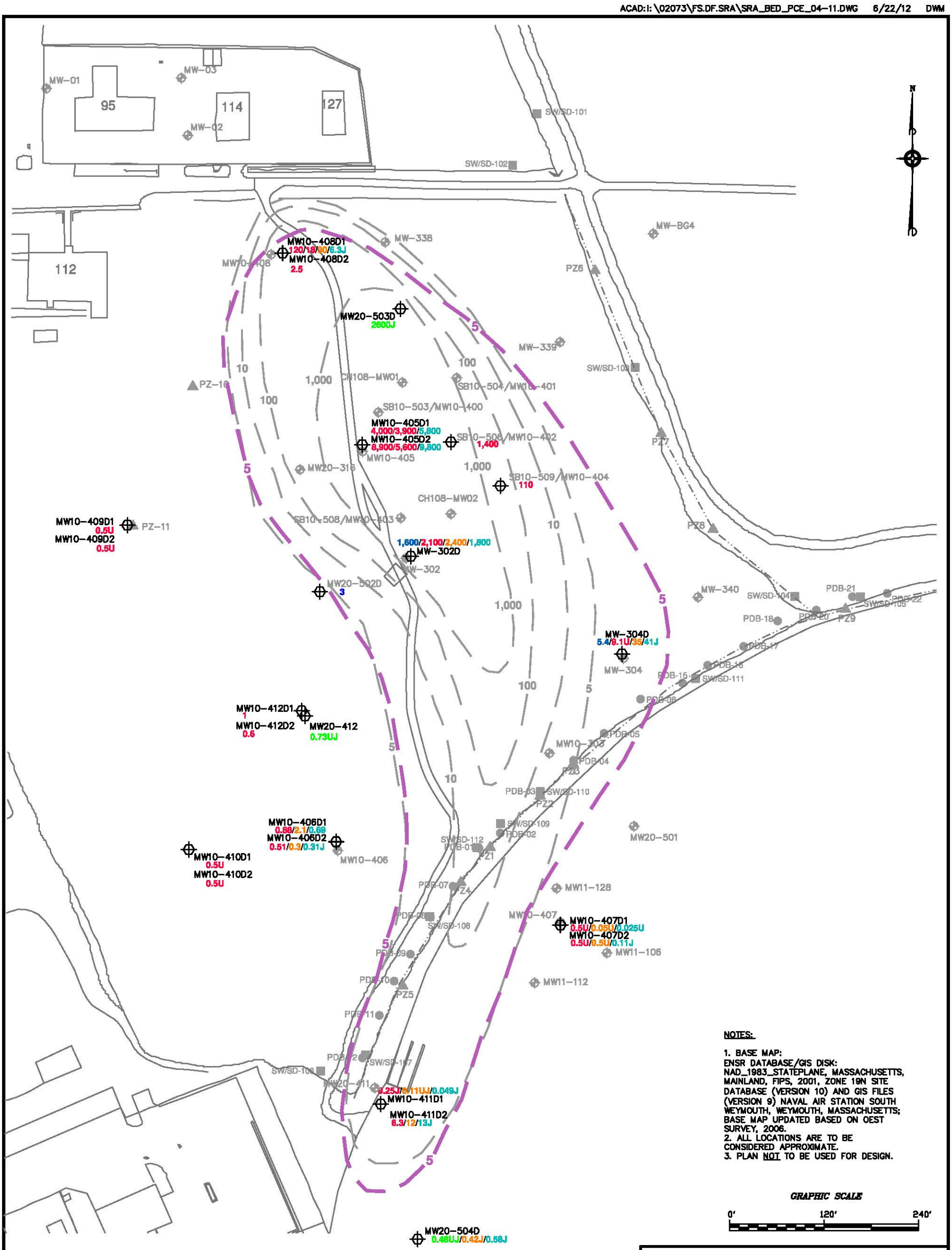
TETRA TECH

OVERBURDEN GROUNDWATER TETRACHLOROETHENE CONCENTRATIONS – 2003-2011
SOLVENT RELEASE AREA
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

FILE	SCALE
\..\SRA_OB_PCE_03-11.DWG	PER-SCALE BAR
FIGURE NUMBER 1-6	REV 0 / DATE 6/22/12

ACAD:I:\02073\FS.DF.SRA\SRA_OB_PCE_03-11.DWG 6/22/12 DWM

ACAD:I:\02073\FS.DF.SRA\SRA_BED_PCE_04-11.DWG 6/22/12 DWM



NOTES:

1. BASE MAP:
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NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
3. PLAN NOT TO BE USED FOR DESIGN.

GRAPHIC SCALE

0' 120' 240'

LEGEND

MW10-411D	BEDROCK GROUNDWATER MONITORING WELL
CH108-MW02	OVERBURDEN GROUNDWATER MONITORING WELL
PZ5	STREAM PIEZOMETER
SW/SD-107	SURFACE WATER/SEDIMENT SAMPLING LOCATION
PDB-12	PASSIVE DIFFUSION BAG LOCATION
	TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
	FORMER TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

270	TETRACHLOROETHENE CONCENTRATION (µg/L) 2004
120/18	TETRACHLOROETHENE CONCENTRATION (µg/L) IN NOV. 2006/DEC. 2007
3	TETRACHLOROETHENE CONCENTRATION (µg/L) IN NOVEMBER 2009
5.6	TETRACHLOROETHENE CONCENTRATIONS (µg/L) IN APRIL 2011
5.6	2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L) IN AUGUST 2011

TETRA TECH

FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

SHALLOW AND DEEP BEDROCK GROUNDWATER TETRACHLOROETHENE CONCENTRATIONS - 2004-2011

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_BED_PCE_04-11.DWG	PER-SCALE BAR

FIGURE NUMBER	REV	DATE
1-7	0	6/22/12

2.0 REMEDIAL ACTION OBJECTIVES AND GENERAL RESPONSE ACTIONS

This section develops RAOs and presents cleanup goals for contaminated groundwater and surface water in the EMD impacted by discharge of contaminated groundwater. The regulatory requirements and guidances (e.g., ARARs) that may potentially govern remedial activities are presented in this section. In addition, this section presents COCs identified in Section 1.0 and the conceptual pathways through which these chemicals may affect human health and the environment, and thus determines the environmental media of concern. The cleanup goals for contaminated media are developed in this section, and GRAs that may be suitable to achieve the cleanup goals are presented. Finally, this section presents estimates of the volumes of the contaminated media of concern.

As shown on Figure 2-1, the Site is located in a portion of the Base where MassGIS has not mapped any medium- or high-yield aquifers. MassDEP has assigned category GW-3 to groundwater at the Site. The Local Redevelopment Authority, SSTTDC, as well as the Master Developer, LNR South Shore LLC (LNR), have indicated that groundwater production, supply, and irrigation needs for the redevelopment can be provided by sources other than the groundwater associated with the SRA Site. Future uses of Site groundwater for production, supply, and irrigation are not reasonably foreseeable uses and, therefore, will be prohibited and are not exposure scenarios that will be evaluated in the FS.

The extent of groundwater contamination shown on Figure 2-1 is predominantly in an area zoned for Open Space (OS-W) and recreation uses (RecD). Based on the foregoing, the reasonably foreseeable future uses of the SRA Site include indoor and outdoor commercial recreation and health and fitness clubs and some institutional uses under a special permit only.

2.1 MEDIA OF CONCERN

Based on the results of the risk assessment for human and ecological receptors discussed in Section 1.3.6, the media of concern at the SRA was determined to be groundwater and vapor intrusion due to volatile compounds migrating from groundwater. In addition, although not identified as a medium of concern in the RI, the FS considers surface water a medium of concern and addresses potential future exposures to surface water in the EMD due to discharge of contaminated groundwater to the EMD. Using the USEPA cancer risk range, no unacceptable risks were identified in the Human Health Risk Assessment (HHRA) for sediment, soil, and surface water. There are no risks or contaminants with concentrations greater than leachability criteria in the soil. Therefore, there are no unsaturated soil COCs. Although exposures to surface water do not currently contribute significantly to total receptor hazards, the FS will address future recreational exposure to surface water in the EMD since surface water may be impacted by discharge of contaminated groundwater.

2.2 CHEMICALS OF CONCERN FOR REMEDIATION

2.2.1 Chemicals of Concern in Groundwater

Based on the non-cancer and cancer evaluations, the following contaminants with non-cancer hazard quotients greater than 1 or with cancer risks greater than $1x10^{-6}$ in a scenario with total cancer risks greater than $1x10^{-4}$ were identified as primary risk drivers: PCE, TCE, cis-1,2-DCE, VC, PCP, 3,3-dichlorobenzidine, arsenic, and barium in groundwater used as drinking water, with PCE in groundwater as the primary risk driver for unacceptable risk to future residents and future construction workers. While high concentrations of PCE were found in soils in the saturated zone, this contamination would be addressed as part of groundwater remediation. PCE was also the major risk driver for chemicals migrating from groundwater through vapor intrusion (industrial and residential scenarios). Therefore, the following chemicals were selected as COCs for SRA: PCE, TCE, cis-1-2,DCE, VC, PCP, 3,3'-dichlorobenzidine, arsenic, and barium in groundwater used as drinking water; and PCE in the vapor intrusion pathway.

However, as discussed in Section 1.3.4, PCP is present at a concentration greater than its MCL in only one well, which is a deep bedrock well. Similarly, 3,3'-dichlorobenzidine is present in only one well, which is in the shallow bedrock. Barium is present at a concentration greater than its MCL in only one well, which is in the deep bedrock. The occurrence and risk associated with these three COCs is low. Arsenic was detected in most wells, but all concentrations were less than its MCL. As discussed in the summary of the HHRA in Section 1.3.6.1, the risk associated with these compounds is via ingestion of groundwater. Since site groundwater will not be used for production, supply or irrigation purposes, the FS addresses the risk to a construction worker from exposure to COCs via incidental ingestion, dermal contact, and inhalation. The PCE risk via ingestion of groundwater is an order of magnitude greater than the risk associated with these four COCs. Active treatment of these COCs does not appear to be necessary and is not discussed in the FS.

2.2.2 Chemicals of Concern in Surface Water

Based on the non-cancer and cancer evaluations in the HHRA, there are no contaminants with non-cancer hazard quotients greater than 1 or with cancer risks greater than $1x10^{-6}$ in a scenario with total cancer risks greater than $1x10^{-4}$. However, based on the MassDEP risk level of 10^{-5}, Aroclor-1248 is a COC in surface water.

In addition, contaminated groundwater flows into the EMD. Currently, the concentrations of the COCs in the groundwater do not cause an unacceptable risk for exposure to the surface water, but there is a

potential for higher concentrations of groundwater COCs to reach the EMD. Therefore, PCE, TCE, cis-1,2-DCE, and VC are evaluated as COCs in surface water.

2.3 REMEDIAL ACTION OBJECTIVES

RAOs are medium-specific goals that define the objective of conducting remedial actions to protect human health and the environment. The RAOs specify the COCs, potential exposure routes and receptors, and acceptable concentrations (i.e., cleanup goals) for the site.

The development of cleanup goals takes into consideration chemical-specific ARARs and TBCs. Section 2.3.2 identifies the ARARs and TBCs for groundwater and surface water remediation. Note that the RAOs do not address exposure to groundwater via production, supply or irrigation wells since cleanup of groundwater to allow these uses is not warranted. Land use controls (LUCs) will be imposed to prevent these exposures.

2.3.1 Statement of Remedial Action Objectives

To protect the public from potential current and future health risks, as well as to protect the environment, the following RAOs have been developed for groundwater and surface water at SRA.

RAO No. 1: Prevent the migration of COCs to surface water at concentrations that pose an unacceptable risk to human health.

RAO No. 2: Prevent exposure of building occupants to VOCs resulting from vapor intrusion into future buildings at the Site at concentrations that pose unacceptable risk.

RAO No. 3: Prevent exposure of construction workers during excavation activities to VOCs and COCs in groundwater at concentrations that pose unacceptable risk.

RAO No. 4: Prevent migration of groundwater containing COCs at concentrations that pose unacceptable risk.

2.3.2 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

ARARs consist of the following:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-siting law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

Per 40 Code of Federal Regulations (CFR) 300.400(g)(3), TBCs are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing a remedial action or are necessary for determining what is protective to human health and/or the environment. Examples of TBCs include USEPA Vapor Intrusion Guidance, Reference Doses (RfDs) and Cancer Slope Factors (CSFs).

According to 40 CFR 300.430(f)(1)(i)(A), overall protection of human health and the environment and compliance with ARARs are threshold requirements that each remedial alternative must meet to be eligible for selection.

2.3.2.1 Definitions

The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) at 40 CFR 300.5 provides the following definitions for ARARs:

- Applicable Requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

- Relevant and Appropriate Requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law, although not "applicable" to a hazardous substance, pollutant, contaminant, or remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

Per 40 CFR 300.400(g)(3), other advisories, criteria, or guidance are to be considered for a particular release. The TBC category consists of advisories, criteria, or guidance developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies.

Under CERCLA Section 121(d)(4), USEPA may waive compliance with an ARAR if one of the following conditions can be demonstrated:

- The remedial action selected is only part of a total remedial action that will attain the ARAR level or standard of control upon completion.

- Compliance with the requirement will result in greater risk to human health and the environment than other alternatives.

- Compliance with the requirement is technically impracticable from an engineering perspective.

- The remedial action selected will attain a standard of performance that is equivalent to that required by the ARAR through the use of another method or approach.

- With respect to a state requirement, the state has not consistently applied the ARAR in similar circumstances at other remedial actions within the state.

- Compliance with the ARAR will not provide a balance between protecting public health, welfare, and the environment at the facility with the availability of Superfund money for response at other facilities (fund-balancing). This condition only applies to Superfund-financed actions.

USEPA in various guidance documents and the NCP has divided ARARs into three categories to facilitate identification. Chemical-specific and location-specific ARARs are identified early in the process, generally during the RI; action-specific ARARs are normally identified during the FS in the detailed analysis of alternatives. These three types of ARARs are defined as follows:

- Chemical-Specific: Health- or risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples include MCLs and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQCs).

- Location-Specific: Restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of these areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.

- Action-Specific: Technology- or activity-based requirements, limitations on actions, or conditions involving special substances. Examples of action-specific ARARs include Resource Conservation and Recovery Act (RCRA) regulations for generation, characterization, and management of hazardous wastes and CWA effluent limitations and pre-treatment standards for wastewater discharges.

The following section discusses chemical- and location-specific ARARs and TBCs. Action-specific ARARs and TBCs are presented in Section 2.5.2 along with the discussion of GRAs.

2.3.2.2 Chemical-Specific ARARs and TBCs

Federal and state chemical-specific ARARs and TBCs provide some medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants. Table 2-1 presents federal and Massachusetts chemical-specific ARARs and TBCs for this FS.

2.3.2.3 Location-Specific ARARs and TBCs

Federal and state location-specific ARARs place restrictions on concentrations of contaminants or the conduct of activities based on the site's particular characteristics or location. Table 2-2 presents federal and Massachusetts location-specific ARARs and TBCs for this FS.

2.4 PRELIMINARY REMEDIATION GOALS

PRGs were developed for the Site to establish target cleanup goals for remedial actions to reduce COC concentrations in Site media and mitigate the unacceptable risks to human health and the environment. Final cleanup goals for the selected Site remedial action will be documented in the Record of Decision.

PRGs can be developed based on chemical-specific ARARs, when available, or risk-based factors. In addition, the use of groundwater and the presence of COCs in background locations are also considered in developing the PRGs. The methods used to develop candidate PRGs are discussed below.

2.4.1 Groundwater Preliminary Remediation Goals

2.4.1.1 Human Health Risk-Based Preliminary Remediation Goals

Chemicals with unacceptable human health risks were identified as COCs for human receptors in Section 2.2. Human health risk-based PRGs were developed for those COCs.

Risk-based PRGs establish cleanup goals for remedial actions to reduce concentrations of COCs in site media and mitigate unacceptable risks to human health and the environment. PRGs were derived for the COCs identified in Site groundwater and surface water. The methodology used to derive PRGs for these media and the selected exposure pathways is described below.

Table 2-3 presents the PRGs for the following exposure scenarios, based on the RAOs:

- Recreational exposure to VOCs migrating from the shallow groundwater via vapor intrusion. This would be applied to two exposure scenarios: recreational uses allowed in the upland portions of the OS-W zone; and recreational uses allowed in the RecD zone.

- Construction worker exposure to VOCs in the shallow water table. This would apply to the RecD zone and the OS-W zone.

- Future receptors under the future land uses for the various areas of the site, i.e., recreation, institutional use and construction of buildings, roads and utilities in the RecD area; and, open space, recreation and roads in the OS-W zone.

- Recreation exposure to surface water.

For each scenario, risk-based PRGs were calculated representing the 1×10^{-5} cancer risk level and HI of 1 for each COC based on the exposure routes in each scenario (See Appendix B). These PRGs apply to the specific areas as noted. There are two PRGs for recreational exposure via vapor intrusion due to the different allowable uses in the OS-W and RecD zones. The SSTTDC application to the National Park Service for public benefit conveyance (PBC) of the OS-W area includes walking/bike trails but no structures. The SSTTDC Zoning and Land Use By-Laws do not allow residential, commercial, industrial, or indoor recreational uses in the OS-W area. The allowable uses in the RecD zone however allow for indoor recreational uses, health/fitness clubs, but no residential, other commercial or industrial uses. The lower of the values was selected as the human health risk-based PRG for each scenario. These selected human health risk-based PRGs represent values protective of both cancer and non-cancer risks. For a given COC, the lowest of the carcinogenic and non-carcinogenic risk values was carried forward for comparison with other potential PRGs.

2.4.1.2 ARARs and TBCs

As discussed in Section 2.0, MassDEP has assigned category GW-3 to site groundwater. SSTTDC and LNR have indicated that extraction of site groundwater for production, supply, and irrigation purposes is not a reasonably forseeable use and will be prohibited. As such, drinking water criteria, such as MCLs and Maximum Contaminant Level Goals (MCLGs) are not considered as potential PRGs.

MassDEP GW-3 standards were selected as TBCs and used as maximum values for PRGs. Where a risk-based PRG is greater than the GW-3 standard, the GW-3 standard will be used. These values are shown in Table 2-3.

2.4.1.3 Background Concentrations

Background concentrations may be used as PRGs, since background values represent contaminant concentrations in the absence of site activities when no excess risk is anticipated. Background concentrations are used in selection of PRGs because it is not reasonable and may not be possible to remediate site media to concentrations that are lower than background conditions. Further, it is Navy policy to only address those risks associated with chemical concentrations that are elevated as a result of a site-related release.

Although background groundwater concentrations were developed for NAS South Weymouth, because of the exposure routes and types of COCs (e.g., VOCs), background concentrations were only considered for two COCs. The occurrence of the inorganic COCs (arsenic and barium) is limited to a few wells, and the background concentration developed for barium is less than any of the risk-based PRGs. No background concentration was developed for arsenic. Thus, no background concentrations were selected as PRGs. The background concentrations are included on Table 2-3.

2.4.1.4 Selection of Proposed Groundwater PRGs

The human health risk-based PRGs were typically selected except where they were greater than the MassDEP GW-3 standards. In those cases, the MassDEP GW-3 standard was used. The selected PRGs are the COC concentrations that would provide the highest level of protection of human health and the environment, while still being reasonably achievable by current remediation techniques. Table 2-3 presents the potential and selected PRGs for each compound for groundwater for each exposure scenario (e.g., vapor intrusion, construction worker)**,** the basis for selection, and the risk associated with the selected PRG. Table 2-4 presents the groundwater PRGs selected for the open space and recreation zoning districts for each groundwater COC along with the basis for selection. Because the groundwater and surface water are directly related, the surface water PRGs are included in Table 2-3 along with the groundwater PRGs.

2.4.2 <u>Surface Water Preliminary Remediation Goals</u>

No COCs were identified in surface water by the HHRA. Aroclor-1248 was the only compound identified with a risk (1.4×10^{-5}) greater than 1×10^{-5}, the MassDEP risk level. Therefore, a risk-based PRG for Aroclor-1248 was developed. Because contaminated groundwater flows into the EMD, PRGs for surface water for the VOCs that are present in the groundwater were also developed, as shown in Table 2-3.

2.4.2.1 Human Health Risk-Based Preliminary Remediation Goals

Chemicals with unacceptable human health risks were identified as COCs for human receptors in Section 2.2. Human health risk-based PRGs were developed for those COCs.

Risk-based PRGs are proposed cleanup levels that are based on human health risks, and are intended to be protective of human health. PRGs were derived for the COCs identified in Site surface water and groundwater. The methodology used to derive PRGs for surface at the Site is described below.

Table 2-3 presents the PRGs developed for exposure to surface water. Three receptors were considered: lifelong recreational user, child recreational user, and adolescent trespasser. The exposure routes include dermal contact and incidental ingestion. Of these three exposure scenarios, the estimated PRGs for the lifelong recreational user are the most restrictive and are shown on Table 2-3. The calculations of the PRGs are included in Appendix B.

For each scenario, risk-based PRGs were calculated representing the 1×10^{-5} cancer risk level and HI of 1 for each COC based on the exposure routes in each scenario. The lower of the values was selected as the human health risk-based PRG for each scenario. These selected human health risk-based PRGs represent values protective of both cancer and non-cancer risks. For a given COC, the lowest of the carcinogenic and non-carcinogenic risk values was carried forward for comparison with other potential PRGs.

2.4.2.2 ARARs and TBCs

Because the ditch would not be a suitable source of drinking water, MCLs, MCLGs, and other drinking water standards are not ARARs. Because of the low and variable flow rates of water in the EMD, and because the EMD is often dry, the ditch does not support a permanent aquatic habitat, so water quality criteria were not considered as potential ARARs or TBCs.

2.4.2.3 Background Concentrations

There are no site specific background concentrations for VOCs in surface water, so background concentrations were not considered as potential PRGs.

2.4.2.4 Selection of Proposed Surface Water PRGs

The human health risk-based PRGs were selected because there were no ARARs or TBCs and background values. The selected PRGs are the COC concentrations that would provide the highest level of protection of human health while still being reasonably achievable by current remediation techniques.

Table 2-3 presents the potential and selected PRGs for each compound, the basis for selection, and the risk associated with the selected PRG. As noted, because the groundwater and surface water are directly related, the surface water PRGs are included with the groundwater PRGs on Table 2-3.

2.5 GENERAL RESPONSE ACTIONS AND ACTION-SPECIFIC ARARS

GRAs are broadly defined remedial approaches that may be used (by themselves or in combination with one or more of the others) to attain the RAOs. Action-specific ARARs and TBCs are those regulations, criteria, and guidances that must be complied with or taken into consideration during remedial activities at a site.

2.5.1 General Response Actions

GRAs describe categories of actions that could be implemented to satisfy or address a component of the RAOs for the site. Remedial action alternatives are formed using GRAs singly or in combination to meet the RAOs.

The following GRAs will be considered for groundwater and surface water at SRA:

- No Action
- Limited Action Removal
- In-Situ Treatment

2.5.2 Action-Specific ARARs

Action-specific ARARs and TBCs are technology- or activity-based regulatory requirements or guidance that would control or restrict remedial action. Action-specific ARARs and TBCs for each alternative are developed and presented in Section 4.

2.6 ESTIMATED VOLUMES OF CONTAMINATED GROUNDWATER

2.6.1 Volume of Contaminated Groundwater

The northernmost extent of the PCE plume in the overburden is at MW10-408, with a concentration of 0.91 µg/L. The highest concentration of PCE in overburden (16,000 µg/L) is located in the center of the Site, at CH108-MW01. The plume extends to the south, consistent with the overburden groundwater flow direction, with concentrations of 9,200 µg/L at MW10-400; 7,900 µg/L at CH108-MW02, and 120 µg/L at MW-303 (south of the former Pistol Range). The PCE plume extends to but not beyond (i.e., south of) the East Mat Ditch in the overburden. The plume is somewhat limited in extent to the east and west,

extending about 100 feet to the west from the access road and to the Eastern Drainage Ditch. The outline of the plume at various depths is depicted on Figures 1-4 through 1-7.

The PCE plume in shallow bedrock extends as far to the north as in the overburden plume (MW10-408D1). The highest concentration of PCE in shallow bedrock is in MW10-405D1 (3,900 µg/L). High concentrations are also found in the MW10-402 and MW-302D area, where PCE was detected at concentrations greater than 1,000 µg/L. Downgradient (closer to the former Pistol Range) the concentrations are less than 10 µg/L. PCE was detected further south at MW10-411D1, on the East Mat, at very low concentrations (0.25 µg/L) in the shallow bedrock.

The PCE plume in deep bedrock groundwater has the same general orientation as in the shallow bedrock, but the deep bedrock plume is not as wide in the east-west direction. The maximum PCE concentration in deep bedrock groundwater, 5,600 µg/L (8,900 µg/L in November 2006), is located at MW10-405D2, the same horizontal location where the maximum concentration was detected in shallow bedrock. In addition the PCE concentration at deep bedrock monitoring well location MW20-503D (north of the source area) was 2,600 µg/L. PCE was detected further south at MW10-411D2, on the East Mat, at a concentration of 6.3 µg/L in the deep bedrock.

The volume of groundwater in the overburden plume, based on the 5 µg/L (the MCL) PCE isoconcentration line, is approximately 5,919,000 gallons. Within the plume is an area where PCE concentrations are greater than 10,000 µg/L, and the volume of contaminated groundwater within the 10,000 µg/L PCE isoconcentration lines is approximately 139,000 gallons. Porosity values, based on the RI data, were 0.20 for the overburden zone.

The volume of groundwater in the shallow and deep bedrock plumes, based on the 5 µg/L (the MCL) PCE isoconcentration line, is approximately 1,550,000 gallons. Within the plume is an area where PCE concentrations are greater than 1,000 µg/L, and the volume of contaminated groundwater within the 1,000 µg/L PCE isoconcentration lines is approximately 325,000 gallons. Porosity values, based on the RI data, were 0.02 for the shallow and deep bedrock zone.

2.6.2 Mass of Contaminants - Dissolved and Adsorbed Phases

The masses of contaminants in groundwater and adsorbed to saturated soil were estimated using RI data. Partition coefficients were obtained from literature, and the value for organic carbon in the soil was estimated using data collected during the RI. The mass of contaminants in the PCE plume is summarized in Table 2-5. The calculations are included in Appendix C.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. Alternatives must meet the risk-based cleanup goals developed through the use of this guidance.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. Alternatives must meet the risk-based cleanup goals developed through the use of this guidance.
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. Alternatives must meet the risk-based cleanup goals developed through the use of this guidance.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. Alternatives must meet the risk-based cleanup goals developed through the use of this guidance.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	Used to evaluate the non-carcinogenic risk resulting from exposure to manganese.
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 2-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	The standards are protective of public health, public welfare, and the environment (i.e., represent a condition of "no significant risk"), given the exposures assumed, and are measurable. The GW-3 standard applies to groundwater at the Site.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 2-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities that involve fill material discharge to wetlands must comply with these requirements. If there is no practicable alternative to the discharge, any adverse impacts will be mitigated.

TABLE 2-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (Continued)				
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plans prior to implementation.
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) Ch.,131A 321; Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.

TABLE 2-2

FEDERAL AND STATE LOCATION-SPECIFIC ARARs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (Continued)				
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during remedial activities will be restored.

TABLE 2-3

COMPILATION OF GROUNDWATER AND SURFACE WATER PRGs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Where used	Full site	Full site	OS-W (Groundwater near water table surface)					RecD (Groundwater near water table surface)					RecD and OS-W (Groundwater near water table surface)					Surface Water in EMD				
Scenario	All	All	Vapor Intrusion (Recreational)					Vapor Intrusion (Commercial)					Construction Worker					Life-long Recreational (Incidental ingestion and dermal contact)				
Chemical of Concern	MassDEP GW-3 *	Site-specific Background[1]	ILCR of 10^{-5}	HI = 1	Selection	Selection Rationale	Risk	ILCR of 10^{-5}	HI = 1	Selection	Selection Rationale	Risk	ILCR of 10^{-5}	HI = 1	Selection	Selection Rationale	Risk	ILCR of 10^{-5}	HI = 1	Selection	Selection Rationale	Risk
PCE	30,000	NA	5,100	2,300	2,300	HI	HI = 1	3,890	1,440	1,440	HI	HI = 1	24,000	370	370	HI	HI = 1	6,600	860	860	HI	HI = 1
TCE	5,000	NA	350	170	170	HI	HI = 1	370	109	109	HI	HI = 1	1,500	18	18	HI	HI = 1	520	220	220	HI	HI = 1
cis-1,2-DCE	50,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4,400	4,400	HI	HI = 1	NA	1,000	1,000	HI	HI = 1
Vinyl Chloride	50,000	NA	52	1,900	52	ILCR	ILCR of 10^{-5}	39	1240	39	ILCR	ILCR of 10^{-5}	820	610	610	HI	HI = 1	130	2,700	130	ILCR	ILCR of 10^{-5}
PCP	200	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	69,000	200,000	200*	GW-3	NA	NA	NA	NA	NA	NA
3,3'-DCB	2,000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,200	NA	1,200	ILCR	ILCR of 10^{-5}	NA	NA	NA	NA	NA
Arsenic	900	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	8,500	5,500	900*	GW-3	NA	NA	NA	NA	NA	NA
Barium	50,000	181.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	450,000	50,000*	GW-3	NA	NA	NA	NA	NA	NA
Aroclor-1248	SW only	NA	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	SW only	140	NA	140	ILCR	ILCR of 10^{-5}

Notes:
All concentrations are ug/L.
MCLs were not evaluated since the use of groundwater for production, supply or irrigation purposes will be prohibited through permanent LUCs.
1 - 95% Upper Prediction Limit (UPL) Background Concentrations - Basewide background concentrations calculated in the Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, February 2000) and the Supplement to the Final Summary Report of Background Data Summary Statistics for NAS South Weymouth (Stone & Webster, November 2002).
* - GW-3 value is used where risk-based value is greater than the GW-3 standard (310 CMR 40.0974(2)).
DCB - Dichlorobenzidine.
DCE - Dichloroethene.
EMD - East Mat Ditch.
HI - Hazard Index.
ILCR - Incremental Lifetime Cancer Risk.
NA - Not applicable.
OS-W - Open Space-Weymouth District
PCE - Tetrachloroethene.
PCP - Pentachlorophenol.
RecD - Recreation District
SW - Surface water.
TCE - Trichloroethene.

TABLE 2-4

SELECTION OF GROUNDWATER PRGs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Chemical of Concern	OS-W Zoning District				RecD Zoning District			
	Recreational VI PRG [1]	Construction Worker PRG [1]	Selected PRG [2]	Selection Basis	Commercial VI PRG [1]	Construction Worker PRG [1]	Selected PRG [2]	Selection Basis
PCE	2,300	370	370	Construction Worker	1,440	370	370	Construction Worker
TCE	170	18	18	Construction Worker	109	18	18	Construction Worker
cis-1,2-DCE	NA	4,400	4,400	Construction Worker	NA	4,400	4,400	Construction Worker
Vinyl Chloride	52	610	52	Recreational VI	39	610	39	Commercial VI
PCP	NA	200	200	Construction Worker	NA	200	200	Construction Worker
3,3'-DCB	NA	1,200	1,200	Construction Worker	NA	1,200	1,200	Construction Worker
Arsenic	NA	900	900	Construction Worker	NA	900	900	Construction Worker
Barium	NA	50,000	50,000	Construction Worker	NA	50,000	50,000	Construction Worker

Notes:
[1] Vapor intrusion and construction worker PRG values are from Table 2-3.
[2] Selected PRG is the lowest of the vapor intrusion and construction worker PRGs.

All concentrations are ug/L.
DCB - Dichlorobenzidine.
DCE - Dichloroethene.
OS-W - Open Space-Weymouth District
PCE - Tetrachloroethene.
PCP - Pentachlorophenol.
RecD - Recreation District
SW - Surface water.
TCE - Trichloroethene.
VI - Vapor Intrusion.

TABLE 2-5

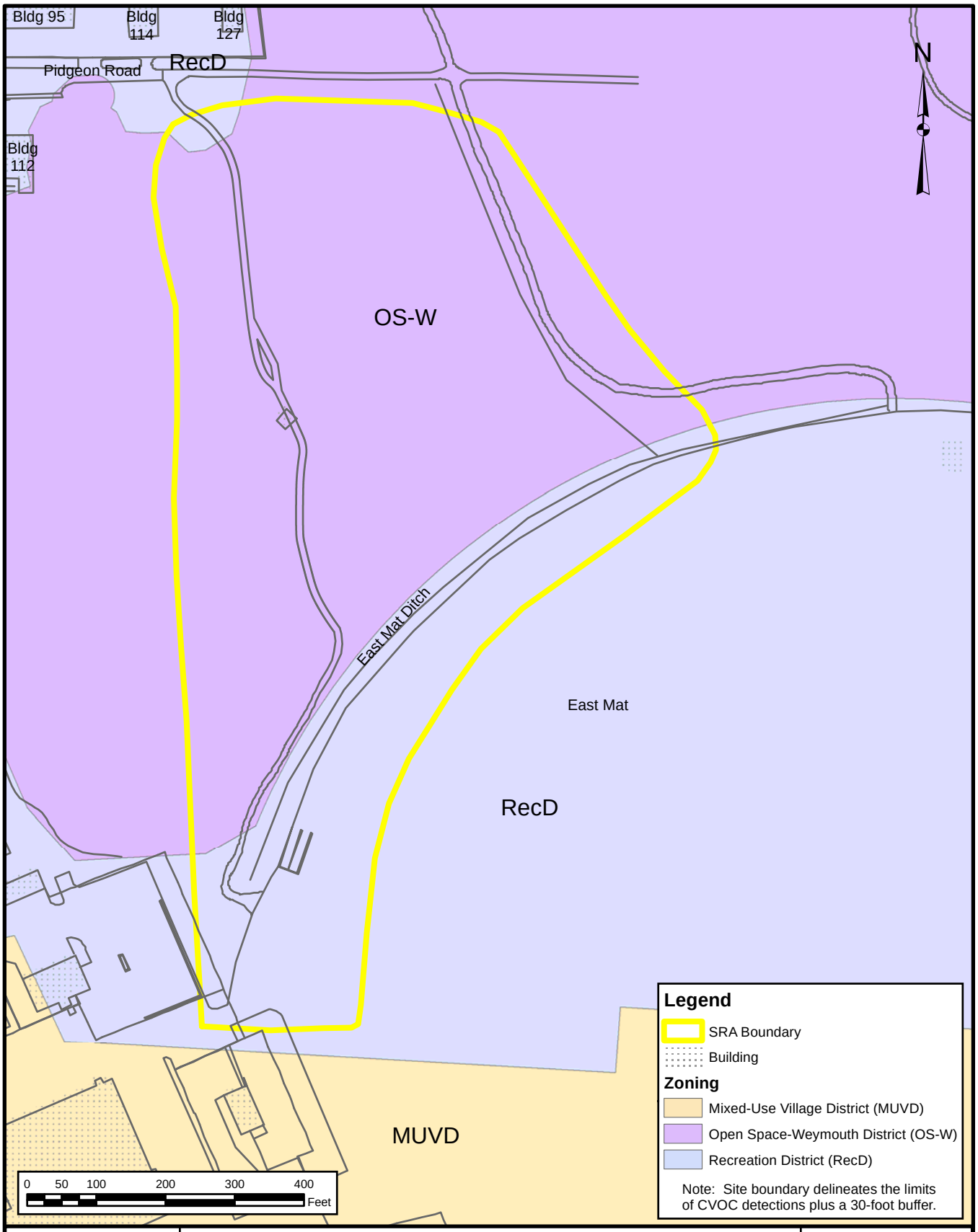
ESTIMATED MASS OF COCs IN GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

COC	Dissolved Phase (pounds)	Sorbed Phase (pounds)	Total (pounds)
Within 10,000 µg/L PCE isoconcentration lines (Overburden)			
PCE	19	218	237
TCE	0.15	0.43	0.58
cis-1,2-DCE	0.9	0.6	1.5
VC	0.00099	0.00014	0.0011
Between 1,000 µg/L and 10,000 µg/L PCE isoconcentration lines (Overburden)			
PCE	62	730	792
TCE	1.01	0.81	1.82
cis-1,2-DCE	0.6	0.4	1.0
VC	-	-	-
Within 1,000 µg/L PCE isoconcentration lines (Bedrock)			
PCE	13	702	715
TCE	0.06	3.39	3.45
cis-1,2-DCE	0.1	0.2	0.3
VC	-	-	-
Between 5 µg/L and 1,000 µg/L PCE isoconcentration lines (Overburden and Bedrock)			
PCE	11	146	157
TCE	0.77	2.16	2.93
cis-1,2-DCE	0.9	0.5	1.4
VC	-	-	-
Total			
PCE	105	1,796	1,901
TCE	1.99	6.79	8.78
cis-1,2-DCE	2.5	1.7	4.2
VC	0.00099	0.00014	0.0011

COC - Chemical of concern.
DCE - Dichloroethene.
PCE – Tetrachloroethene.
TCE - Trichloroethene.
VC - Vinyl chloride.

Note: The estimated mass is based on data collected as of 2011.

I:\02073\FS.DF.SRA\SRA_AQUIFERS&ZONING.MXD 06/22/12 DWM



TETRA TECH

FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

IR SITES, ZONING AND MASS GIS AQUIFER CLASSIFICATIONS

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

SCALE	
PER-SCALE BAR	
FILE	
\..\SRA_AQUIFERS&ZONING.MXD	
REV	DATE
0	06/22/12
FIGURE NUMBER	
2-1	

3.0 SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

This section identifies, screens, and evaluates the potential technologies and process options that may be applicable to the remedial alternatives for SRA. The primary objective of this phase of the FS is to develop an appropriate range of remedial technologies and process options to be used for developing the remedial alternatives.

The basis for technology identification and screening began in Section 2.0 with a series of discussions that included the following:

- Identification of ARARs
- Development of RAOs and PRGs
- Identification of GRAs
- Development of estimated areas and volumes of contaminated groundwater

Technology screening evaluation is performed in this section with the completion of the following analytical steps:

- Identification and screening of remedial technologies and process options
- Evaluation and selection of representative process options

A variety of technologies and process options are identified under each GRA (see Section 2.5.1) and screened. The selection of technologies and process options for initial screening is based on the Guidance for Conducting RI/FS's under CERCLA (USEPA, 1988). The screening is first conducted at a preliminary level to focus on relevant technologies and process options. Then the screening is conducted at a more detailed level based on certain evaluation criteria. Finally, process options are selected to represent the technologies that have passed the detailed evaluation and screening.

The evaluation criteria for detailed screening of the technologies and process options retained after the preliminary screening are effectiveness, implementability, and cost. The following are descriptions of these evaluation criteria:

<u>Effectiveness</u>

The effectiveness evaluation is focused on the following elements:

- Potential effectiveness of process options in handling the estimated areas or volumes of media of concern and in meeting the RAOs

- Potential impacts to human health and the environment during the construction and implementation phases

- Reliability and proven effectiveness of the process with respect to the COCs and the site-specific conditions.

Implementability

The implementability evaluation includes both the technical and institutional (administrative) feasibility of implementing each technology or process option. This initial technology screening eliminates technology types or process options that are clearly ineffective or unworkable at the site. The institutional aspects considered include the following:

- Potential for obtaining regulatory approval
- Availability of necessary equipment and skilled workers to implement the technology
- Availability of treatment, storage, and disposal services
- Time required for implementation
- Ability to achieve the applicable remediation standards within a reasonable timeframe.

Cost

For this screening evaluation, a qualitative cost analysis is presented to indicate whether costs are prohibitive or if other process options within the same technology type were comparably effective and implementable but less costly. Preliminary cost estimates for the remedial technologies retained in the screening step are presented in Section 4 as part of each of the remedial alternatives developed from the technologies retained in this section.

3.1 PRELIMINARY SCREENING OF GROUNDWATER TECHNOLOGIES AND PROCESS OPTIONS

This section identifies and screens remediation technologies and process options for groundwater based on implementation with respect to site-specific conditions and COCs. Table 3-1 summarizes the results of this preliminary screening process. It presents the GRAs, identifies the technologies and process options, and provides a brief description of each process option followed by comments about the results of the screening process.

As indicated in Table 3-1, containment, groundwater extraction/interception, ex-situ treatment, and discharge/disposal GRAs are eliminated as a result of the screening process. The following are the groundwater technologies and process options remaining for detailed screening.

General Response Action	Technology	Process Options
No Action	None	Not applicable
Limited Action	LUCs	Physical controls
		Institutional controls
	Monitoring	Sampling and analysis
	Natural Attenuation	Naturally occurring biodegradation and physical processes
	Phytoremediation	Use of plants to reduce hazardous organic and inorganic compounds to nontoxic or less toxic concentration levels
In-Situ Treatment	Biological	Enhancement of biodegradation of organics by addition of nutrients and oxidizers
	Chemical	Permeable reactive barriers
		Chemical oxidation
	Thermal	Electrical resistance heating (ERH)

3.2 DETAILED SCREENING OF GROUNDWATER TECHNOLOGIES AND PROCESS OPTIONS

3.2.1 No Action

No Action consists of maintaining the status quo at the site. As required under CERCLA regulations, the No Action alternative is carried through the FS to provide a baseline for comparison with other alternatives and their effectiveness in mitigating risks posed by site contaminants.

Effectiveness

No Action would not be effective in meeting the RAOs. No Action would not be effective in evaluating either potential contaminant reduction through natural attenuation or potential contaminant migration off site because no monitoring would be performed.

Implementability

There would be no implementability concerns because no action would be implemented.

Cost

Because hazardous substances, pollutants, or contaminants would be present on site in excess of levels that allow for unlimited use and unrestricted exposure, statutory five-year reviews would be conducted. Costs would be low.

Conclusion

No Action is retained because of NCP requirements, although it would not be effective.

3.2.2 Limited Action

3.2.2.1 Land Use Controls

LUCs would be designed to protect public health and the environment from residual contamination at environmental sites. LUCs would consist of administrative or legal mechanisms (e.g., deed or zoning restrictions, permits, etc.) designated as institutional controls and/or physical controls (e.g., fencing, security guards, etc.) designated as engineering controls. Site-specific LUCs would typically be formulated through a LUC RD that is prepared in accordance with the Navy's LUCs Principles (Department of Defense [DoD], 2003) following approval of the ROD. LUCs would typically also include the performance of regular site inspections to verify continued implementation. Depending upon the site-specific conditions, LUCs can be used alone or in conjunction with other remedial actions.

Effectiveness

Site use restrictions would be effective for minimizing human exposure to site COCs through the use of access controls and/or implementation of deed restrictions. Permanent or interim deed or zoning restrictions could be effectively used to control site use permanently if no other remedial measures were undertaken or temporarily while remediation is ongoing. The effectiveness of these measures would be dependent on adequate enforcement of administrative controls. Signage would be used to indicate that LUCs may be implemented on the site. Physical restrictions such as fencing, physical barriers, and site security would be applicable during implementation and construction activities. Short-term LUCs could be effectively implemented during performance of the remedial action until cleanup goals are reached.

Implementability

Current site use is controlled by the Navy. There are no unacceptable risks to current site use scenarios, however, since the Site may be redeveloped in the future, limitations on use (e.g., well installation, building construction methods) of the Site would be readily implementable as part of the property transfer

process and documentation. Short-term LUCs would be easily implemented until the remedial action is complete.

Cost

Site use restrictions are generally inexpensive, although long-term administration, enforcement, and maintenance are required if applied long-term.

Conclusion

LUCs are retained only for use in combination with other process options for the development of groundwater remedial alternatives.

3.2.2.2 Monitoring

Sampling and analysis of groundwater, surface water and sediment would be used to evaluate migration of COCs. Monitoring would also be used to evaluate the progress of active groundwater remediation.

Effectiveness

Monitoring would not of itself reduce the toxicity, mobility, or volume of COCs in groundwater, but it would allow the evaluation of potential migration of these COCs and the expected reductions in their concentrations through active remediation.

Implementability

A groundwater, surface water and sediment monitoring program could be readily implemented and is routinely performed at other sites. Monitoring well installation would need to comply with state and local regulations.

Cost

In general, monitoring costs are low; however, such costs can become high if an extensive monitoring program is implemented over a long period of time.

Conclusion

Monitoring is retained only for use in combination with other process options for the development of groundwater remedial alternatives.

3.2.2.3 Natural Attenuation

Natural attenuation (NA) would consist of allowing naturally occurring processes such as biodegradation, dispersion, dilution, and adsorption to reduce concentrations of groundwater COCs over time. To evaluate natural attenuation, groundwater samples would be regularly collected and analyzed to establish trends in COC concentrations. Installation of new monitoring wells may be required. Samples from new and existing wells would be regularly collected and analyzed for natural attenuation parameters such as oxidation-reduction potential (ORP), dissolved oxygen (DO), pH, alkalinity, temperature, conductivity, total organic carbon (TOC), ferrous and total iron, sulfur compounds (sulfide and sulfate), nitrogen compounds (nitrite and nitrate), orthophosphate, chloride, and metabolic gases (methane, ethane, ethene, and carbon dioxide).

Effectiveness

Naturally occurring processes could reduce concentrations of PCE and other contaminants in groundwater over the long term. Based on the results of samples collected during the RI (Tetra Tech, 2010), natural reductive dechlorination is occurring at the Site but only to a very limited degree. Groundwater samples from the Site typically have high DO concentrations and high ORP values which are not favorable to reductive dechlorination.

Groundwater monitoring would provide an effective means of evaluating the concentrations of COCs in groundwater and of assessing the rate of decrease of these concentrations. Monitoring of indicator parameters would help to evaluate the potential effectiveness of the reductive dechlorination process.

Implementability

Natural attenuation would be very easy to implement because it requires monitoring as the only action. As noted earlier, the resources and materials required for monitoring are readily available.

Cost

In general, monitoring costs are low; however, such costs can become high if an extensive natural attenuation monitoring program is implemented over a long period of time.

Conclusion

Natural attenuation is not retained for the development of groundwater remedial alternatives because it is unlikely to be effective in reducing concentration of COCs before they reach the EMD.

3.2.2.4 Phytoremediation

Phytoremediation involves the use of plants to reduce hazardous organic and inorganic compounds to nontoxic or less toxic concentration levels. Phytoremediation is most applicable in large areas with low to moderate contaminant levels. The remedial technology may be utilized to process COCs in groundwater through several of the mechanisms discussed below:

Phytoextraction – root uptake or translocation of contaminants within plants. Plant harvesting is generally required for contaminant removal. Demonstrated mechanism for cadmium, cobalt, chromium, mercury, manganese, arsenic, and zinc COCs.

Phytostabilization – immobilization of a contaminant via root absorption, adsorption, accumulation, or precipitation or the utilization of plants to prevent contaminant migration. Demonstrated mechanism for arsenic, cadmium, chromium, arsenic, and zinc COCs.

Rhizodegradation – microbial breakdown of contaminants in groundwater within the root zone of plants. Demonstrated mechanism for PAHs, pesticides, chlorinated solvents, and PCBs COCs.

Phytodegradation – metabolic breakdown of contaminants by plants or the external breakdown of contaminants from compounds produced by plants. Demonstrated mechanism for organic compounds, chlorinated solvents, phenols, and herbicides COCs.

Phytovolatilization – contaminant uptake and transpiration by a plant to the atmosphere. Demonstrated mechanism for chlorinated solvents and several inorganic compounds (e.g., selenium, mercury, and arsenic) COCs.

Phytoremediation may utilize various species of plants depending on the required mechanism and COCs. A treatability study would be required in order to verify species selection and quantify removal efficiency for specific COCs. If found applicable, native or introduced species may be planted into the areas of groundwater contamination. If non-native plants are utilized, appropriate control techniques should be used to verify that genetic contamination or invasive spread does not occur. If native species are selected, the remediation potential of existing plants should be carefully assessed.

An array of the above mechanisms may be implemented for COC removal and containment. Groundwater samples would be regularly collected and analyzed to evaluate the progress of remediation.

Based on the observation of low concentrations in the shallow groundwater compared to higher concentrations with depth, the existing trees and vegetation may be reducing contaminant levels near the water table.

Effectiveness

The effectiveness of phytoremediation is documented in many cases for the in-situ removal or containment of inorganic and organic compounds such as the COCs on-site. A combination of several mechanisms may be utilized to incorporate the variety of COCs requiring remedial action. Treatability testing would be required to evaluate the site-specific applicability of phytoremediation. Successful application of phytoremediation could achieve RAOs and limit human and ecological risks. However, plant toxicology and organisms within the herbivorous food chain should be heavily studied prior to application to ensure implementation does not create adverse effects. In addition, phytoremediation may have limited effectiveness at the Site since COC concentrations increase with depth.

Implementability

Phytoremediation would be difficult to implement at the SRA since the majority of the site is forested wetland. The replacement of the existing native wetland plants and trees with species more effective for phytoremediation would eliminate the forested wetlands within the treatment area.

Cost

The capital and O&M costs for phytoremediation would be low.

Conclusion

Phytoremediation is eliminated as a technology because of its limited effectiveness on the treatment of deep groundwater and because implementation would result in a loss of the existing forested wetland.

3.2.3 In-Situ Treatment

The technologies considered under this GRA are enhanced bioremediation, chemical oxidation, permeable reactive barriers (PRBs), and thermal treatment.

3.2.3.1 Enhanced Bioremediation

Enhanced bioremediation involves the use of microorganisms, primarily bacteria and fungi, to break down contaminants into nontoxic or less toxic forms. In-situ enhanced bioremediation incorporates

biostimulation and/or bioaugmentation. Aerobic and anaerobic bioremediation processes are evaluated below.

Biostimulation is the most common type of in-situ enhanced bioremediation and can be used to stimulate the growth of either anoxic/anaerobic or aerobic indigenous microorganisms depending on the type of contaminant to be biodegraded. Anoxic/anaerobic biostimulation uses an electron donor compound such as lactic acid or emulsified oil substrate (EOS), and aerobic biostimulation uses either oxygen or an oxygen-release compound (ORC) such as magnesium peroxide.

Bioaugmentation is less common and is typically used in addition to biostimulation. Bioaugmentation consists of using a bacterial culture to increase the naturally-occurring microorganism population and to provide organisms specifically targeted to the degradation of COCs.

The enhanced bioremediation reagent (electron donor compound, oxygen, ORC, and/or bacterial culture) can be injected into contaminated groundwater using multiple temporary direct-push technology (DPT) injection points and/or permanent injection wells. DPT injection would be simple to implement and could be applied selectively in small locations or across large surface areas. Enhanced bioremediation can also be used as a barrier technology by positioning one or more lines of injection points (biotreatment barriers) in the projected path of a contaminant plume. Alternatively, biotreatment barriers can be constructed from mulch and other organic material and installed as a permeable reactive barrier (see Section 3.2.4.4 below).

Effectiveness

Enhanced anaerobic bioremediation would be an effective process option primarily for PCE and other chlorinated solvents. ORC application would not be effective for the treatment of the chlorinated VOCs in groundwater. However, although increasingly documented, the effectiveness of these technologies, particularly in cases of very high contaminant concentrations, typically needs to be demonstrated through site-specific treatability testing.

Implementability

The shallow depth to groundwater (1 to 2 feet) limits the ability to inject electron donors into the overburden groundwater. Mounding and the limited interval to seal monitoring wells may cause reagent and/or contaminated groundwater to breakthrough to the surface during injection. Therefore, injection of an electron donor substrate into the overburden must be conducted at a low flow rate. Injection into the shallow bedrock may be more successful, but distribution of the electron donor is uncertain. Injection into overburden and bedrock via injection wells can be readily implemented and can provide accurate reagent

delivery into target areas. Field pilot testing would be required to test the effectiveness and feasibility of injection.

Cost

The capital and operation and maintenance (O&M) costs for enhanced in-situ bioremediation by injection into overburden and bedrock would be moderate.

Conclusion

Enhanced in-situ bioremediation via anaerobic bioremediation is retained in the development of groundwater remedial alternatives for treatment of the source areas. Injection of a substrate into overburden is likely to be effective, but there is more uncertainty for injection into the bedrock. Pilot testing will be required in order to demonstrate feasibility.

3.2.3.2 Chemical Oxidation

In-situ chemical oxidation involves the injection of chemical agents into the contaminant plume. These chemical agents promote the generation of highly reactive hydroxyl radicals that react with the COCs and result in the oxidative cleavage of the carbon-to-carbon bond, yielding water, carbon dioxide, oxygen, and dilute hydrochloric acid as by-products.

Traditionally, the chemical agents used for this purpose have included powerful oxidants such as iron-catalyzed hydrogen peroxide (known as Fenton's Reagent), sodium persulfate, potassium permanganate, or ozone. More recently, milder oxidants such as catalytically complexed sodium percarbonate (marketed as Regenesis RegenOx™) have also been successfully used.

Similar to in-situ biological treatment additives, in-situ chemical oxidation reagents are generally injected in contaminant plumes using either multiple DPT or permanent injection locations. However, as noted in Section 3.2.4.1, injection into the overburden must be conducted at a low flow rate. Oxidizers can also be applied to the overburden groundwater by soil mixing methods.

Effectiveness

In-situ chemical oxidation with strong oxidants such as Fenton's Reagent is a well-established technology that could be effective for the destruction of COCs. Pilot-scale treatability testing would be highly desirable to confirm effectiveness and to determine injection system design criteria.

The effectiveness of in-situ chemical oxidation can also be impacted by heterogeneous subsurface conditions that could result in uneven distribution of the injected chemical agents and incomplete contact of these agents with the groundwater COCs. Due to the stratigraphic variations associated with the site overburden, a pilot study would be required within the deep and shallow groundwater zones to evaluate oxidant distribution and injection conditions.

Implementability

The shallow depth to groundwater (1 to 2 feet) limits the ability to inject oxidizers into the overburden groundwater. Mounding and the limited interval to seal monitoring wells will cause reagent and/or contaminated groundwater to breakthrough to the surface during injection. Therefore, injection of an oxidizer into the overburden must be conducted at a low flow rate, and as noted, soil mixing technology could also be used. Although injection into the shallow bedrock is expected to be more successful, the uncertainty of the distribution of the oxidizer limits the effectiveness. Oxidizers are typically short-lived and are likely to react with other constituents in the groundwater and soil matrix before reacting with contaminants.

In-situ chemical oxidation with a strong oxidant using soil mixing is feasible, but may cause some negative impacts to the site such as significant disturbance to the wetlands. The number of qualified contractors specializing in the application of this technology is relatively limited.

The chemical reactions that result from the application of strong oxidizing agents may generate heat and high pressures that can alter subsurface characteristics and even result in hazardous conditions. Air quality monitoring of the remediation area would be required while strong oxidizing agents are utilized.

Cost

Capital and O&M costs for in-situ chemical oxidation with a strong oxidant using soil mixing methods would be high.

Conclusion

Chemical oxidation (both by soil mixing and injection) are not retained for development of alternatives. Soil mixing is not retained because of significant site impacts and high cost, while injection is not retained because injection flow rates are relatively difficult under the site conditions and application to the bedrock is uncertain.

3.2.3.3 Permeable Reactive Barriers

PRBs involve emplacement of reactive materials in the subsurface to intercept a contaminant plume, provide a flow path through the reactive media, and transform the contaminant(s) into environmentally acceptable forms to attain PRGs downgradient of the barrier.

PRBs have been used to treat a wide range of groundwater contaminants, including chlorinated and non-chlorinated VOCs. Iron metal [zero-valent iron (ZVI)] is the most common reactive media used in PRBs for the treatment of CVOCs such as PCE. Organic material, such as wood mulch can also be used to create a biological PRB. A ZVI PRB aids in the dechlorination of the CVOCs; a mulch PRB provides an organic source for microorganisms which stimulates anaerobic degradation of the CVOCs.

PRBs are generally built in two basic configurations: funnel-and-gate and continuous. The funnel-and-gate PRB uses impermeable walls (sheet pilings, slurry walls, etc.) as a ”funnel” to direct the contaminant plume into a “gate” containing the reactive media, whereas the continuous PRB completely intercepts the plume flow path with reactive media. Because PRBs are not designed to contain groundwater movement but to intercept groundwater contaminants, the permeability of the reactive media must be at least equal or greater than the permeability of the surrounding aquifer to avoid diversion of the groundwater flow path. This is particularly necessary with the funnel-and-gate design where the cross section of the permeable zones is restricted. Because the emplacement of reactive material generally requires excavation, both types of PRBs have typically been limited to relatively shallow depths of approximately 50 feet bgs. However, the use of alternate technologies, such as slurry injection and hydrofracturing, may help to overcome some of these emplacement limitations.

Placement of PRBs must consider both groundwater and contaminant velocity and lifespan of the reactive material in the PRB. For this site, PRBs located in the upland portion of the site and/or at the leading edge of the plume would be effective in treating the plume and preventing contaminants from further migration. Mulch barriers have shorter effective time spans and must be regenerated periodically by the addition of electron donor substrate.

<u>Effectiveness</u>

The use of ZVI and mulch PRBs would be effective for the in-situ treatment of PCE and other organic compounds at SRA. It is expected that the concentrations of PCE would be reduced to the vapor intrusion and surface water PRGs.

Implementability

PRBs would be easy to install to a depth of up to 30 feet bgs because this could be accomplished with single pass trench excavators. The number of competent contractors available to implement these specialized techniques would be relatively limited.

This method cannot readily be applied to bedrock. A PRB would treat contaminants in the surficial aquifer, but another method would be required to address contaminated groundwater in bedrock.

There are no structures, utilities, or routine operations at the SRA site that would interfere with the installation of a PRB.

Once installed, the O&M requirements of PRBs would be minimal and would be essentially limited to the monitoring of groundwater quality to verify performance and routine inspections to verify continued integrity of the structure. Due to the shorter lifespans of mulch barriers, replenishment by injection of an electron donor substrate will be needed periodically (e.g., every 5 years). However, for ZVI PRBs, the need for replacement of the ZVI material in 15 to 20 years is likely because of the potential for reactivity loss and mineral fouling.

Cost

Capital cost of installation of PRBs, as required at SRA, would be moderate to high. The cost for ZVI is significantly higher than the cost for mulch. O&M costs would be very low.

Conclusion

Mulch PRBs are retained in combination with other process options for the development of groundwater remedial alternatives. ZVI PRBs are not retained because of the need for replacement in 15 to 20 years and the related capital cost and site impacts during installation.

3.2.3.4 In-Situ Electrical Resistance Heating

In-situ ERH involves passing alternating current between electrodes in the ground, resulting in heating of the material through which the current passes. This technology can be employed using either three-phase or six-phase current. With the six-phase heating, six electrodes are placed in a circular array, with each connected to a single-phase transformer. With each electrode at a different voltage phase, each conducts electrical current to other electrodes in the array and provides more uniform heating than with three-phase heating. Typical electrodes consist of steel-cased vertical pipes with iron filings and graphite in the annular space. The heating boils the aquifer, resulting in a combination of volatilization and steam

stripping of contaminants that can then be removed using the electrodes as vapor extraction (VE) points. As required and similar to air sparging (AS)/VE systems, extracted vapors may be treated with GAC adsorption or other appropriate technologies prior to venting to the atmosphere. If GAC adsorption is selected for vapor treatment, these vapors would first need to be dehumidified to maintain the effectiveness of the GAC adsorption.

Effectiveness

In-situ ERH could be an effective technology to remove PCE from the chlorinated VOC plume in the overburden. Because thermal conductivity is not very sensitive to variations in soil characteristics, the effectiveness of ERH is typically less affected than other in-situ treatment technologies by the presence of heterogeneous subsurface conditions such as is the case at SRA. However, similar to in-situ oxidation with strong chemical oxidants, ERH has proven most effective for the treatment highly contaminated groundwater or soil. This means that the application of ERH should be limited to the PCE hot spots.

Although the successful use of both six- and three-phase current has been fairly well documented for the removal of PCE, treatability testing, preferably of the pilot-scale type, would still be highly desirable to confirm effectiveness and to determine ERH system design criteria.

Implementability

In-situ ERH could be implemented at SRA. The services of a limited number of qualified contractors specializing in the application of this technology would be available. Because of the depth of the chlorinated VOC plume, the installation of heating electrodes and vapor recovery wells would be fairly difficult and costly. In addition, a significant effort would be required to operate and maintain the ERH systems, and a large amount of electrical energy would have to be expended to bring the subsurface up to operating temperatures needed to volatilize the COCs. As previously noted, a pilot-scale treatability test would most likely have to be performed to confirm effectiveness and to establish the design criteria of the ERH system. High voltage is required for this technology, and the nearest tie-in for high voltage is approximately 0.5 mile away. Finally, this technology could not be applied to the deep bedrock contamination.

Cost

Capital and O&M costs for in-situ ERH would be high.

Conclusion

ERH is not retained for development of alternatives based on its implementability issues and high cost.

3.3 SELECTION OF REPRESENTATIVE TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER

The following technologies and process options, under the GRAs as noted, were retained for the development of groundwater remedial alternatives:

- No Action
- Limited Action: LUCs, and Monitoring
- In-Situ Treatment: Enhanced Bioremediation, and Mulch PRB

The next step was to select representative process options from each technology to assemble an adequate variety of alternatives and evaluate the alternatives in sufficient detail to aid in the final selection process. The alternatives are presented in Section 4.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
No Action	None	Not Applicable	No activities conducted at site to remedy or monitor contamination.	Retain. No action is retained as a baseline for comparison with other technologies.
Limited Action	Monitoring	Sampling and Analysis	Periodic sampling and analysis of groundwater to track changes in the extent of contamination.	Retain. This technology could assess natural attenuation and/or migration of contaminants and evaluate progress of active remediation.
	Land Use Controls (LUCs)	Active Controls: Physical Barriers/ Security Guards	Fencing, markers, and warning signs to restrict site access.	Retain in part. Restricted access would not reduce risk of exposure to groundwater. Physical barriers would affect site reuse.
		Passive Controls: Deed and Land Use Restrictions	Administrative action using LUCs to restrict future site use and to prohibit use of groundwater as a source of drinking water.	Retain. Groundwater is currently not used as a drinking water source and is not classified as a potential source. This process option will limit all future uses of groundwater and thus limit human exposure to groundwater.
	Natural Attenuation	Naturally Occurring Biodegradation and Physical Processes	Monitoring groundwater to assess the reduction in concentrations of chemicals of concern (COCs) through natural processes, such as biological activity, dilution, dispersion, and sorption.	Retain. This technology may decrease concentrations of PCE and other VOCs over time.
	Phytoremediation	Use of Plants	A set of processes that uses plants to remove, transfer, stabilize and destroy organic/inorganic contamination in groundwater, surface water, and leachate. Applicable to shallow contamination.	Retain. This technology may decrease concentrations of PCE and other VOCs over time.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
Containment	Vertical Barriers	Slurry Wall	Low-permeability wall formed in a perimeter trench to restrict horizontal migration of groundwater.	Eliminate. There are no downgradient receptors so containment is not needed. This technology would not restore groundwater quality. Difficult to apply to fractured bedrock.
		Sheet Piling	Metal sheet piling driven into the ground to restrict horizontal migration of groundwater.	Eliminate. There are no downgradient receptors so containment is not needed. This technology would not restore groundwater quality. Difficult to apply to bedrock.
		Grout Curtain	Pressure injection of grout to form a low-permeability perimeter wall to restrict horizontal migration of groundwater.	Eliminate. There are no downgradient receptors so containment is not needed. This technology would not restore groundwater quality.
		Hydraulic Barrier	Use of extraction wells and/or collection trenches to restrict horizontal migration of groundwater.	Eliminate. There are no downgradient receptors so containment is not needed. This technology may eventually restore groundwater quality. Long-term groundwater treatment would be needed.
	Horizontal Barriers	Physical Barrier	Injection of bottom-sealing slurry beneath source to minimize vertical migration of groundwater.	Eliminate. Not applicable. Contaminants extend through surficial groundwater to fractured bedrock below.
Removal	Groundwater Extraction	Extraction Wells	Series of conventional pumping wells used to remove contaminated groundwater.	Eliminate. Limited effectiveness if DNAPL is present. Long-term operation of treatment system would be required.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
Removal (continued)		Collection Trench	A permeable trench used to intercept and collect groundwater.	Eliminate. This technology may reduce groundwater contaminant levels, but could reach asymptotic level greater than target treatment levels. A trench would not be effective in capturing the bedrock plume. Limited effectiveness for DNAPL.
	Excavation	Excavation	Saturated soil/groundwater is dewatered and excavated for off-site disposal.	Retain. Source area could be addressed by limited excavation of saturated soil.
In-Situ Treatment	Biological	Anaerobic/ Aerobic	Enhancement of biodegradation of organics in an anaerobic (oxygen-deficient) or aerobic (oxygen-rich) environment by injection of electron-donor compounds or oxygen source. Microorganism cultures may need to be added.	Retain. Anaerobic reductive dechlorination is effective at removing PCE and other chlorinated VOCs. Shallow water table limits injection rate when applied in overburden.
	Physical/ Biological	Air Sparging (AS) or AS/Soil Vapor Extraction (SVE)	Volatilization and enhancement of biodegradation of organic compounds by supply of air with or without capture and treatment of volatilized compounds.	Eliminate. The heterogeneous subsurface would make effective implementation of this method difficult. Not effective in bedrock.
		Dynamic Underground Stripping	Steam injection at the periphery of the contaminated area resulting in the vaporization of volatile compounds bound to soil and the movement of contaminants to a centrally located extraction well.	Eliminate. The heterogeneous subsurface would make effective implementation of this method difficult. Not effective in bedrock.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
In-Situ Treatment (continued)	Chemical	Chemical Oxidation	Chemical destruction of organic COCs through oxidation with hydrogen peroxide and ferrous iron (Fenton's Reagent), catalyzed percarbonate (RegenOx™), or potassium permanganate.	Retain. This technology could remove the chlorinated VOCs, although the subsurface heterogeneity would affect the distribution of the chemical. A pilot study is typically needed. Shallow water table limits injection rate when applied in overburden. Difficult to apply to bedrock.
		Permeable Reactive Barriers (PRBs)	Use of a permeable barrier with zero-valent iron (ZVI) or mulch, which allows the passage of groundwater and reacts with the contaminants.	Retain. Depth of contaminated groundwater is suited to this process. Not applicable in bedrock.
	Thermal	Electrical Resistance Heating	Volatilization of organic COCs through groundwater and soil heating with electrical electrodes in combination with vacuum extraction of volatilized material.	Retain. This technology could remove the chlorinated VOC. A pilot study is typically needed. Not effective for deep bedrock.
Ex-Situ Treatment	Biological	Aerobic/ Anaerobic	Natural degradation of organic COCs via microorganisms in an aerobic (oxygen-rich) or anaerobic (oxygen-deficient) environment.	Eliminate. Biological treatment would not be cost-efficient. Not applicable since groundwater will not be extracted.
	Physical	Filtration	Separation of suspended solids from water via entrapment in a bed of granular media or membrane.	Eliminate. Not effective for VOC removal. Not applicable since groundwater will not be extracted.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
Ex-Situ Treatment (Continued)		Air Stripping	Contact of water with an air stream to remove VOCs.	Eliminate. Not applicable since groundwater will not be extracted.
		Granular Activated Carbon (GAC) Adsorption	Separation of dissolved contaminants from water or air streams via adsorption onto GAC.	Eliminate. Not applicable since groundwater will not be extracted.
		Solvent Extraction	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the COCs.	Eliminate. Not proven to be cost-effective for VOC removal. Not applicable since groundwater will not be extracted.
		Sedimentation	Separation of solids from water via gravity settling.	Eliminate. Not applicable since groundwater will not be extracted.
	Chemical	Coagulation/ Flocculation	Use of chemicals to neutralize surface charges and promote attraction of colloidal particles to facilitate settling.	Eliminate. Not applicable since groundwater will not be extracted.
		Neutralization/pH Adjustment	Use of acid or base to counteract high or low pH conditions.	Eliminate. Not applicable since groundwater will not be extracted.
		Chemical Precipitation	Use of reagents to convert soluble compounds into insoluble compounds.	Eliminate. This process is not used for VOC removal. Not applicable since groundwater will not be extracted.

TABLE 3-1

PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

General Response Action	Technology	Process Options	Description	Screening Comment
Ex-Situ Treatment (Continued)	Chemical (Continued)	Ion Exchange	Removal of dissolved ions through exchange with similarly charged ions held on the active sites of a synthetic resin that is contacted with the liquid to be treated.	Eliminate. This process is not used for VOC removal. Not applicable since groundwater will not be extracted.
		Enhanced Oxidation	Use of oxidizers such as ozone, hydrogen peroxide, or potassium permanganate to break down certain organic compounds.	Eliminate. Treatment costs are much higher compared to typical treatment methods for VOCs, such as air stripping. Not applicable since groundwater will not be extracted.
Discharge/ Disposal	Surface Discharge	Direct Discharge	Discharge of treated water to surface water.	Eliminate. Not applicable since groundwater will not be extracted.
		Indirect Discharge	Discharge of collected/treated water to local sewage treatment plant.	Eliminate. Not applicable since groundwater will not be extracted.
		Off-Site Treatment Facility	Treatment and disposal of water at an off-site treatment works.	Eliminate. Not applicable since groundwater will not be extracted.
	Subsurface Discharge	Reinjection	Use of injection wells, spray irrigation, or infiltration to discharge of treated groundwater underground.	Eliminate. Not applicable since groundwater will not be extracted.

PRB = Permeable reactive barrier.
COC = Chemical of concern.
VOC = Volatile organic compound.
LUC = Land use control.
PCE = Tetrachloroethene.
AS = Air sparging.
SVE = Soil vapor extraction.
ZVI = Zero-valent iron.

4.0 ASSEMBLY AND DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents an evaluation of each remedial alternative with respect to the criteria of the NCP (40 CFR Part 300). These criteria and their relative importance are described in the following subsections.

4.1 DEVELOPMENT OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

As outlined in Sections 2.3 and 2.5, RAOs and GRAs for the Site were developed to mitigate unacceptable risks to human health and ecological receptors associated with concentrations of PCE, TCE, cis-1,2-DCE, VC, PCP, 3,3'-dichlorobenzidine, arsenic, and barium in groundwater. This section presents the development and detailed analysis of the remedial alternatives for groundwater to achieve the Site RAOs. Each alternative was developed from the technologies that were retained from the screening process presented in Section 3. The alternatives cover a wide variety of treatment technologies in order to provide a range of remedial alternatives for consideration. From the technologies retained from the preliminary screening summarized in Table 3-1, the following potential remedial alternatives were developed to mitigate the concentrations of COCs exceeding PRGs in groundwater at the Site:

- Alternative G-1: No Action
- Alternative G-2: Monitoring, Engineering Controls, and LUCs
- Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs
- Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
- Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs
- Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs

4.1.1 Evaluation Criteria

In accordance with the NCP (40 CFR Part 300.430), the following nine criteria are used for the evaluation of remedial alternatives:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs
- Long-Term Effectiveness and Permanence
- Reduction of Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost
- State Acceptance
- Community Acceptance

The last two evaluation criteria, State Acceptance and Community Acceptance, are not formally addressed until the ROD is prepared. Each of the remaining seven criteria are discussed below.

4.1.1.1 Overall Protection of Human Health and the Environment

Alternatives must be assessed for adequate protection of human health and the environment, in both the short and long term, from unacceptable risks posed by hazardous substances or contaminants present at the site by eliminating, reducing, or controlling exposure to levels exceeding PRGs. Overall protection draws on the assessments of the other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

4.1.1.2 Compliance with ARARs

Alternatives must be assessed to determine whether they attain ARARs under federal environmental laws and state environmental or facility siting laws. CERCLA Section 121(d), specifies in part, that remedial actions for cleanup of hazardous substances must comply with requirements and standards under federal or more stringent state environmental laws and regulations that are applicable or relevant and appropriate (i.e., ARARs) to the hazardous substances or particular circumstances at a site or a waiver must be obtained [see also 40 CFR 300.430(f)(1)(ii)(B)]. ARARs include only federal and state environmental or facility siting laws/regulations and do not include occupational safety or worker protection requirements. In addition, per 40 CFR 300.405(g)(3), other advisories, criteria, or guidance may be considered in determining remedies (TBC guidance category).

4.1.1.3 Long-Term Effectiveness and Permanence

Alternatives must be assessed for the long-term effectiveness and permanence they offer, along with the degree of certainty that the alternative would prove successful. Factors to be considered, as appropriate, include the following:

- Magnitude of Residual Risk - Risk posed by untreated waste or treatment residuals at the conclusion of remedial activities. The characteristics of residuals should be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate.

- Adequacy and Reliability of Controls - Controls such as containment systems and LUCs that are necessary to manage treatment residuals and untreated waste must be shown to be reliable. Examples include: the uncertainties associated with land disposal for providing long-term protection from residuals; assessment of the potential need to replace technical components of the alternative such as a cap, a slurry wall, or a treatment system; and potential exposure pathways and risks posed if the remedial action needs replacement.

4.1.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which the alternative employs recycling or treatment that reduces the toxicity, mobility, or volume is to be assessed, including how treatment is used to address the principal threats posed by the site. Factors to be considered, as appropriate, include the following:

- The treatment or recycling processes the alternative employs and the materials that these processes will treat.

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled.

- The degree of expected reduction in toxicity, mobility, or volume of waste due to treatment or recycling and the amount of reduction(s) that is occurring.

- The degree to which the treatment is irreversible.

- The type and quantity of residuals that will remain following treatment considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- The degree to which treatment reduces the inherent hazards posed by the principal threats at the site.

4.1.1.5 Short-Term Effectiveness

The short-term impacts of the alternatives are to be assessed considering the following:

- Short-term risks that might be posed to the community during implementation.

- Potential impacts on workers during the remedial action and the effectiveness and reliability of protective measures.

- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation.

- Time until protection is achieved.

Although not a CERCLA-criterion, the sustainability of each alternative is evaluated per Navy policy. Sustainability factors are similar to those evaluated as part of the Short-Term Effectiveness criterion, so they are discussed in this section. Sustainability evaluations provide insight into elements of a remedy that have the greatest impact on the environmental footprint. For example, the amount of greenhouse gas (GHG) emissions related to materials production generally exceeds that from installation, transportation, or operations. Other factors that are considered include emissions of criteria air pollutants, water usage, and energy consumption. Sensitivity analysis of such factors can help provide an optimal design that minimizes the overall environmental footprint of the remedial action. Sustainability evaluations were performed for each remedial alternative and are provided in Appendix E.

4.1.1.6 Implementability

The ease or difficulty of implementing the alternatives is to be assessed by considering the following types of factors, as appropriate:

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, reliability of the technology, ease of undertaking additional remedial actions, and ability to monitor the effectiveness of the remedy.

- Administrative feasibility, including activities needed to coordinate with other offices and agencies, and the ability and time required to obtain any necessary approvals and permits from other agencies (for off-site actions).

- Availability of services and materials, including the availability of adequate off-site treatment capacity, storage capacity, and disposal capacity and services; availability of necessary equipment and specialists and provisions to ensure necessary additional resources; availability of services and materials; and availability of prospective technologies.

4.1.1.7 Cost

Capital costs, including both direct and indirect costs, and annual O&M costs are provided. A net present value of the capital and O&M costs is also provided. Typically, the cost estimate accuracy range is plus 50 percent to minus 30 percent.

4.1.2 Relative Importance of Criteria

Among the nine criteria, the threshold criteria are considered to be:

- Overall Protection of Human Health and the Environment
- Compliance with ARARs (excluding those that may be waived)

The threshold criteria must be satisfied for an alternative to be eligible for selection.

Among the remaining criteria, the following five criteria are considered to be the primary balancing criteria:

- Long-Term Effectiveness and Permanence
- Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment
- Short-Term Effectiveness
- Implementability
- Cost

The balancing criteria are used to weigh the relative merits of the alternatives.

The remaining two of the nine criteria: State Acceptance and Community Acceptance, are considered to be modifying criteria that must be considered during remedy selection. The state's concerns that must be assessed include the state's position and key concerns related to the preferred alternative and other

alternatives and state comments on ARARs or the proposed use of waivers, The assessment of community acceptance consists of responses of the community to the Proposed Plan and includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose. These last two criteria can be evaluated after the FS has been reviewed by the Commonwealth of Massachusetts and the Proposed Plan has been discussed at a public meeting. Therefore, this document addresses only seven of the nine criteria.

4.1.3 Selection of Remedy

The selection of a remedy is a two-step process. The first step consists of identification of a preferred alternative and presentation of the alternative in a Proposed Plan to the community for review and comment. The preferred alternative must meet the following criteria:

- Protection of human health and the environment.
- Compliance with ARARs unless a waiver is justified.
- Cost effectiveness in protecting human health and environment and in complying with ARARs.
- Utilization of permanent solutions and alternate treatment technologies or resource recovery technologies to the maximum extent practicable.

The second step consists of the review of the public comments and determination of whether or not the preferred alternative continues to be the most appropriate remedial action for the site, in consultation with the Commonwealth of Massachusetts.

4.2 ASSEMBLY AND DETAILED ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES

The detailed descriptions and evaluation of the six remedial alternatives developed for site groundwater and surface water are presented in Sections 4.2.1 through 4.2.6.

Alternative G-1 was developed and analyzed to serve as a baseline for comparison to other alternatives, as required by CERCLA and the NCP. Alternative G-2 was developed to monitor the migration and attenuation of the COCs over time and provide engineering controls and LUCs to prevent exposure to COCs in groundwater and surface water. Alternatives G-3 and G-4 were developed and analyzed to evaluate capture and treatment of the PCE plume at its leading edge upgradient of the EMD. Alternatives G-5 and G-5A were developed and analyzed to evaluate active remediation of the areas with the most contaminated groundwater in overburden and bedrock in addition to plume capture and treatment included in Alternatives G-3 and G-4. Treatment of the PCE plume at its leading edge in Alternatives G-3 through G-5A would continue for a long time as contaminated groundwater slowly flows through the treatment zones and discharges to surface water in the EMD. The treatment of groundwater with high

PCE concentrations in overburden and bedrock source areas in Alternatives G-5 and G-5A would be completed in approximately 1 to 5 years. A description and detailed analysis of these alternatives are presented in the following sections.

The areas near the EMD and at the upland edge were selected for capture and passive treatment of the PCE plume in overburden using mulch PRBs. The 10,000 µg/L PCE concentration contour in the overburden and the area adjacent to MW10-405D1/D2 with approximately 8,000 µg/L PCE in bedrock were selected as the areas for active treatment using enhanced bioremediation. Based on the solubility of PCE, these areas are most likely to include potential sources of the PCE such as residual DNAPL and diffusion source in rock matrix. The approach to groundwater remediation was to reduce the mass in the source areas by active treatment and prevent plume migration by capture and passive treatment of the plume at its leading edge.

The degradation of CVOCs could impact the groundwater geochemistry and result in mobilization of metals, such as arsenic, iron, and manganese, from reductive dissolution of minerals in soil. However, it is expected that these metals will be attenuated through naturally-occurring processes when the CVOCs are depleted and the geochemistry returns to the relatively toxic conditions in the subsurface that favor the adsorption and/or precipitation of metals. The alternatives discussed below include a monitoring component to evaluate changes in geochemistry during the naturally-occurring processes (Alternative G-2) or during and after the treatment phase (G-3 through G-5A) of the selected remedy so that any potential migration or attenuation of metal contaminants will be monitored.

4.2.1 Alternative G-1: No Action

4.2.1.1 Description

The No Action alternative maintains the site as is. This alternative does not address the groundwater contamination and is retained to provide a baseline for comparison to other alternatives. There would be no reduction in toxicity, mobility, or volume of the contaminants other than what would result from natural dispersion, dilution, and other attenuating factors.

4.2.1.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-1 would not provide protection of human health and the environment. There could be unacceptable risks to human health from exposure to contaminated groundwater. Groundwater contamination might migrate off site and have an immediate negative impact on the surface water in the

ditches. Because no monitoring would be performed, potential migration of contaminants would not be detected.

Compliance with ARARs and TBCs

Alternative G-1 would not comply with chemical-specific ARARs or TBCs listed in Table 4-1 because no action would be taken to reduce contaminant concentrations. Chemical-specific ARARs may be eventually met by natural processes, but there would be no monitoring to verify the changes. Compliance with location-specific ARARs or TBCs would be purely incidental. Action-specific ARARs or TBCs are not applicable.

Long-Term Effectiveness and Permanence

Alternative G-1 would have little long-term effectiveness and permanence because: contaminated groundwater would remain on site; there would be no LUCs to restrict construction methods to mitigate vapor intrusion; and there would be no groundwater monitoring and no means to detect potential off-site migration of COCs. Although COC concentrations might eventually decrease through natural processes, no monitoring would verify this.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-1 would not reduce toxicity, mobility, or volume of groundwater COCs through treatment because no treatment would occur.

Short-Term Effectiveness

Because no action would occur, implementation of Alternative G-1 would not have any short-term adverse impact from cleanup activities to the local community or the environment. Alternative G-1 might achieve the RAOs. Although the PRGs might eventually be achieved through natural processes, this would not be verified through monitoring. There are no sustainability impacts to consider because no actions would be implemented. Sustainability evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria.

Implementability

Because no action would occur, Alternative G-1 would be readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable. Implementability of additional administrative measures is not applicable because no such measures would be taken.

Cost

The only cost associated with the No Action alternative is the required 5-year reviews.

Capital Cost:	$	11,000
30-Year NPW of Annual Costs:	$	109,000
30-Year NPW:	$	120,000

A detailed breakdown of estimated costs for this alternative is provided in Appendix G.

4.2.2 Alternative G-2: Monitoring, Engineering Controls, and LUCs

4.2.2.1 Description

Alternative G-2 would consist of three major components: (1) monitoring, (2) engineering controls, and (3) LUCs.

Component 1: Monitoring

Monitoring would consist of groundwater monitoring, surface water monitoring, and sediment monitoring. Monitoring wells will be located to monitor groundwater both north and south of the EMD. The final long term monitoring (LTM) well locations and surface water and sediment locations in the EMD will be determined during the RD phase for the selected remedy.

Long-term groundwater monitoring wells would be selected to monitor: (1) groundwater immediately north of the EMD (to verify that the overburden source and impacted groundwater remain contained at levels protective of EMD); (2) groundwater south of the EMD (to verify that the nature and boundaries of any LUCs (see Component 3) are still appropriate); and (3) groundwater at the eastern edge of the plume (e.g., MW-304) (to verify that the impacted groundwater is not migrating to the east).

It is assumed for costing purposes that groundwater samples would be collected from 20 new and existing monitoring wells and analyzed for PCE, TCE, cis,1-2,DCE, VC, arsenic, iron, and manganese. In addition, one well (MW10-412D2) would be sampled for analysis of PCP, one well (MW10-402) for 3,3'-dichlorobenzidine, and one well (MW-303) for barium. Specific wells would be identified in a long-term monitoring plan. Sampling frequency would be quarterly for the first year, semi-annually for years 2 and 3, and annually for the remaining years.

Surface water monitoring to confirm that surface water PRGs are being met would include collection of four surface water samples from the EMD and analysis for PCE, TCE, cis,1-2,DCE, VC, arsenic, iron, and

manganese at the same frequency of groundwater monitoring. Samples would be collected under normal flow conditions (rather than storm conditions).

Sediment monitoring to confirm that no accumulation of iron and manganese is occurring in the sediment would include collection of four sediment samples from the EMD and analysis for arsenic, iron, and manganese at the same frequency of groundwater monitoring. The sediment samples would be collected at locations most likely to be impacted by the incoming groundwater that might have elevated iron and manganese concentrations due to the reducing conditions created by naturally-occurring reductive dechlorination.

If the monitoring results indicate that concentrations of contaminants in the EMD are unacceptable, then active remediation will be implemented.

Component 2: Engineering Controls

A temporary fence would be installed around the portion of the EMD where potential recreational user risk greater than 1×10^{-5} is present to prevent contact of the surface water in the EMD by human receptors (see Figure 4-1). The fence will remain in place until the groundwater and surface water monitoring indicates that the surface water PRGs have been achieved, no unacceptable risk remains, and the remedy is operating properly and successfully.

Component 3: LUCs

The remedial action at SRA will require a long remediation timeframe, thus the implementation of LUCs would control exposure to COCs in groundwater during this period.

Because the SRA Site is not located within a potentially productive aquifer and SSTTDC and LNR have indicated that the potable and irrigation water needs for site redevelopment can be provided by sources other than the groundwater under the Site, future use of the Site groundwater for potable or irrigation uses are not exposure scenarios evaluated in the FS. Therefore, a permanent LUC that prevents the installation or permitting of production, supply or irrigation wells at the SRA Site would be used to prevent exposure to VOCs in groundwater at concentrations that pose unacceptable risk. The approximate boundary of the permanent LUC area is shown on the figures that depict each alternative, for example Figure 4-1.

The PRGs for the vapor intrusion and construction worker pathways shown in Table 2-4 would be used to establish specific LUC boundaries as shown on Figure 4-1 (for example). Based on the low contaminant concentrations in shallow overburden groundwater south of the EMD, LUCs to prevent construction

worker or vapor intrusion exposures are not being considered south of the EMD. Therefore, it is anticipated that the EMD will be established as the LUC compliance boundary and no LUCs (other than the permanent LUC prohibiting installation of groundwater wells for production, supply, or irrigation) would be imposed downgradient of the EMD. SSTTDC and LNR have indicated that the interim LUCs listed below would be consistent with the proposed future uses of the area upgradient of the EMD.

- A LUC requiring prior EPA and MassDEP approval of construction dewatering plans before excavation activities could be conducted, until PRGs are achieved.

- A LUC specifying health and safety procedures to be used by construction workers to prevent unacceptable exposure risks based upon risk-based values until PRGs are achieved.

The interim LUCs listed above would be established in the area of the Site north of the EMD, which is the LUC compliance boundary, and would be narrowly tailored to prevent specific, identified risks and exposure scenarios identified in the HHRA and applicable to this FS. These LUCs would be limited in both location and scope so as not to unreasonably burden or prohibit reasonably foreseeable uses anticipated by the Reuse Plan and Zoning By-Laws. The results of the long-term groundwater sampling will be routinely compared to the recreational exposure vapor intrusion PRGs (see Table 2-4) to determine if LUCs that pertain to vapor intrusion can be lifted.

To implement LUCs, the Navy would develop a LUC RD during the RD phase that would describe the specific controls for the site, as well as the implementation protocols and upkeep requirements. The LUC RD would use PRGs to define the boundaries of the LUC areas for groundwater use, health and safety, and vapor intrusion, as well as conditions, terms, and limitations of the controls, such as meeting PRGs for lifting vapor intrusion LUCs (see Figure 4-1 for the approximate boundaries of LUC areas). The LUC RD would also outline the required inspection, reporting, and enforcement protocols.

Annual inspections of the site would be conducted to confirm compliance with the LUC objectives, and an annual compliance certificate would be prepared and provided to USEPA and MassDEP. Prior to any property conveyance, USEPA and MassDEP would be notified.

Because this remedy will result in hazardous substances, pollutants, or contaminants remaining on site in excess of levels that allow for unlimited use and unrestricted exposure, in accordance with Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(c), a statutory review will be conducted within 5 years of initiation of remedial action and every 5 years thereafter to ensure that the remedy continues to be protective of human health and the environment. Each five-year review will consist of a review of relevant documents, interviews, a site inspection, and preparation of a summary report.

4.2.2.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-2 would be protective of human health and the environment.

Naturally occurring processes such as biodegradation, dispersion, and dilution would reduce concentrations of groundwater COCs over the long term. Monitoring would be used to verify the continued protectiveness of the remedy by evaluating the change in contaminant concentrations and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Engineering controls and LUCs would ensure protection of human health and the environment until remediation goals are met. Restricting the use of groundwater would be protective of human health by avoiding unacceptable risks of exposure to COCs in groundwater. Exposure to VOCs through vapor intrusion would be controlled by the LUC requiring special building construction methods.

Compliance with ARARs and TBCs

Alternative G-2 would comply with chemical-specific ARARs and TBCs through LUCs. This would be verified through monitoring. Alternative G-2 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-2 are listed in Tables 4-2, 4-3, and 4-4, respectively.

Long-Term Effectiveness and Permanence

Alternative G-2 would provide long-term effectiveness and permanence through LUCs. However, residual risk would remain since there is no groundwater treatment. Monitoring surface water and the change in groundwater quality would be an effective means to evaluate the change in contaminant concentrations and verify that no migration of COCs is occurring. An active remedy may be needed as a contingency in the event that unacceptable contaminant concentrations are detected in the EMD.

Groundwater use restrictions would effectively prevent the use of groundwater. Requirements for specific construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The engineering and administrative controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction of toxicity, mobility, or volume through treatment under this alternative.

Short-Term Effectiveness

Alternative G-2 would result in few short-term effects. Exposure of workers to contamination during groundwater and surface water sampling would be minimized by compliance with the requirements of the OSHA, including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of LUCs would not adversely impact the surrounding community or the environment. Because there is no treatment, there could be exposure to contaminants in surface water if elevated concentrations in the plume reach the EMD.

Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. Monitoring and five-year reviews would be used to confirm that RAO No. 4 is met. Monitoring and LUCs would be maintained for approximately 70 years based on preliminary modeling using BIOCHLOR (Appendix F).

The environmental footprint of each of the impact categories evaluated using SiteWise^{TM} is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. For Alternative G-2, GHG emissions have a low to moderate relative impact, emitting 121 tons of carbon dioxide equivalents (CO_2e). For the criteria air pollutants, the relative impact of nitrogen oxides (NO_X) emissions is moderate to high, emitting 0.40 ton; the relative impact of sulfur oxides (SO_X) emissions is low to moderate, emitting 0.26 ton of SO_X; and the relative impact of particulate matter (PM_{10}) emissions is low, releasing 0.01 ton of PM_{10} to the atmosphere. The relative use of energy for Alternative G-2 is low, utilizing 1,656 million British Thermal Units (MMBTU). The water use impact is low, with a total consumption of 613 gallons of water for Alternative G-2.

Implementability

Sampling and maintenance of existing monitoring wells, implementation of engineering controls and LUCs, and the performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The administrative aspects of Alternative G-2 for the property under the control of the Navy would be relatively simple to implement. However, if a change in ownership of the site occurs prior to completion of

remediation, appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of aquifer use restrictions and monitoring.

Cost

The estimated costs for Alternative G-2 are as follows:

Capital Cost:	$	180,000
30-Year NPW of Annual Costs:	$	923,000
30-Year NPW:	$	1,103,000

A detailed breakdown of estimated costs for this alternative is provided in Appendix G.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternative (see Appendix F) the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

4.2.3 Alternative G-3: One Overburden Mulch PRB, Monitoring, Engineering Controls, and LUCs

4.2.3.1 Description

Alternative G-3 would consist of four major components: (1) mulch PRB in the overburden near the EMD, (2) monitoring, (3) engineering controls, and (4) LUCs.

Component 1: Mulch PRB in the Overburden near the EMD

One mulch PRB would be installed in the overburden north of and near the EMD to intercept and treat the overburden PCE plume at its leading edge (see Figure 4-2). Conventional barrier technology using injection of ED solutions can also be considered, but a field pilot treatability study would be needed to evaluate the effectiveness of injection due to the very shallow water table.

The useful life of a mulch PRB is typically 5 years, and the PRB will need to be replenished with an ED every 5 years. The PRB would be maintained as long as concentrations in the groundwater will cause the surface water PRGs to be exceeded.

A pilot treatability study would be performed prior to design to determine the details of the construction of the PRB. Existing site information and assumptions based on typical PRBs were used for the conceptual design at this stage. The mulch PRB would be installed using a one-pass trencher to the top of bedrock.

The estimated width of the mulch barrier is 2 feet, and the vertical thickness of the PRB would be approximately 15 feet. Wells would be installed in the PRB to allow for replenishment with an oil-based ED after the organic material in the mulch is exhausted. Excavated soil from the trenches would be allowed to drain back into the trench and then would be disposed off-site. All excavated soils will be characterized to determine the appropriate method of off-site disposal.

Monitoring wells on both sides of the mulch PRB would be used to monitor the progress and effectiveness of treatment (see Component 2).

Disturbance to wetlands is not expected from construction of this mulch PRB. Therefore, wetland restoration would not be needed.

The reducing conditions caused by the mulch barriers may mobilize iron, manganese, and arsenic from the soil to the groundwater. As part of the long-term monitoring program, groundwater samples downgradient of the PRB and surface water samples from the EMD would be analyzed for iron, manganese, and arsenic. If the concentrations of these metals exceed target levels (to be determined during the preparation of the long-term monitoring plan) that would cause unacceptable risks or conditions in the EMD, then a contingency measure would be implemented. The contingency measure would change the reducing conditions to oxidizing conditions in the area between the PRB and the EMD.

There are several technologies that would be considered to promote oxidizing conditions. Air could be injected using a blower through a series of air sparging wells. This would require bringing electrical power to the site and building a small building for the blower and installing air distribution piping. Pure oxygen can also be sparged into the wells using compressed oxygen tanks and specialized diffusers in diffusion wells. Because pure oxygen is used, oxygen can diffuse further from the wells compared to compressed air. Small vaults would be installed near each well to house the compressed oxygen cylinders. A third method would use an oxygen-releasing compound (ORC) that would be injected into wells at multiple locations. The ORC would gradually release oxygen into the surrounding groundwater, and the subsequent reinjections would be required. The specific technology would be selected after evaluating the conditions at the site.

<u>Component 2: Monitoring</u>

This component would be identical to Component 1 of Alternative G-2, except that 1 more overburden well immediately upgradient of the proposed mulch PRB near the EMD would be included in the groundwater monitoring program and monitored for PCE, TCE, cis-1,2-DCE, VC, arsenic, iron, and manganese at the same frequency of the other wells. Monitoring wells will be located to monitor groundwater both north and south of the EMD as well as groundwater flowing into an active treatment

area such as a PRB. The sediment samples would be collected at locations most likely to be impacted by the incoming groundwater that might have elevated iron and manganese concentrations due to the reducing condition created by the mulch PRB. The final LTM well locations and surface water and sediment locations in the EMD will be determined during the RD phase for the selected remedy.

Component 3: Engineering Controls

This component would be identical to Component 2 of Alternative G-2. Construction of the mulch PRB near the EMD would allow for removal of the engineering controls after the upgradient portion of the overburden PCE plume is cleaned up.

Component 4: LUCs

This component would be identical to Component 3 of Alternative G-2.

4.2.3.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-3 would be protective of human health and the environment.

By intercepting the overburden PCE plume at its leading edge, the mulch PRB would control the plume migration and treat groundwater to levels protective of the EMD. Monitoring would be used to verify the continued protectiveness of the remedy by evaluating the progress of plume containment and passive treatment by the mulch PRB and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Engineering controls and LUCs would ensure protection of human health and the environment during the remedial period until PRGs are met. Restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods.

Compliance with ARARs and TBCs

Alternative G-3 would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ treatment and LUCs. Alternative G-3 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-3 are listed in Tables 4-5, 4-6, and 4-7, respectively.

Long-Term Effectiveness and Permanence

Alternative G-3 would provide long-term effectiveness and permanence.

The mulch PRB near the EMD would treat the overburden PCE plume and prevent further contaminant migration. Groundwater flow through the PRB would be treated to levels protective of surface water in the EMD. Monitoring the progress of the mulch PRB's treatment would be an effective means to evaluate the progress of remediation, monitor changes in contaminant composition from biological degradation (such as vinyl chloride concentrations), and verify that no migration of COCs is occurring beyond the PRB.

Groundwater use restrictions would effectively prevent the use of groundwater until the PRGs are met. Requirements for specific construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The engineering and administrative controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-3 would reduce the toxicity, mobility, and volume of groundwater COCs through the in-situ treatment by the PRB. In-situ treatment with the overburden mulch PRB would permanently remove PCE from groundwater flowing through it. No treatment residues would be generated by this alternative other than the temporary formation of biodegradation by-products which would also be reduced over time.

Short-Term Effectiveness

Alternative G-3 would result in some short-term effects. Exposure of workers to contamination during barrier installation, replenishment with ED injection, and groundwater and surface water sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of the components would have an impact at the area near the EMD only. There will be a slight impact on the local community during the transport of contaminated soil from the barrier for off-site disposal.

Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of the mulch barrier would be completed in approximately 1 month. Replenishment of organic substrate in the PRB by ED injection would be completed in approximately 1 week every 5 years after PRB installation. Monitoring and five-year reviews would be used to confirm

that RAO No. 4 is met. It is estimated that the PRB would need to be maintained for approximately 70 years based on preliminary modeling using BIOCHLOR (Appendix F).

The environmental footprint of each of the impact categories evaluated using SiteWise™ is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. For Alternative G-3, GHG emissions have a moderate to high relative impact, emitting 236 tons of CO_2e. For the criteria air pollutants, the relative impact of SO_X, and PM_{10} emissions is moderate to high, emitting 0.52 and 0.034 ton of SO_X and PM_{10}, respectively. For NO_X, the relative impact of these emissions is high, with a total of 0.4 ton emitted to the atmosphere. The relative use of energy for Alternative G-3 is moderate to high, utilizing 6,734 MMBTU. The total water use for Alternative G-3 is 149,000 gallons of water, corresponding to a moderate impact.

Implementability

The mulch barrier could be readily installed for capture and in-situ treatment of the PCE plume at its leading edge. There are several qualified contractors to implement the mulch barrier technology and numerous qualified contractors to implement the ED injection for replenishment. Sampling and maintenance of existing monitoring wells, implementation of engineering controls and LUCs, and the performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

The administrative aspects of Alternative G-3 for the property under the control of the Navy would be relatively simple to implement. However, if a change in ownership of the site occurs prior to completion of remediation, appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of remediation, aquifer use restrictions and monitoring.

Cost

Estimated costs for Alternative G-3 are as follows:

Capital Cost:	$	920,000
30-Year NPW of Annual Costs:	$	1,692,000
30-Year NPW:	$	2,612,000

A detailed cost estimate for this alternative is provided in Appendix G.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternative (see Appendix F) the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

4.2.4 Alternative G-4: Two Overburden Mulch PRBs, Monitoring, Engineering Controls, and LUCs

4.2.4.1 Description

Alternative G-4 would consist of four major components: (1) two mulch PRBs in the overburden near the EMD and at the upland edge, (2) monitoring, (3) engineering controls, and (4) LUCs.

Component 1: Overburden Mulch PRBs

This component would be similar to Component 1 of Alternative G-3. In addition to the mulch PRB north of and near the EMD, one more mulch PRB would be installed at the upgradient edge of the upland north of the EMD to treat the overburden PCE plume entering the upland area (see Figure 4-3). This additional PRB would be located south of the wetland to avoid wetland impacts. As with Component 1 of Alternative G-3, it is assumed that each PRB will need to be replenished with an ED every 5 years. The PRBs would be maintained as long as concentrations in the groundwater will cause the surface water PRGs and the vapor intrusion PRGs to be exceeded.

A pilot treatability study would be performed prior to design to determine the details of the construction of the PRBs. Existing site information and assumptions based on typical PRBs were used for the conceptual design at this stage. The mulch PRBs would be installed using a one-pass trencher to the top of the bedrock. The estimated width of each mulch PRB is 2 feet, and the vertical thickness of the PRBs would be approximately 15 feet. Wells would be installed in the PRBs to allow for replenishment with an oil-based ED after the organic material in the mulch is exhausted. Excavated soil from the trenches would be allowed to drain back into the trench and then would be disposed off-site. All excavated soil will be characterized to determine the appropriate method of off-site disposal.

Monitoring wells on both sides of the mulch PRBs would be used to monitor the progress and effectiveness of treatment (see Component 2).

Disturbance to wetlands is not expected from construction of the mulch PRBs. Therefore, wetland restoration would not be needed. If a PRB is constructed in a wetland or wetland buffer zone, other construction techniques may be required.

If reducing conditions cause unacceptable mobilization of iron, manganese, or arsenic into the EMD, a contingency measure, as described in Alternative G-3 would be implemented.

Component 2: Monitoring

This component would be identical to Component 2 of Alternative G-3, except that one more overburden well immediately upgradient of the proposed mulch PRB at the upland edge would be included in the groundwater monitoring program and monitored for PCE, TCE, cis-1,2-DCE, VC, arsenic, iron, and manganese at the same frequency of the other wells. Monitoring wells will be located to monitor groundwater both north and south of the EMD as well as groundwater flowing into an active treatment area such as a PRB. The sediment samples would be collected at locations most likely to be impacted by the incoming groundwater that might have elevated iron and manganese concentrations due to the reducing condition created by the mulch PRB. The final LTM well locations and surface water and sediment locations in the EMD will be determined during the RD phase for the selected remedy.

Component 3: Engineering Controls

This component would be identical to Component 2 of Alternative G-2. Construction of the mulch PRB near the EMD would allow for removal of the engineering controls after the upgradient portion of the overburden PCE plume is cleaned up.

Component 4: LUCs

This component would be identical to Component 3 of Alternative G-2. Construction of the mulch PRB at the upland edge would allow for removal of vapor intrusion LUCs in the upland area when the overburden PCE plume upgradient of the upland area is cleaned up.

4.2.4.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-4 would be protective of human health and the environment.

By intercepting the overburden PCE plume at its leading edge the two mulch PRBs would control the plume migration, treat groundwater to levels protective of the EMD, and reduce the concentration of chlorinated VOCs beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Monitoring would be used to verify the continued protectiveness of the remedy by evaluating the progress of plume containment and passive treatment by the two mulch PRBs and

detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Engineering controls and LUCs would ensure protection of human health and the environment during the remedial period until PRGs are met. Restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods.

Compliance with ARARs and TBCs

Alternative G-4 would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ treatment and LUCs. Alternative G-4 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-4 are listed in Tables 4-8, 4-9, and 4-10, respectively.

Long-Term Effectiveness and Permanence

Alternative G-4 would provide long-term effectiveness and permanence.

The mulch PRBs near the EMD and at the upland edge would treat the overburden PCE plume. Groundwater flow through the PRB near the EMD would be treated to levels protective of the EMD. The PRB at the upland edge would reduce the concentration of chlorinated VOCs beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Monitoring the progress of groundwater treatment by the mulch PRBs would be an effective means to evaluate the progress of remediation and to verify that no migration of COCs is occurring.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met. Requirements for specific construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The engineering and administrative controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-4 would reduce the toxicity, mobility, and volume of groundwater COCs through the in-situ treatment by the PRBs. In-situ treatment with the two overburden mulch PRBs would permanently remove PCE from groundwater flowing through them. No treatment residues would be generated by this

alternative other than the temporary formation of biodegradation by-products which would also be reduced over time.

Short-Term Effectiveness

Alternative G-4 would result in some short-term effects. Exposure of workers to contamination during installation of mulch PRBs, replenishment with ED injection, and groundwater and surface water sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of the components would have an impact at the upland area and the area near the EMD only. There will be a slight impact on the local community during the transport of the contaminated soil from the barriers for off-site disposal.

Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of the mulch barriers would be completed in approximately 1 months. Replenishment of organic substrate in the PRBs by ED injection would be completed in approximately 2 weeks every 5 years after the installation of the PRBs. Monitoring and five-year reviews would be used to confirm that RAO No. 4 is met. It is estimated that the PRBs would need to be maintained for approximately 70 years based on preliminary modeling using BIOCHLOR (Appendix F).

The environmental footprint of each of the impact categories evaluated using SiteWise^{TM} is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CECLA evaluation criteria. For Alternative G-4, GHG emissions have a high relative impact, emitting 315 tons of CO_2e. For the criteria air pollutants, the relative impact of NO_X, SO_X, and PM_{10} emissions is high, emitting 0.48, 0.70, and 0.048 ton of NO_X, SO_X and PM_{10}, respectively. The relative use of energy and water for Alternative G-4 is high, utilizing 10,565 MMBTU and 267,000 gallons of water respectively.

Implementability

The mulch barriers could be readily installed for capture and in-situ treatment of the PCE plume at its leading edge. There are several qualified contractors to implement the mulch barrier technology and numerous qualified contractors to implement the ED injection for replenishment. Sampling and maintenance of existing monitoring wells, implementation of engineering controls and LUCs, and performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

Construction of a PRB in a wetland or wetland buffer zone would comply with the applicable requirements of the MassDEP regulations and SSTTDC Wetlands Protection Rules and Regulations for NAS South Weymouth.

The administrative aspects of Alternative G-4 for the property under the control of the Navy would be relatively simple to implement. However, if a change in ownership of the site occurs prior to completion of remediation, appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of remediation, aquifer use restrictions and monitoring.

Cost

Estimated costs for Alternative G-4 are as follows:

Capital Cost:	$	1,107,000
30-Year NPW of Annual Costs:	$	2,074,000
30-Year NPW:	$	3,181,000

A detailed cost estimate for this alternative is provided in Appendix G.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternative (see Appendix F) the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

4.2.5 Alternative G-5: Overburden and Bedrock Source Area Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs

4.2.5.1 Description

Alternative G-5 would consist of five major components: (1) in-situ enhanced bioremediation in overburden (10,000 µg/L PCE) and bedrock (~8,000 µg/L PCE) source areas, (2) one mulch PRB in overburden near EMD, (3) monitoring, (4) engineering controls, and (5) LUCs.

Component 1: Overburden and Bedrock Source Area Enhanced Bioremediation

Active treatment by in-situ enhanced bioremediation would be applied to areas with the highest groundwater concentrations in overburden and bedrock to reduce the source mass of the PCE plumes. A target concentration of 1,000 µg/L PCE is assumed as the treatment goal. Treatment to the PRGs is not needed, and the downgradient PRB would further treat the overburden groundwater. This level of treatment would also reduce the overall mass of contaminants. The area of 10,000 µg/L PCE

concentration contour in the overburden and the area adjacent to MW10-405D1/D2 with approximately 8,000 µg/L PCE in bedrock were selected as the target treatment zones (TTZs) for enhanced bioremediation (see Figure 4-4). Based on the solubility of PCE, these areas may include potential sources of PCE that could continuously release PCE to groundwater via dissolution from residual DNAPL or back diffusion from the rock matrix.

Prior to the design of the enhanced bioremediation system, a pilot treatability study would be performed to determine chemical injection rates, buffering requirements, injection well spacing, and details of the construction of the PRB. Existing site information and assumptions based on typical enhanced bioremediation systems and PRBs were used for the conceptual design at this stage. As part of the study, the need for bioaugmentation by the addition of microorganisms would also be evaluated. This study is estimated to last 1 year. Although some of the injection wells used for the pilot treatability study may be used as part of the final design, for the purposes of this estimate, it is assumed that none would be used.

Because of the uncertainty in the ability to distribute an oil-based ED in the bedrock fractures, a soluble ED, sodium lactate, is proposed for the initial injection in both the overburden and bedrock TTZs through grids of injection points. At each injection location, a sodium lactate solution would be injected via an injection well over the entire saturated thickness. A buffering agent, such as sodium bicarbonate, may be needed to maintain the pH in the optimum range.

The conceptual design is based on typical well spacing and estimate of chemical feed requirements based on existing data. In the overburden TTZ, the spacing of injection wells along lines perpendicular to groundwater flow would be 10 feet and the spacing between these lines would be 20 feet. A total of 1,500 lb of sodium lactate (approximately 1,800 gallon of 10 percent solution) would be injected over a targeted depth interval of approximately 2 to 17 feet bgs into a total of 42 wells in the overburden TTZ over a period of one week.

Based on the conceptual design, in the bedrock TTZ the spacing of injection wells along lines perpendicular to groundwater flow and the spacing between these lines would both be 10 feet to account for uncertainty in lateral interconnection of fractures. A total of 60 lb of sodium lactate (approximately 70 gallon of 10 percent solution) would be injected over a targeted depth interval of approximately 17 to 37 feet bgs into a total of 9 wells in the bedrock TTZ over a period of one week.

Because of the shallow depth to groundwater, surface break out of the injected solution and/or groundwater is likely to occur; therefore a slow injection rate has been assumed.

To account for any residual sources after the initial treatment with sodium lactate, an oil based ED, such as the emulsified oil product EOS, would be injected into both TTZs after 6 months and again 2 years later to replenish the organic substrates in the TTZs at half the dosage of the injected sodium lactate. A total of 15 gallons and 0.6 gallon of EOS (60 percent oil) would be injected along with sufficient dilution water into the overburden and bedrock TTZs, respectively. Following each re-injection, the results would be evaluated to determine if additional treatment is required.

Because the source area treatment would impact wetlands, the impacted areas would need to be restored after injection process is completed.

Component 2: Overburden Mulch PRBs

This component would be identical to Component 1 of Alternative G-3.

If reducing conditions cause unacceptable mobilization of iron, manganese, or arsenic into the EMD, a contingency measure, as described in Alternative G-3 would be implemented.

Component 3: Monitoring

This component would be nearly identical to Component 2 of Alternative G-3, except that one more overburden well in the overburden TTZ and one more bedrock well in the bedrock TTZ will be included in the groundwater monitoring program and monitored for PCE, TCE, cis-1,2-DCE, VC, arsenic, iron, and manganese at the same frequency of the other wells. Monitoring wells will be located to monitor groundwater both north and south of the EMD as well as groundwater flowing into an active treatment area such as a PRB. The sediment samples would be collected at locations most likely to be impacted by the incoming groundwater that might have elevated iron and manganese concentrations due to the reducing condition created by the mulch PRB. The final LTM well locations and surface water and sediment locations in the EMD will be determined during the RD phase for the selected remedy.

Component 5: Engineering Controls

This component would be the same as Component 2 of Alternative G-2. Construction of the mulch PRB near the EMD would allow for removal of the engineering controls after the upgradient portion of the overburden PCE plume is cleaned up.

Component 6: LUCs

This component would be identical to Component 3 of Alternative G-2. Construction of the mulch PRB at the upland edge would allow for removal of vapor intrusion LUCs in the upland area when the overburden PCE plume upgradient of the upland area is cleaned up.

4.2.5.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-5 would be protective of human health and the environment.

By actively removing the sources of PCE contamination, enhanced bioremediation in the TTZs would significantly reduce the source mass and the expansion of the PCE plumes in overburden and bedrock. This would significantly reduce the risk from exposure to contaminated groundwater, and provide protection to future human receptors that may be exposed during intrusive activities. The enhanced bioremediation is expected to reduce or eliminate most of the contamination in the source areas, thereby improving downgradient groundwater quality and reducing impacts on the surface water over time. In addition, by intercepting the overburden PCE plume at its leading edge, the PRB would control the plume migration, and treat groundwater to levels protective of the EMD. Monitoring would be used to verify the continued protectiveness of the remedy by evaluating the progress of source zone enhanced bioremediation and plume containment and passive treatment by the mulch PRB and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Engineering controls and LUCs would ensure protection of human health and the environment during the remedial period until PRGs are met. Restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods.

Compliance with ARARs and TBCs

Alternative G-5 would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ treatment with PRBs and injections. Alternative G-5 would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-5 are listed in Tables 4-11, 4-12, and 4-13, respectively.

Long-Term Effectiveness and Permanence

Alternative G-5 would provide long-term effectiveness and permanence.

In-situ treatment by enhanced bioremediation would effectively and permanently remove most of the contamination in the source areas. This would reduce contaminant migration and possibly reduce the duration that the PRB must be maintained. In addition, the mulch PRB near the EMD would treat the overburden PCE plume and prevent contaminants from further migration. Groundwater flowing through the PRB near the EMD would be treated to levels protective of the EMD. Prior to design of the source zone treatment, a pilot-scale treatability study would need to be performed.

Monitoring the progress of enhanced bioremediation of source area groundwater and treatment by the overburden mulch PRB would be an effective means to evaluate the progress of remediation, monitor changes in contaminant composition from biological degradation (such as vinyl chloride concentrations), and verify that no migration of COCs is occurring.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met. Requirements for specific construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The engineering and administrative controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-5 would reduce the toxicity, mobility, and volume of groundwater COCs through in-situ treatment. In-situ enhanced bioremediation would permanently reduce PCE in groundwater in the TTZs. Passive treatment with the overburden mulch PRB would permanently remove PCE from groundwater flowing through it. It is estimated that the PRB would need to be maintained for approximately 55 years based on preliminary modeling using BIOCHLOR (Appendix F). No treatment residues would be generated by this alternative other than the temporary formation of biodegradation by-products which would also be reduced over time.

Short-Term Effectiveness

Alternative G-5 would result in some short-term effects. Exposure of workers to contamination during installation of injection wells and mulch PRB, ED injection, and groundwater and surface water sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of the components would have

an impact in the high contamination area as well as near the EMD. There will be a slight impact on the local community during the transport of contaminated soil from barriers to off-site disposal.

Implementation of this alternative will impact the wetland at the site. The impacted wetland must be restored after the injection process is completed.

Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of injection wells and injection of EOS for enhanced bioremediation at the source areas and the installation of the mulch PRB would be completed in approximately 3 months. The initial injection in the source areas would be followed up with re-injection of EOS after 6 months and again 2 years later over a period of approximately 2 weeks each. Replenishment of organic substrate in the PRB by ED injection would be completed in approximately 1 week every 5 years after the installation of the PRB. Monitoring and five-year reviews would be used to confirm that RAO No. 4 is met. It is estimated that the PRB would need to be maintained for approximately 55 years. Once the PRB no longer needs to be maintained the interim LUCs on the upland area would be lifted.

The environmental footprint of each of the impact categories evaluated using SiteWise^{TM} is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. For Alternative G-5, GHG emissions have a high relative impact, emitting 264 tons of CO_2e. For the criteria air pollutants, the relative impact of NO_X, and PM_{10} emissions is high, emitting 0.50, and 0.040 ton of NO_X, and PM_{10}, respectively. For SO_X, the relative impact is moderate to high, emitting 0.50 ton of SO_X. The relative use of energy for Alternative G-5 is moderate to high, utilizing 7,332 MMBTU. The total water consumption for this alternative is 158,000 gallons of water, corresponding to a moderate impact.

Implementability

The injection wells for source zone enhanced bioremediation and the mulch PRB at the leading edge of the PCE plume could be readily installed. However, there is uncertainty in the effectiveness of the bedrock treatment because of the difficulties in injecting and distributing the ED. There are several qualified contractors to implement the mulch barrier technology and there are many qualified contractors for installing ED injection wells and injecting the ED. Sampling and maintenance of existing monitoring wells, implementation of engineering controls and LUCs, and performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

Construction of a PRB in a wetland or wetland buffer zone would comply with the applicable requirements of the SSTTDC Wetlands Protection Rules and Regulations for NAS South Weymouth.

The administrative aspects of Alternative G-5 such as LUCs for the property under the control of the Navy would be relatively simple to implement. However, if a change in ownership of the site occurs prior to completion of remediation, appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of remediation, aquifer use restrictions and monitoring.

Cost

The estimated costs for Alternative G-5 are as follows:

Capital Cost:	$	1,615,000
30-Year NPW of Annual Costs:	$	1,987,000
30-Year NPW:	$	3,602,000

A detailed breakdown of the estimated costs for this alternative is provided in Appendix G.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternative (see Appendix F) the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

4.2.6 Alternative G-5A: Overburden and Bedrock Source Area Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs

4.2.6.1 Description

Alternative G-5A would consist of five major components: (1) in-situ enhanced bioremediation in overburden (10,000 µg/L PCE) and bedrock (~8,000 µg/L PCE) source areas, (2) two mulch PRBs in overburden near EMD and at the upland edge, (3) monitoring, (4) engineering controls, and (5) LUCs.

Component 1: Overburden and Bedrock Source Area Enhanced Bioremediation

Active treatment by in-situ enhanced bioremediation would be applied to areas with the highest groundwater concentrations in overburden and bedrock to reduce the source mass of the PCE plumes. A target concentration of 1,000 µg/L PCE is assumed as the treatment goal. Treatment to the PRGs is not needed, and the downgradient PRB would further treat the overburden groundwater. This level of treatment would also reduce the overall mass of contaminants. The area of 10,000 µg/L PCE concentration contour in the overburden and the area adjacent to MW10-405D1/D2 with approximately

8,000 µg/L PCE in bedrock were selected as the target treatment zones (TTZs) for enhanced bioremediation (see Figure 4-5). Based on the solubility of PCE, these areas may include potential sources of PCE that could continuously release PCE to groundwater via dissolution from residual DNAPL or back diffusion from the rock matrix.

Prior to the design of the enhanced bioremediation system, a pilot treatability study would be performed to determine chemical injection rates, buffering requirements, injection well spacing, and details of the construction of the PRBs. Existing site information and assumptions based on typical enhanced bioremediation systems and PRBs were used for the conceptual design at this stage. As part of the study, the need for bioaugmentation by the addition of microorganisms would also be evaluated. This study is estimated to last 1 year. Although some of the injection wells used for the pilot treatability study may be used as part of the final design, for the purposes of this estimate, it is assumed that none would be used.

Because of the uncertainty in the ability to distribute an oil-based ED in the bedrock fractures, a soluble ED, sodium lactate, is proposed for the initial injection in both the overburden and bedrock TTZs through grids of injection points. At each injection location, a sodium lactate solution would be injected via an injection well over the entire saturated thickness. A buffering agent, such as sodium bicarbonate, may be needed to maintain the pH in the optimum range.

The conceptual design is based on typical well spacing and estimate of chemical feed requirements based on existing data. In the overburden TTZ, the spacing of injection wells along lines perpendicular to groundwater flow would be 10 feet and the spacing between these lines would be 20 feet. A total of 1,500 lb of sodium lactate (approximately 1,800 gallon of 10 percent solution) would be injected over a targeted depth interval of approximately 2 to 17 feet bgs into a total of 42 wells in the overburden TTZ over a period of one week.

Based on the conceptual design, in the bedrock TTZ the spacing of injection wells along lines perpendicular to groundwater flow and the spacing between these lines would both be 10 feet to account for uncertainty in lateral interconnection of fractures. A total of 60 lb of sodium lactate (approximately 70 gallon of 10 percent solution) would be injected over a targeted depth interval of approximately 17 to 37 feet bgs into a total of 9 wells in the bedrock TTZ over a period of one week.

Because of the shallow depth to groundwater, surface break out of the injected solution and/or groundwater is likely to occur; therefore a slow injection rate has been assumed.

To account for any residual sources after the initial treatment with sodium lactate, an oil based ED, such as the emulsified oil product EOS, would be injected into both TTZs after 6 months and again 2 years later to replenish the organic substrates in the TTZs at half the dosage of the injected sodium lactate. A total of 15 gallons and 0.6 gallon of EOS (60 percent oil) would be injected along with sufficient dilution water into the overburden and bedrock TTZs, respectively. Following each re-injection, the results would be evaluated to determine if additional treatment is required.

Because the source area treatment would impact wetlands, the impacted areas would need to be restored or mitigated after the injection process is completed.

Component 2: Overburden Mulch PRBs

This component would be identical to Component 1 of Alternative G-4 and similar to Component 1 of Alternative G-3. In addition to the mulch PRB north of and near the EMD, one more mulch PRB would be installed at the upgradient edge of the upland north of the EMD to treat the overburden PCE plume entering the upland area (see Figure 4-5). This additional PRB would be located south of the wetland to avoid wetland impacts. As with Component 1 of Alternative G-3, it is assumed that each PRB will need to be replenished with an ED every 5 years. The PRBs would be maintained as long as concentrations in the groundwater will cause the surface water PRGs and the vapor intrusion PRGs to be exceeded.

A pilot treatability study would be performed prior to design to determine the details of the construction of the PRBs. Existing site information and assumptions based on typical PRBs were used for the conceptual design at this stage. The mulch PRBs would be installed using a one-pass trencher to the top of the bedrock. The estimated width of each mulch PRB is 2 feet, and the vertical thickness of the PRBs would be approximately 15 feet. Wells would be installed in the PRBs to allow for replenishment with an oil-based ED after the organic material in the mulch is exhausted. Excavated soil from the trenches would be allowed to drain back into the trench and then would be disposed off-site. All excavated soil will be characterized to determine the appropriate method of off-site disposal.

Monitoring wells on both sides of the mulch PRBs would be used to monitor the progress and effectiveness of treatment (see Component 3).

Disturbance to wetlands is not expected from construction of the mulch PRBs. Therefore, wetland restoration would not be needed. If a PRB is constructed in a wetland or wetland buffer zone, other construction techniques may be required.

If reducing conditions cause unacceptable mobilization of iron, manganese, or arsenic into the EMD, a contingency measure, as described in Alternative G-3 would be implemented.

Component 3: Monitoring

This component would be nearly identical to Component 2 of Alternative G-4, except that one more overburden well in the overburden TTZ and one more bedrock well in the bedrock TTZ will be included in the groundwater monitoring program and monitored for PCE, TCE, cis-1,2-DCE, VC, arsenic, iron, and manganese at the same frequency of the other wells. Monitoring wells will be located to monitor groundwater both north and south of the EMD as well as groundwater flowing into an active treatment area such as a PRB. The sediment samples would be collected at locations most likely to be impacted by the incoming groundwater that might have elevated arsenic, iron, and manganese concentrations due to the reducing conditions created by the mulch PRB. The final LTM well locations and surface water and sediment locations in the EMD will be determined during the RD phase for the selected remedy.

Component 5: Engineering Controls

This component would be the same as Component 2 of Alternative G-2. Construction of the mulch PRB near the EMD would allow for removal of the engineering controls after the upgradient portion of the overburden PCE plume is remediated.

Component 6: LUCs

This component would be identical to Component 3 of Alternative G-2. Construction of the mulch PRB at the upland edge would allow for removal of vapor intrusion LUCs in the upland area when the overburden PCE plume upgradient of the upland area is remediated.

4.2.6.2 Detailed Analysis

Overall Protection of Human Health and the Environment

Alternative G-5A would be protective of human health and the environment.

By actively removing the sources of PCE contamination, enhanced bioremediation in the TTZs would significantly reduce the source mass and the expansion of the PCE plumes in overburden and bedrock. This would significantly reduce the risk from exposure to contaminated groundwater and provide protection to future human receptors that may be exposed during intrusive activities. The enhanced bioremediation is expected to reduce or eliminate most of the contamination in the source areas, thereby improving downgradient groundwater quality and reducing impacts on the surface water over time. In addition, by intercepting the overburden PCE plume at its leading edge, the two PRBs would control the plume migration, treat groundwater to levels protective of the EMD, and reduce the concentration of

chlorinated VOCs beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Monitoring would be used to verify the continued protectiveness of the remedy by: evaluating the progress of source zone enhanced bioremediation, plume containment and passive treatment by the mulch PRBs; and detecting potential migration of contaminated groundwater so that appropriate contingency measures can be taken, if required.

Engineering controls and LUCs would ensure protection of human health and the environment during the remedial period until PRGs are met. Restricting the use of groundwater would be protective of human health and the environment by avoiding unacceptable risks of exposure to contaminated groundwater. Exposure to VOCs through vapor intrusion would be controlled by building construction methods.

Compliance with ARARs and TBCs

Alternative G-5A would eventually comply with chemical-specific ARARs and TBCs through a combination of in-situ treatment with PRBs and injections. Alternative G-5A would also comply with location- and action-specific ARARs and TBCs. The chemical-, location-, and action-specific ARARs and TBCs for Alternative G-5A are listed in Tables 4-14, 4-15, and 4-16, respectively.

Long-Term Effectiveness and Permanence

Alternative G-5A would provide long-term effectiveness and permanence.

In-situ treatment by enhanced bioremediation would effectively and permanently remove most of the contamination in the source areas. This would reduce contaminant migration and possibly reduce the duration that the PRBs must be maintained. In addition, the mulch PRB near the EMD would treat the overburden PCE plume and prevent further migration of contaminants. Groundwater flowing through the PRB near the EMD would be treated to levels protective of the EMD. The PRB at the upland edge would reduce the concentration of chlorinated VOCs beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Prior to design of the source zone treatment, a pilot-scale treatability study would need to be performed.

Monitoring the progress of enhanced bioremediation of source area groundwater and treatment by the overburden mulch PRBs would be an effective means to evaluate the progress of remediation, monitor changes in contaminant composition from biological degradation (such as vinyl chloride concentrations), and verify that no migration of COCs is occurring beyond the PRB near the EMD.

Groundwater use restrictions would effectively prevent the use of groundwater until PRGs are met. Requirements for specific construction methods would effectively prevent exposure to VOCs through vapor intrusion.

The engineering and administrative controls proposed in this alternative are considered reliable.

Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative G-5A would reduce the toxicity, mobility, and volume of groundwater COCs through in-situ treatment. In-situ enhanced bioremediation would permanently reduce PCE in groundwater in the TTZs. Passive treatment with the overburden mulch PRBs would permanently remove PCE from groundwater flowing through them. No treatment residues would be generated by this alternative other than the temporary formation of biodegradation by-products which would also be reduced over time.

Short-Term Effectiveness

Alternative G-5A would result in some short-term effects. Exposure of workers to contamination during installation of injection wells and mulch PRBs, ED injection, and groundwater and surface water sampling would be minimized by compliance with OSHA requirements including wearing of appropriate PPE and adherence to site-specific health and safety procedures. Implementation of the components would have an impact in the high contamination area as well as near the EMD. There will be a slight impact on the local community during the transport of contaminated soil from barriers to off-site disposal.

Implementation of this alternative will impact the wetland at the site. The impacted wetland must be restored and/or mitigated after the injection process is completed.

Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of injection wells and injection of EOS for enhanced bioremediation at the source areas and the installation of the mulch PRBs would be completed in approximately 6 months. The initial injection in the source areas would be followed up with re-injection of EOS after 6 months and again 2 years later over a period of approximately 2 weeks each. Replenishment of organic substrate in the PRBs by ED injection would be completed in approximately 2 weeks every 5 years after the installation of the PRBs. Monitoring and five-year reviews would be used to confirm that RAO No. 4 is met. It is estimated that the PRBs would need to be maintained for approximately 55 years. However, the contaminant concentrations in the groundwater between the two PRBs would meet PRGs in approximately 10 years, allowing for LUCs (except those for groundwater) to be lifted in that area.

The environmental footprint of each of the impact categories evaluated using SiteWiseTM is based on the normalization of the remedial alternatives considered in the FS. The results of the environmental footprint evaluation are provided in Appendix E. These evaluations are required by Navy policy and are not part of the CERCLA evaluation criteria. For Alternative G-5A, GHG emissions have a high relative impact, emitting 342 tons of CO_2e. For the criteria air pollutants, the relative impact of NO_X, SO_X, and PM_{10} emissions is high, emitting 0.54, 0.74, and 0.052 ton of NO_X, SO_X and PM_{10}, respectively. The relative use of energy for Alternative G-5A is high, utilizing 11,000 MMBTU. The total water consumption for this alternative is 276,000 gallons of water, corresponding to a high impact.

Implementability

The injection wells for source zone enhanced bioremediation and the mulch PRBs could be readily installed. However, there is uncertainty in the effectiveness of the bedrock treatment because of the difficulties in injecting and distributing the ED. There are several qualified contractors to implement the mulch barrier technology and there are many qualified contractors for installing ED injection wells and injecting the ED. Sampling and maintenance of existing monitoring wells, implementation of engineering controls and LUCs, and performance of 5-year reviews could readily be accomplished. The resources, equipment, and materials required for these activities are readily available.

Construction of a PRB in a wetland or wetland buffer zone would comply with the applicable requirements of the MassDEP regulations and SSTTDC Wetlands Protection Rules and Regulations for NAS South Weymouth.

The administrative aspects of Alternative G-5A such as LUCs for the property under the control of the Navy would be relatively simple to implement. However, if a change in ownership of the site occurs prior to completion of remediation, appropriate provisions would be incorporated into property transfer documents to ensure continued implementation of remediation, aquifer use restrictions and monitoring.

Cost

The estimated costs for Alternative G-5A are as follows:

Capital Cost:	$	1,783,000
30-Year NPW of Annual Costs:	$	2,357,000
30-Year NPW:	$	4,140,000

A detailed breakdown of the estimated costs for this alternative is provided.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternative the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-1 – NO ACTION
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	USEPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks caused by exposure to contaminants will not be addressed.
Reference Doses (RfDs)	USEPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential non-carcinogenic hazards caused by exposure to contaminants will not be addressed.
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks caused by exposure to contaminants will not be addressed.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-1 – NO ACTION
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/R-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will not meet the risk-based cleanup goals developed through the use of this guidance since potential carcinogenic risks to children caused by exposure to contaminants will not be addressed.
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	This alternative would not address risks estimated through this guidance since potential exposure to volatile organic compounds in structures would not be addressed.

TABLE 4-1

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-1 – NO ACTION
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	The No Action alternative will not achieve these criteria.
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	USEPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence will prevent exposure to COCs in surface water, and LUCs will prevent exposure to COCs in groundwater.
Reference Doses (RfDs)	USEPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence will prevent exposure to COCs in surface water, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence will prevent exposure to COCs in surface water, and LUCs will prevent exposure to COCs in groundwater.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/R-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence will prevent exposure to COCs in surface water, and LUCs will prevent exposure to COCs in groundwater.
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance and LUCs that address building design and construction methods will control exposure.

TABLE 4-2

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by monitoring. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where the background concentration is greater than the health advisory value.
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-3

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities, such as fence installation could involve fill material discharge to wetlands. If there is no practicable alternative to the discharge, any adverse impacts will be mitigated. A Least Environmentally Damaging Practicable Alternative determination to protect wetland resources and provide the best balance of addressing contaminated media within and adjacent to wetlands while minimizing both temporary and permanent alteration of wetlands and aquatic habitats on site will be made when the remedy is selected.
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plan for the fence and monitoring well installation prior to implementation.

TABLE 4-3

FEDERAL AND STATE LOCATION-SPECIFIC ARARs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) ch.,131A 321 Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during fence installation or monitoring well activities will be restored.

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
There are no federal action-specific ARARs or TBCs.				
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes,	310 Code of Massachusetts Regulations (CMR) 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste that is generated as part of this remedial action is classified as hazardous, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and to the accumulation of waste prior to off-site disposal.	Wastes generated during remedial actions that are determined to be hazardous will be handled in compliance with the substantive requirements of these regulations.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring.

TABLE 4-4

FEDERAL AND STATE ACTION-SPECIFIC ARARs – ALTERNATIVE G-2 – MONITORING, ENGINEEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Erosion and Sediment Control Guidance		To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, such as installation and maintenance of wells, will be managed to control erosion and sedimentation.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water and LUCs will prevent exposure to COCs in groundwater.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water and LUCs will prevent exposure to COCs in groundwater.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/R-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance and LUCs that address building design and construction methods will control exposure.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by monitoring. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where the background concentration is greater than the health advisory value.

TABLE 4-5

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Flood Plain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities, such as PRB installation may involve fill material discharge to wetlands. If there is no practicable alternative to the discharge, any adverse impacts will be mitigated. A Least Environmentally Damaging Practicable Alternative determination to protect wetland resources and provide the best balance of addressing contaminated media within and adjacent to wetlands while minimizing both temporary and permanent alteration of wetlands and aquatic habitats on site will be made when the remedy is selected.

TABLE 4-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (Continued)				
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plan for the fence, PRB installation, and monitoring well installation prior to implementation.
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) Ch.,131A 321 Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.

TABLE 4-6

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (Continued)				
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during fence installation, PRB installation, or monitoring well activities will be restored.

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 et seq.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data to not indicate that any wastes will be hazardous.
Underground Injection Control (UIC)	40 CFR 144,146, and 147.1100	Applicable	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of biological or chemical substance into the groundwater. In-situ treatment using bioremediation will be conducted in compliance with these standards.
Clean Water Act Section 402 -- National Pollution Discharge Elimination System (NPDES)	40 CFR 122-125, 131, 136	Applicable	Includes discharge limitations, monitoring requirements, and best management practices. Substantive requirements under NPDES are written such that state and federal ambient water quality criteria (AWQC) are met.	The standards apply to the digging of the trench and any dewatering of wetlands. The standard would apply only if there were a discharge associated with the remedial activities.

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 U.S.C § 7412 40 CFR Parts 61 and 63	Applicable	The regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive dust and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes,	310 Code of Massachusetts Regulations (CMR) 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, such as soil from PRB installation, contaminated purge water from groundwater sampling, or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Hazardous wastes generated as part of the remedial action will be handled in compliance with the requirements of these regulations.

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions involve underground injection, such as an electron donor for replenishment of PRBs. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of electron donor for replenishment of PRBs. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.

TABLE 4-7

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-3 – ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring.
Erosion and Sediment Control Guidance		To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly PRB installation and installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.
Air Pollution Control - Dust, Odor, Construction and Demolition	310 CMR 7.09	Applicable	Requires control of dust and particulate emissions from construction operations.	Water sprays and other dust suppression methods will control dust from excavation and backfill of PRBs.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, the PRB will reduce concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, the PRB will reduce concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, the PRB will reduce concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/R-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, the PRB will reduce concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance and LUCs that address building design and construction methods will control exposure.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by monitoring. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where the background concentration is greater than the health advisory value.

TABLE 4-8

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-9

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives such as PRB installation conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities, such as PRB installation may involve fill material discharge to wetlands. If there is no practicable alternative to the discharge, any adverse impacts will be mitigated. A Least Environmentally Damaging Practicable Alternative determination to protect wetland resources and provide the best balance of addressing contaminated media within and adjacent to wetlands while minimizing both temporary and permanent alteration of wetlands and aquatic habitats on site will be made when the remedy is selected.

TABLE 4-9

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (Continued)				
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plan for the fence, PRB installation, and monitoring well installation prior to implementation.
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) Ch.,131A 321; Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.

TABLE 4-9

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (Continued)				
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during fence installation, PRB installation, or monitoring well activities will be restored.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 et seq.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data to not indicate that any wastes will be hazardous.
Underground Injection Control (UIC)	40 CFR 144,146, and 147.1100	Applicable	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of biological or chemical substance into the groundwater. In-situ treatment using bioremediation will be conducted in compliance with these standards.
Clean Water Act Section 402 -- National Pollution Discharge Elimination System (NPDES)	40 CFR 122-125, 131, 136	Applicable	Includes discharge limitations, monitoring requirements, and best management practices. Substantive requirements under NPDES are written such that state and federal ambient water quality criteria (AWQC) are met.	The standards apply to the digging of the trench and any dewatering of wetlands. The standard would apply only if there were a discharge associated with the remedial activities.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 U.S.C § 7412 40 CFR Parts 61 and 63	Applicable	The regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive dust and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes,	310 Code of Massachusetts Regulations (CMR) 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, such as soil from PRB installation, contaminated purge water from groundwater sampling, or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Hazardous wastes generated as part of the remedial action will be handled in compliance with the requirements of these regulations.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions involve underground injection, such as an electron donor for replenishment of PRBs. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of electron donor for replenishment of PRBs. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.

TABLE 4-10

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-4 – TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
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WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring.
Erosion and Sediment Control Guidance		To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly PRB installation and installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.
Air Pollution Control - Dust, Odor, Construction and Demolition	310 CMR 7.09	Applicable	Requires control of dust and particulate emissions from construction operations.	Water sprays and other dust suppression methods will control dust from excavation and backfill of PRBs.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRB will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
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WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance and LUCs that address building design and construction methods will control exposure.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by monitoring. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where the background concentration is greater than the health advisory value.

TABLE 4-11

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-12

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives such as source area treatment conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities, such as source area treatment will involve fill material discharge to wetlands. If there is no practicable alternative to the discharge, any adverse impacts must be minimized and mitigated. A Least Environmentally Damaging Practicable Alternative determination to protect wetland resources and provide the best balance of addressing contaminated media within and adjacent to wetlands while minimizing both temporary and permanent alteration of wetlands and aquatic habitats on site will be made when the remedy is selected.

TABLE 4-12

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (Continued)				
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plan for the fence, source area treatment, PRB installation, and monitoring well installation prior to implementation.
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) Ch.,131A 321; Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.

TABLE 4-12

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (Continued)				
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during fence installation, source area treatment, PRB installation, or monitoring well activities will be restored.

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
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FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 et seq.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data to not indicate that any wastes will be hazardous.
Underground Injection Control (UIC)	40 CFR 144,146, and 147.1100	Applicable	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of biological or chemical substance into the groundwater. In-situ treatment using bioremediation will be conducted in compliance with these standards.
Clean Water Act Section 402 -- National Pollution Discharge Elimination System (NPDES)	40 CFR 122-125, 131, 136	Applicable	Includes discharge limitations, monitoring requirements, and best management practices. Substantive requirements under NPDES are written such that state and federal ambient water quality criteria (AWQC) are met.	The standards apply to the digging of the trench and any dewatering of wetlands. The standard would apply only if there were a discharge associated with the remedial activities.

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
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FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 U.S.C § 7412 40 CFR Parts 61 and 63	Applicable	The regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive dust and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes,	310 Code of Massachusetts Regulations (CMR) 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, such as soil cuttings from injection wells, soil from PRB installation, contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous, other than soil cuttings from wells in the source area.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Hazardous wastes generated as part of the remedial action will be handled in compliance with the requirements of these regulations.

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions that involve underground injection, such as an electron donor for bioremediation of source area. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of bioremediation agents. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.

TABLE 4-13

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-5 – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.
Erosion and Sediment Control Guidance		To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.
Air Pollution Control - Dust, Odor, Construction and Demolition	310 CMR 7.09	Applicable	Requires control of dust and particulate emissions from construction operations.	Water sprays and other dust suppression methods will control dust from excavation and backfill of PRBs.

TABLE 4-14

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5A – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Cancer Slope Factors (CSFs)	US EPA, Integrated Risk Information System	To be considered (TBC)	Guidance used to compute individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media	Used to compute the individual incremental cancer risk resulting from exposure to carcinogenic contaminants in site media. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRBs will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Reference Doses (RfDs)	US EPA, Integrated Risk Information System	TBC	Guidance used to compute human health hazard resulting from exposure to non-carcinogens in site media	Used to calculate potential non-carcinogenic hazards caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRBs will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-14

FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs AND TBCs – ALTERNATIVE G-5A – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Guidelines for Carcinogen Risk Assessment	EPA/630/p-03/001F March 2005	TBC	Guidelines for assessing cancer risk	Used to calculate potential carcinogenic risks caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRBs will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens	EPA.630/r-03/003F March 2005	TBC	Guidance for assessing cancer risks in children	Used to calculate potential carcinogenic risks to children caused by exposure to contaminants. This alternative will meet the risk-based cleanup goals developed through the use of this guidance because the fence and PRBs will prevent exposure to COCs in surface water, source area treatment and PRBs will reduce the concentrations of COCs in groundwater, and LUCs will prevent exposure to COCs in groundwater.

TABLE 4-14

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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
Draft Guidance for Evaluating Vapor Intrusion to Indoor Air Pathways from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)	EPA 530-D-02-004 November, 2002	TBC	Guidance for assessing vapor intrusion risk.	Since the future use includes structures on the site, assessment of potential vapor intrusion risks will be conducted in accordance with the guidance and LUCs that address building design and construction methods will control exposure.
Health Advisories	EPA Office of Drinking Water, EPA-822-R-04-003, January, 2004	TBC	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants which do not have chemical-specific ARARs where groundwater may be used for drinking water. The non-enforceable federal guideline Health Advisory for manganese is 0.3 mg/l.	This alternative will achieve these guidelines since non-carcinogenic risk resulting from exposure to compounds identified in the Health Advisory (e.g., manganese) will be addressed by monitoring. Land use controls will prevent short-term exposure until protective levels are reached. Would not be considered where the background concentration is greater than the health advisory value.

TABLE 4-14

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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State				
Massachusetts Contingency Plan – GW-3 Standards	310 CMR 40.0974(2)	TBC	Least protective state cleanup standards.	Risk-based PRGs will be compared to the GW-3 standards, and the GW-3 standards will be used when less than the risk-based PRGs.

TABLE 4-15

FEDERAL AND STATE LOCATION-SPECIFIC ARARs - ALTERNATIVE G-5A – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs
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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal				
Floodplain Management and Protection of Wetlands	44 Code of Federal Regulations (CFR) 9	Relevant and Appropriate	FEMA regulations that set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11990, Protection of Wetlands.	Remedial alternatives such as source area treatment conducted within federal jurisdictional wetlands will be implemented in compliance with these standards.
Clean Water Act, Section 404; Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material	33 United States Code (USC) 1344; 40 CFR 230, 231 and 33 CFR 320-323	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. If activity takes place, impacts must be minimized to the maximum extent. Controls discharges of dredged or fill material to protect aquatic ecosystems. Filling or discharge of dredged material will only occur where there is no other practicable alternative and any adverse impacts to aquatic ecosystems will be mitigated.	Remedial activities, such as source area treatment will involve fill material discharge to wetlands. If there is no practicable alternative to the discharge, any adverse impacts must be minimized and mitigated. A Least Environmentally Damaging Practicable Alternative determination to protect wetland resources and provide the best balance of addressing contaminated media within and adjacent to wetlands with minimizing both temporary and permanent alteration of wetlands and aquatic habitats on site will be made when the remedy is selected.

TABLE 4-15

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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
Federal (Continued)				
Fish and Wildlife Coordination Act	16 USC 661 et seq.,	Applicable	Enacted to protect fish and wildlife when federal actions result in the control or modification of a natural stream or body of water. Requires federal agencies to take into consideration the effect that water-related projects would have on fish and wildlife resources; to take action to prevent loss or damage to those resources; and to provide for the development and improvement of those resources.	All construction will be conducted in a manner to mitigate impacts. Actions taken will minimize adverse impacts to fish and wildlife. Relevant federal and state agencies will be contacted and allowed to review the proposed work plan for the fence, source area treatment, PRB installation, and monitoring well installation prior to implementation.
State				
Massachusetts Endangered Species Act	Massachusetts General Laws (MGL) Ch.,131A 321; Code of Massachusetts Regulations (CMR) 10.00	Applicable	Sets out authority to research, list, and protect any species deemed endangered, threatened, or of other special concern. Actions must be conducted in a manner that minimizes the effect on listed Massachusetts species.	A state-listed species of special concern (Eastern Box Turtle) has been observed at the base, but not at the SRA site. Appropriate measures will be taken during remedial actions to ensure that the species is not harmed by the alternative.

TABLE 4-15

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Requirement	Citation	Status	Synopsis	Evaluation/Action to be Taken
State (Continued)				
MA Wetlands Protection Act	310 CMR 10.00	Applicable	These regulations govern activities in freshwater wetlands, 100-year floodplains, 100-foot buffer zones beyond such areas, and 200-foot buffer zones to waterways. Regulated activities include certain types of construction and excavation activities. Performance standards are provided and include evaluating the acceptability of various activities.	Any temporary disturbance of a wetland during fence installation, source area treatment, PRB installation, or monitoring well activities will be restored.

TABLE 4-16

FEDERAL AND STATE ACTION-SPECIFIC ARARs - ALTERNATIVE G-5A – OVERBURDEN AND BEDROCK SOURCE ZONES ENHANCED BIOREMEDIATION, TWO OVERBURDEN PRBS, MONITORING, ENGINEERING CONTROLS, AND LUCs
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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal				
Resource Conservation and Recovery Act (RCRA)	42 USC § 6901 et seq.	Applicable	Federal standards used to identify, manage, and dispose of hazardous waste. Massachusetts has been delegated the authority to administer the RCRA standards through its state hazardous waste management regulations.	Specific state hazardous waste standards authorized under the Act would apply when determining whether or not a solid waste is hazardous, either by being listed or by exhibiting a hazardous characteristic, such as contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data to not indicate that any wastes will be hazardous.
Underground Injection Control (UIC)	40 CFR 144,146, and 147.1100	Applicable	These regulations address the discharge of wastes, chemicals or other substances into the subsurface. The federal UIC program designates injection wells incidental to aquifer remediation and experimental technologies as Class V wells authorized by rule that do not require a separate UIC permit. State requirements apply in this case; see 310 CMR 27.00 below.	These standards regulate the injection of biological or chemical substance into the groundwater. In-situ treatment using bioremediation will be conducted in compliance with these standards.
Clean Water Act Section 402 -- National Pollution Discharge Elimination System (NPDES)	40 CFR 122-125, 131, 136	Applicable	Includes discharge limitations, monitoring requirements, and best management practices. Substantive requirements under NPDES are written such that state and federal ambient water quality criteria (AWQC) are met.	The standards apply to the digging of the trench and any dewatering of wetlands. The standard would apply only if there were a discharge associated with the remedial activities.

TABLE 4-16

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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
Federal (Continued)				
CAA National Emission Standards for Hazardous Air Pollutants (NESHAPs)	42 U.S.C § 7412 40 CFR Parts 61 and 63	Applicable	The regulations establish emission standards for 189 hazardous air pollutants. Standards are set for fugitive dust and other release sources.	If remedial activities generate regulated air pollutants, then measures will be implemented to meet the standards.
State				
Hazardous Waste Rules for Identification and Listing of Hazardous Wastes,	310 Code of Massachusetts Regulations (CMR) 30.100	Applicable	Establish requirements for determining whether wastes are hazardous. Defines listed and characteristic hazardous wastes.	These regulations would apply when determining whether or not a solid waste generated as part of this remedial action is classified as hazardous, such as soil cuttings from injection wells, soil from PRB installation, contaminated purge water from groundwater sampling or contaminated material generated from well installation or maintenance. Existing data do not indicate that any wastes will be hazardous, other than soil cuttings from wells in the source area.
Hazardous Waste Management Rules – Requirements for Generators	310 CMR 30.300	Applicable	These regulations contain requirements for generators of hazardous waste. The regulations apply to generators of sampling waste and also apply to the accumulation of waste prior to off-site disposal.	Hazardous wastes generated as part of the remedial action will be handled in compliance with the requirements of these regulations.

TABLE 4-16

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Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Management Procedures for Remedial Wastewater and Remedial Additives	310 CMR 40.0040	Applicable	Establishes requirements and procedures for the management of remedial wastewater and/or remedial additives, and for the construction, installation, modification, operation and maintenance of treatment works for the management of remedial wastewater and/or remedial additives.	These regulations would apply to remedial actions that involve underground injection, such as an electron donor for bioremediation of source area. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.
Underground Injection Control Program	310 CMR 27.00	Applicable	The federal Underground Injection Control program under the Safe Drinking Water Act has been delegated to the Commonwealth of Massachusetts. Establishes a State Underground Injection Control Program consistent with federal requirements to protect underground sources of drinking water.	The regulations apply to remedial actions involving underground injection, including use of bioremediation agents. To ensure that the remedial action complies with the substantive requirements of these regulations, the proposed quantities to be injected will be included in the design and submitted to EPA and MassDEP for comment and concurrence and the groundwater monitoring program will assess the impact of the injected compounds.

TABLE 4-16

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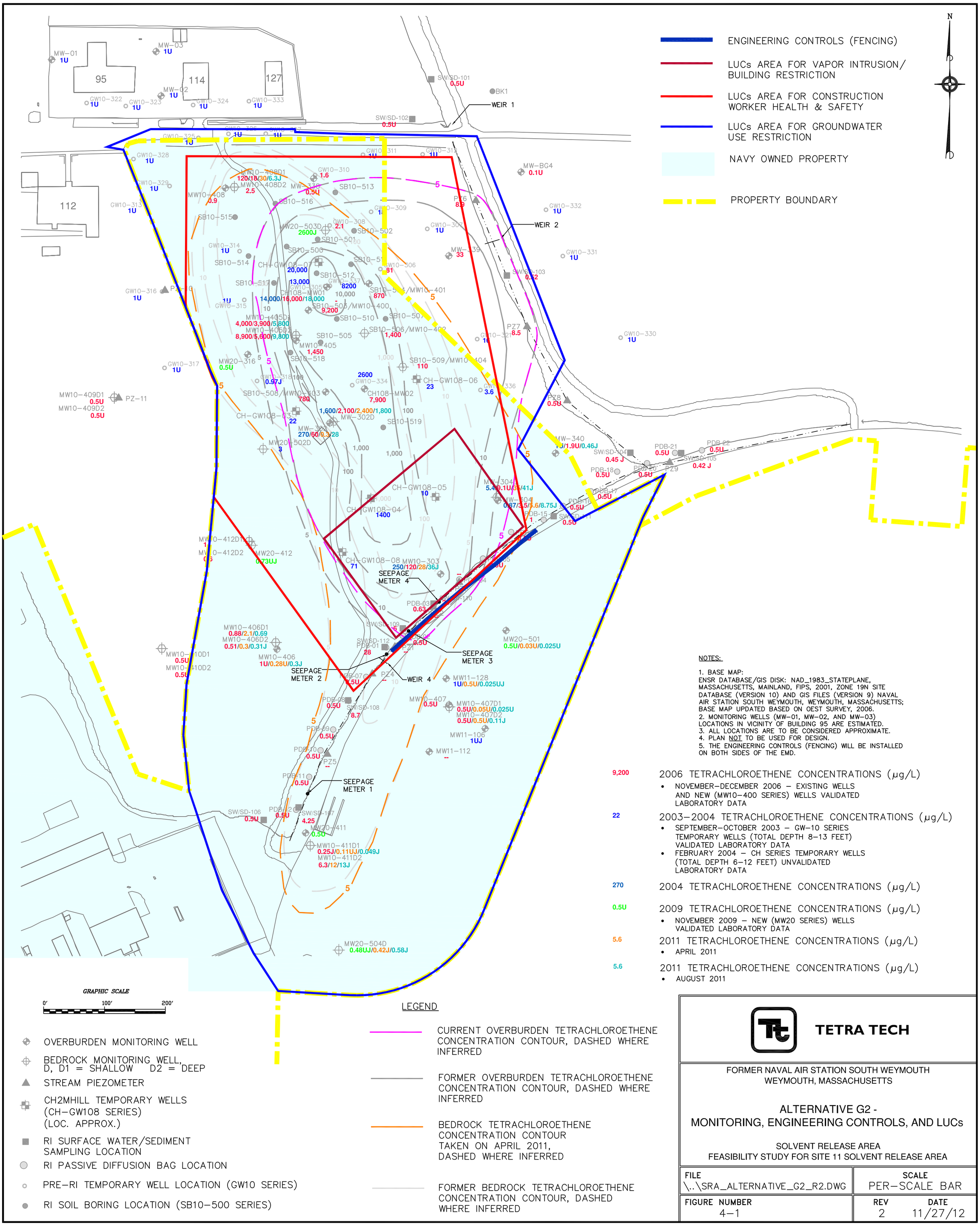
Requirement	Citation	Status	Synopsis	Evaluation/Action To Be Taken
State (Continued)				
Certification of Well Drillers and Filing of Well Completion Reports	313 CMR 3.03 (predecessor regulations); 310 CMR 46	Applicable	Requirements relating to well abandonment	Well drillers will follow all regulatory requirements for drilling and decommissioning of wells.
Standard References for Monitoring Wells	WSC-310-91 MADEP April 1991	To Be Considered	This guidance describes the technical requirements for locating, drilling, installing, sampling and decommissioning monitoring wells.	Applies to wells installed for monitoring and/or groundwater treatment.
Erosion and Sediment Control Guidance		To Be Considered	This guidance includes standards for preventing erosion and sedimentation.	Remedial actions, particularly installation and maintenance of wells and other components of the remedy, will be managed to control erosion and sedimentation.
Air Pollution Control - Dust, Odor, Construction and Demolition	310 CMR 7.09	Applicable	Requires control of dust and particulate emissions from construction operations.	Water sprays and other dust suppression methods will control dust from excavation and backfill of PRBs.



NOTES:

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3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
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9,200 — 2006 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER-DECEMBER 2006 – EXISTING WELLS AND NEW (MW10-400 SERIES) WELLS VALIDATED LABORATORY DATA

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- FEBRUARY 2004 – CH SERIES TEMPORARY WELLS (TOTAL DEPTH 6-12 FEET) UNVALIDATED LABORATORY DATA

270 — 2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)

0.5U — 2009 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER 2009 – NEW (MW20 SERIES) WELLS VALIDATED LABORATORY DATA

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- APRIL 2011

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- AUGUST 2011

LEGEND

- OVERBURDEN MONITORING WELL
- BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP
- STREAM PIEZOMETER
- CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)
- RI SURFACE WATER/SEDIMENT SAMPLING LOCATION
- RI PASSIVE DIFFUSION BAG LOCATION
- PRE-RI TEMPORARY WELL LOCATION (GW10 SERIES)
- RI SOIL BORING LOCATION (SB10-500 SERIES)

- CURRENT OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- FORMER OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR TAKEN ON APRIL 2011, DASHED WHERE INFERRED
- FORMER BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

TETRA TECH

FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

ALTERNATIVE G2 -
MONITORING, ENGINEERING CONTROLS, AND LUCs

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_ALTERNATIVE_G2_R2.DWG	PER-SCALE BAR
FIGURE NUMBER 4-1	REV 2 / DATE 11/27/12

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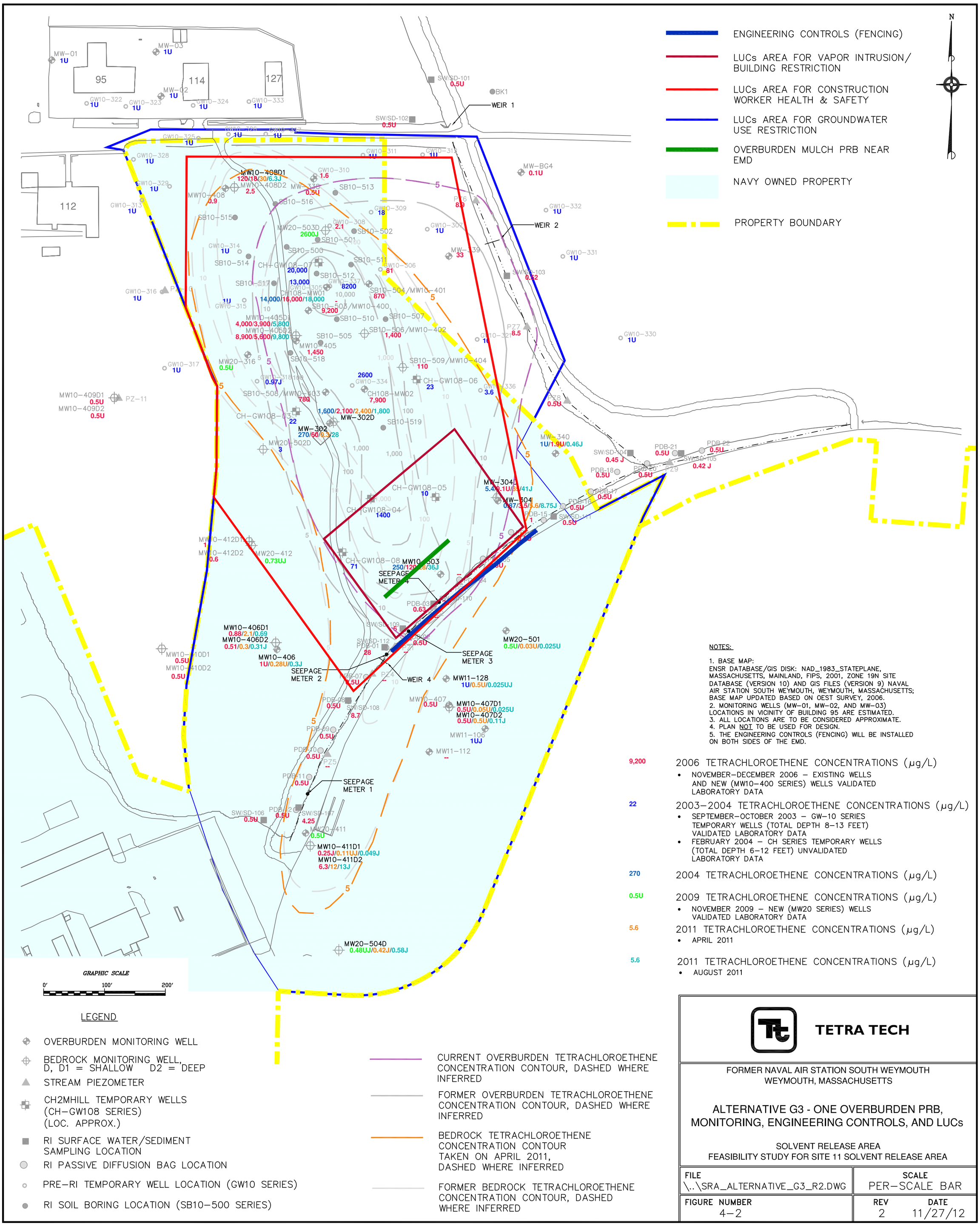
ENGINEERING CONTROLS (FENCING)
LUCs AREA FOR VAPOR INTRUSION/ BUILDING RESTRICTION
LUCs AREA FOR CONSTRUCTION WORKER HEALTH & SAFETY
LUCs AREA FOR GROUNDWATER USE RESTRICTION
OVERBURDEN MULCH PRB NEAR EMD
NAVY OWNED PROPERTY
PROPERTY BOUNDARY
N
95
114
127
112
WEIR 1
WEIR 2
WEIR 4
SEEPAGE METER 1
SEEPAGE METER 2
SEEPAGE METER 3
SEEPAGE METER 4
MW10-408D1
120/18/30/6.3J
MW10-408D2
2.5
MW10-408
0.9
MW-338
0.5U
MW20-503D
2600J
CH-GW108-07
20,000
13,000
8200
14,000/16,000/18,000
9,200
870
1,400
4,000/3,900/5,800
8,900/5,600/9,800
1,450
110
23
7,900
780
1,600/2,100/2,400/1,800
MW-302D
MW-302
270/60/0.3/28
MW20-502D
3
CH-GW108-05
10
CH-GW108-04
1400
CH-GW108-08
71
MW10-503
250/120/8/36J
MW-304D
5.4/9.1U/35/41J
MW-304
0.87/3.5/5.6/8.75J
MW-340
1U/1.9U/0.46J
MW10-412D1
1
MW10-412D2
0.6
MW20-412
0.73UJ
MW10-406D1
0.88/2.1/0.69
MW10-406D2
0.51/0.3/0.31J
MW10-406
1U/0.28U/0.3J
MW10-410D1
0.5U
MW10-410D2
0.5U
MW20-501
0.5U/0.03U/0.025U
MW11-128
1U/0.5U/0.025UJ
MW10-407
0.5U
MW10-407D1
0.5U/0.05U/0.025U
MW10-407D2
0.5U/0.5U/0.11J
MW11-106
1UJ
MW11-112
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MW20-411
0.5U
MW10-411D1
0.25J/0.11UJ/0.049J
MW10-411D2
6.3/12/13J
MW20-504D
0.48UJ/0.42J/0.58J
MW10-409D1
0.5U
MW10-409D2
0.5U
GRAPHIC SCALE
0' 100' 200'
LEGEND
OVERBURDEN MONITORING WELL
BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP
STREAM PIEZOMETER
CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)
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CURRENT OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
FORMER OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR TAKEN ON APRIL 2011, DASHED WHERE INFERRED
FORMER BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
NOTES:
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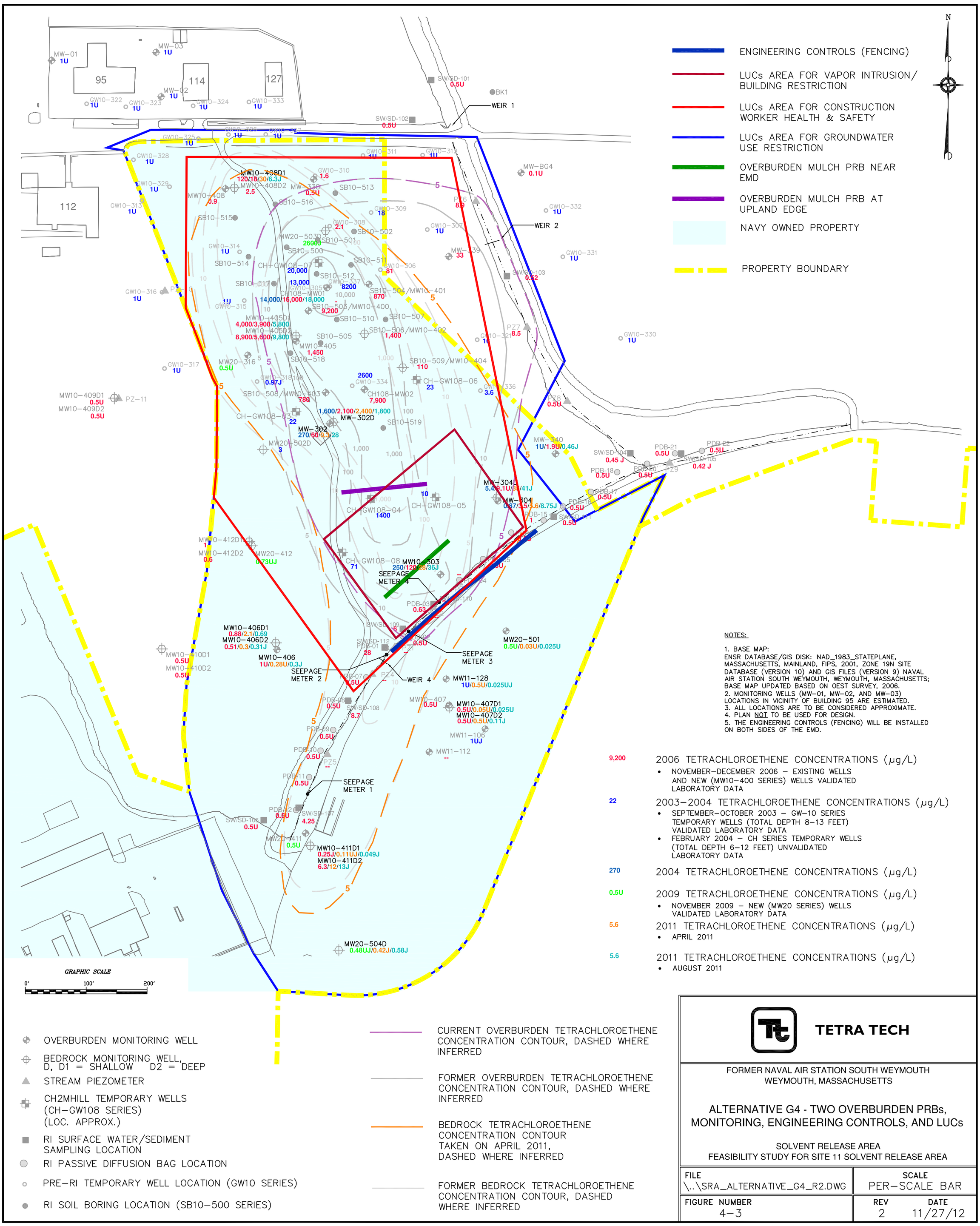
TETRA TECH
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS
ALTERNATIVE G3 - ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs
SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA
FILE \..\SRA_ALTERNATIVE_G3_R2.DWG
SCALE PER-SCALE BAR
FIGURE NUMBER 4-2
REV 2
DATE 11/27/12
ACAD: I:\02073\FS.DF.SRA\SRA_ALTERNATIVE_G3_R2.DWG 11/27/12 DWM



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OVERBURDEN MONITORING WELL

BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP

STREAM PIEZOMETER

CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)

RI SURFACE WATER/SEDIMENT SAMPLING LOCATION

RI PASSIVE DIFFUSION BAG LOCATION

PRE-RI TEMPORARY WELL LOCATION (GW10 SERIES)

RI SOIL BORING LOCATION (SB10-500 SERIES)

CURRENT OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

FORMER OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR TAKEN ON APRIL 2011, DASHED WHERE INFERRED

FORMER BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

TETRA TECH

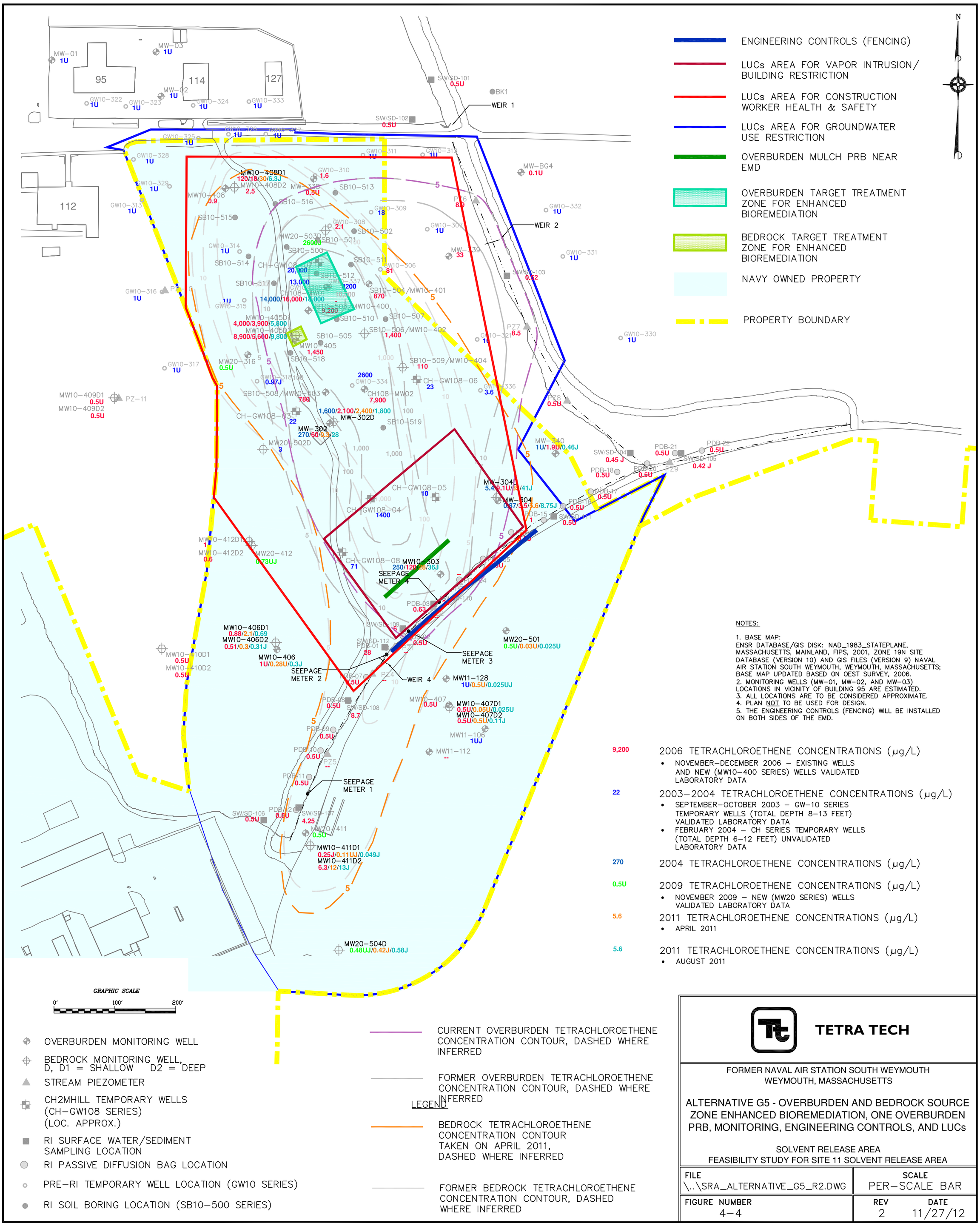
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

ALTERNATIVE G4 - TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_ALTERNATIVE_G4_R2.DWG	PER-SCALE BAR
FIGURE NUMBER 4-3	REV 2 / DATE 11/27/12

ACAD:I:\02073\FS.DF.SRA\SRA_ALTERNATIVE_G4_R2.DWG 11/27/12 DWM



NOTES:

1. BASE MAP: ENSR DATABASE/GIS DISK: NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. MONITORING WELLS (MW-01, MW-02, AND MW-03) LOCATIONS IN VICINITY OF BUILDING 95 ARE ESTIMATED.
3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
4. PLAN NOT TO BE USED FOR DESIGN.
5. THE ENGINEERING CONTROLS (FENCING) WILL BE INSTALLED ON BOTH SIDES OF THE EMD.

9,200 — 2006 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER-DECEMBER 2006 – EXISTING WELLS AND NEW (MW10-400 SERIES) WELLS VALIDATED LABORATORY DATA

22 — 2003-2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- SEPTEMBER-OCTOBER 2003 – GW-10 SERIES TEMPORARY WELLS (TOTAL DEPTH 8-13 FEET) VALIDATED LABORATORY DATA
- FEBRUARY 2004 – CH SERIES TEMPORARY WELLS (TOTAL DEPTH 6-12 FEET) UNVALIDATED LABORATORY DATA

270 — 2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)

0.5U — 2009 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER 2009 – NEW (MW20 SERIES) WELLS VALIDATED LABORATORY DATA

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- APRIL 2011

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- AUGUST 2011

TETRA TECH

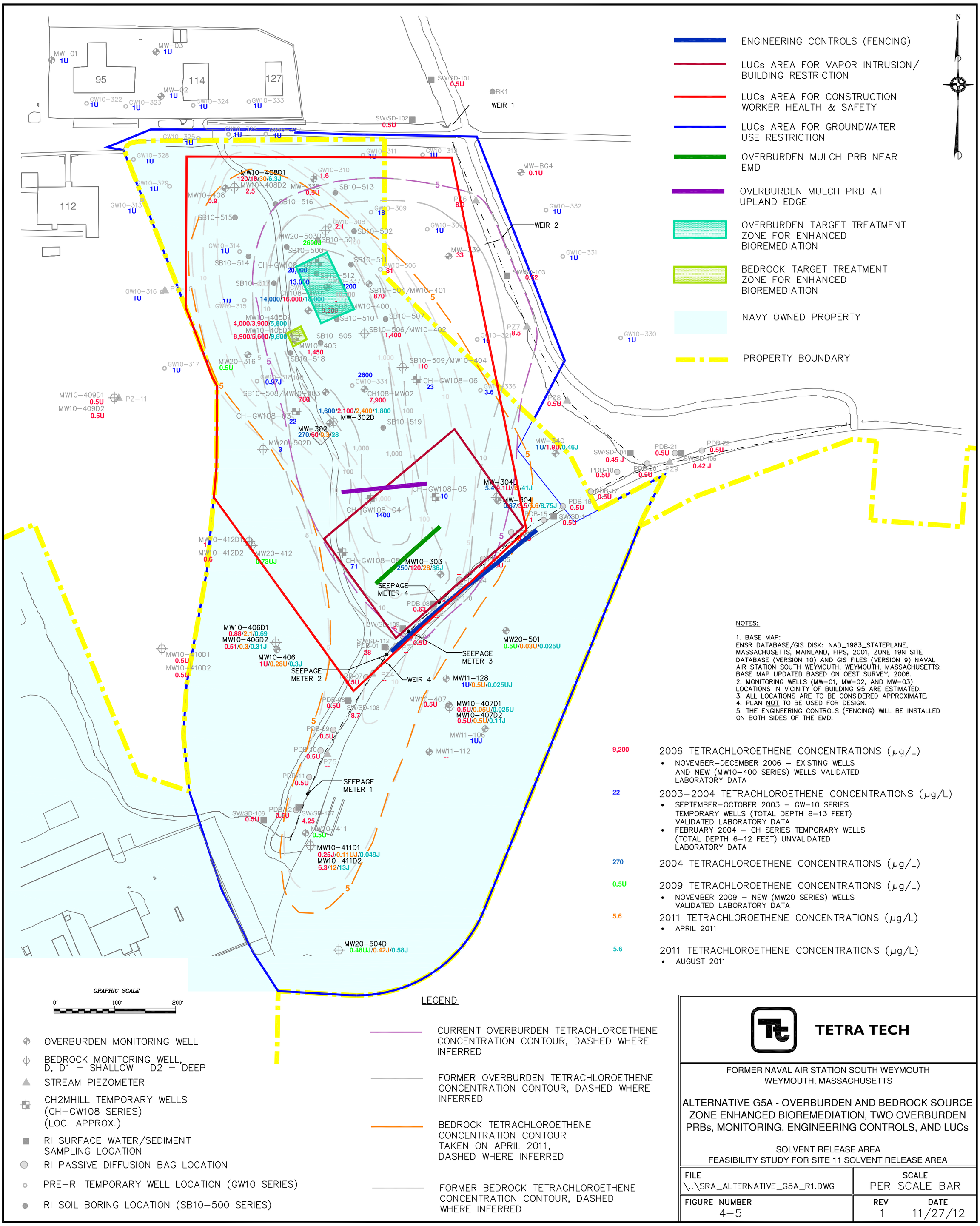
FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

ALTERNATIVE G5 - OVERBURDEN AND BEDROCK SOURCE ZONE ENHANCED BIOREMEDIATION, ONE OVERBURDEN PRB, MONITORING, ENGINEERING CONTROLS, AND LUCs

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_ALTERNATIVE_G5_R2.DWG	PER-SCALE BAR
FIGURE NUMBER 4-4	REV 2 / DATE 11/27/12

ACAD: I:\02073\FS.DF.SRA\SRA_ALTERNATIVE_G5_R2.DWG 11/27/12 DWM



NOTES:

1. BASE MAP: ENSR DATABASE/GIS DISK: NAD_1983_STATEPLANE, MASSACHUSETTS, MAINLAND, FIPS, 2001, ZONE 19N SITE DATABASE (VERSION 10) AND GIS FILES (VERSION 9) NAVAL AIR STATION SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS; BASE MAP UPDATED BASED ON OEST SURVEY, 2006.
2. MONITORING WELLS (MW-01, MW-02, AND MW-03) LOCATIONS IN VICINITY OF BUILDING 95 ARE ESTIMATED.
3. ALL LOCATIONS ARE TO BE CONSIDERED APPROXIMATE.
4. PLAN NOT TO BE USED FOR DESIGN.
5. THE ENGINEERING CONTROLS (FENCING) WILL BE INSTALLED ON BOTH SIDES OF THE EMD.

9,200 — 2006 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER–DECEMBER 2006 – EXISTING WELLS AND NEW (MW10-400 SERIES) WELLS VALIDATED LABORATORY DATA

22 — 2003–2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- SEPTEMBER–OCTOBER 2003 – GW-10 SERIES TEMPORARY WELLS (TOTAL DEPTH 8–13 FEET) VALIDATED LABORATORY DATA
- FEBRUARY 2004 – CH SERIES TEMPORARY WELLS (TOTAL DEPTH 6–12 FEET) UNVALIDATED LABORATORY DATA

270 — 2004 TETRACHLOROETHENE CONCENTRATIONS (µg/L)

0.5U — 2009 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- NOVEMBER 2009 – NEW (MW20 SERIES) WELLS VALIDATED LABORATORY DATA

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- APRIL 2011

5.6 — 2011 TETRACHLOROETHENE CONCENTRATIONS (µg/L)
- AUGUST 2011

LEGEND

- OVERBURDEN MONITORING WELL
- BEDROCK MONITORING WELL, D, D1 = SHALLOW D2 = DEEP
- STREAM PIEZOMETER
- CH2MHILL TEMPORARY WELLS (CH-GW108 SERIES) (LOC. APPROX.)
- RI SURFACE WATER/SEDIMENT SAMPLING LOCATION
- RI PASSIVE DIFFUSION BAG LOCATION
- PRE-RI TEMPORARY WELL LOCATION (GW10 SERIES)
- RI SOIL BORING LOCATION (SB10-500 SERIES)

- CURRENT OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- FORMER OVERBURDEN TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED
- BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR TAKEN ON APRIL 2011, DASHED WHERE INFERRED
- FORMER BEDROCK TETRACHLOROETHENE CONCENTRATION CONTOUR, DASHED WHERE INFERRED

TETRA TECH

FORMER NAVAL AIR STATION SOUTH WEYMOUTH
WEYMOUTH, MASSACHUSETTS

ALTERNATIVE G5A - OVERBURDEN AND BEDROCK SOURCE ZONE ENHANCED BIOREMEDIATION, TWO OVERBURDEN PRBs, MONITORING, ENGINEERING CONTROLS, AND LUCs

SOLVENT RELEASE AREA
FEASIBILITY STUDY FOR SITE 11 SOLVENT RELEASE AREA

FILE	SCALE
\..\SRA_ALTERNATIVE_G5A_R1.DWG	PER SCALE BAR
FIGURE NUMBER 4-5	REV 1 / DATE 11/27/12

ACAD:I:\02073\FS.FR.SRA\SRA_ALTERNATIVE_G5A_R1.DWG 11/27/12 DWM

5.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This section compares the analyses for each of the groundwater remedial alternatives presented in Section 4.0 of this FS. The criteria for comparison are identical to those used for the detailed analysis of individual alternatives.

5.1 COMPARISON OF GROUNDWATER REMEDIAL ALTERNATIVES BY CRITERIA

The following remedial alternatives for the SRA are compared in this section:

- Alternative G-1: No Action
- Alternative G-2: Monitoring, Engineering Controls, and LUCs
- Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs
- Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
- Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs
- Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs

5.1.1 Overall Protection of Human Health and the Environment

Alternatives G-2 through G-5A would all provide protection to human health and the environment. Engineering Controls and LUCs would provide protection of human health until PRGs are met by restricting the use of groundwater and by preventing exposure through vapor intrusion by controlling building design and construction methods. Alternative G-5A would provide the greatest protection because it treats the high-PCE concentration source areas in overburden and bedrock with enhanced bioremediation and part of the plume with two PRBs. Alternative G-5 would provide the next greatest protection because it treats the high-PCE concentration source areas in overburden and bedrock with enhanced bioremediation and part of the plume with one PRB. Alternatives G-4 and G-3 would provide the third best protection because they would contain the overburden PCE plume and passively treat it as groundwater flows through the mulch PRBs. In Alternative G-2, COCs would persist for the longest time because no treatment would be performed.

Monitoring would be effective in detecting the potential migration of the plume and presence of COCs in the EMD surface water and in evaluating the progress of the remediation.

Alternative G-1 would provide no protection of human health and the environment. The absence of engineering controls and LUCs would allow for potential receptor exposure and because no monitoring would be performed, potential migration of COCs would not be detected.

5.1.2 Compliance with ARARs and TBCs

Alternatives G-2 through G-5A would comply with location- and action-specific ARARs and TBCs.

Alternatives G-2 through G-5A would not immediately comply with chemical-specific ARARs and TBCs, but these alternatives would eventually achieve compliance as they attain PRGs through a combination of in-situ treatment and LUCs.

Alternative G-1 would not comply with chemical-specific ARARs because there would be no restrictions to exposure. Location-specific and action-specific ARARs or TBCs would not apply.

5.1.3 Long-Term Effectiveness and Permanence

Alternatives G-2 through G-5A would provide long-term effectiveness and permanence through a combination of monitoring, engineering controls, and LUCs and treatment for Alternatives G-3 through G-5A. For Alternatives G-2 through G-5A, engineering controls and LUCs could be maintained until PRGs are met. Alternatives G-5 and G-5A would provide the greatest long-term effectiveness and permanence since both overburden and bedrock groundwater will be treated. Alternative G-5A would provide slightly greater long-term effectiveness by providing treatment directly to another part of the plume with the second PRB. The second PRB would shorten the duration of the alternative and reduce the long-term operations and maintenance requirements.

Alternative G-1 would have no long-term effectiveness and permanence because there would be no LUCs to restrict site use and building construction methods, and the potential would also exist for unacceptable risk for human receptors through groundwater use and vapor intrusion. Since there would be no groundwater monitoring, migration of COCs would not be detected.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives G-3 through G-5A would achieve reductions in COC toxicity and volume through treatment.

Alternatives G-3, G-4, G-5, and G-5A would permanently remove PCE from groundwater flowing through the PRBs. In addition, Alternatives G-5 and G-5A would permanently remove PCE from groundwater in the TTZs through source area enhanced bioremediation.

Alternatives G-3 through G-5A would not generate treatment residues, although concentrations of manganese and iron may increase as a result of the reducing conditions created by the bioremediation processes.

Alternatives G-1 and G-2 would not achieve any reduction of toxicity, mobility, or volume of COCs because no treatment would occur.

5.1.5 Short-Term Effectiveness

Short-term effects of Alternatives G-2 through G-5A would result in a possibility of exposing site workers to contaminated groundwater during the maintenance and sampling of existing monitoring wells and during remedial construction and operation. Alternative G-2 would result in the lowest short-term risk, with the potential for exposure only during groundwater sampling. Alternative G-3 would have a higher potential for short term exposure with excavation of contaminated saturated soil during installation of the mulch PRB north of the EMD. Alternative G-4 would have the next higher potential short term exposure because of the installation of the second mulch PRB at the upland edge. Alternative G-5A would have the greatest potential for short-term exposure during groundwater sampling, enhanced bioremediation injection well installation, and excavation of contaminated saturated soil during construction of the mulch PRBs. Alternative G-5 would have the next greatest potential for short-term exposure during groundwater sampling, enhanced bioremediation injection well installation, and excavation of contaminated saturated soil during construction of the single mulch PRB. However, for these alternatives the risks of exposure would be effectively controlled by wearing appropriate PPE and compliance with proper site-specific health and safety procedures.

Implementation of the groundwater alternatives that have treatment components would have slight adverse impacts on the surrounding community or environment. Alternative G-3 would have the least impact due to the transport of contaminated soil from the mulch PRB for off-site disposal. Alternatives G-4 and G-5A would have the highest impacts due to transport of more contaminated soil from the second mulch PRB for off-site disposal.

Implementation of Alternatives G-5 and G-5A would result in the destruction of wetland areas that must be mitigated.

Alternatives G-2 through G-5A would achieve groundwater RAO Nos. 1 through 3 immediately upon implementation of LUCs and monitoring. Construction activities associated with Alternatives G-3, G-4, G-5, and G-5A would be completed in 1 month, 1 month, 3 months, and 4 months, respectively. For Alternatives G-3 through G-5A, replenishment of organic substrate in the PRBs by ED injection would be completed in approximately 2 weeks every 5 years after the installation of the PRBs. Monitoring and five-year reviews would be used to confirm that RAO No. 4 is met. It is estimated that the PRBs would need to be maintained for approximately 70 years under Alternatives G-3 and G-4 and for approximately 55 years under Alternatives G-5 and G-5A. The durations of Alternatives G-5 and G-5A are approximately 15 years less than the other alternatives. Under Alternative G-5A, the time to reach PRGs between the two PRBs is approximately 10 years.

Implementation of Alternative G-1 would not result in risks to site workers or adversely impact the surrounding community or environment because no remedial activities would be performed. Alternative G-1 would not achieve the RAOs.

A summary of the sustainability evaluations for each alternative is provided below. These evaluations were performed per Navy policy and are not part of the CERCLA evaluation criteria.

Alternative G-5A has the highest GHG emissions among the alternatives evaluated, emitting 342 tons of CO_2e. The impact driver for the GHG emissions for Alternative G-5A is the use of laboratory analytical services. The GHG emissions from Alternative G-4 are 315 tons of CO_2e, where laboratory analytical services is the highest driver. Alternative G-5 has the third highest GHG emissions from all alternatives, with 264 tons of CO_2e, where laboratory analytical services have the highest GHG emissions of all the activities that take place during this alternative. Alternatives G-3 and G-2 have the same highest driver for the GHG emissions, which is laboratory analytical services. The GHG emissions resulting from Alternative G-3 and G-2 are 236 tons of CO_2e and 120 tons of CO_2e, respectively.

In terms of NO_X emissions, the activity with the highest impact on this criteria pollutant for all the alternatives evaluated is the use of laboratory analytical services. Alternative G-5A has the highest amount of this pollutant emitted to the atmosphere, followed by Alternatives G-5 and G-4. The emissions of these three remedial alternatives are 0.54, 0.50, and 0.48 tons of NO_X, respectively. Alternative G-2 has the lowest NO_X emissions from all the remedial alternatives evaluated; emitting 0.4 ton of NO_X. Alternative G-3 emits 0.44 ton of NO_X.

In terms of SO_X emissions, Alternative G-2 has the lowest emissions from all the alternatives, with 0.26 ton of SO_X emitted to the atmosphere primarily due to the use of laboratory analytical services. For Alternatives G-3 and G-5, the activity with the highest contribution to SO_X emissions is the use of

laboratory analytical services during long term monitoring. The emissions for remedial alternatives G-3 and G-5 are 0.52 and 0.55 tons of SO_X, respectively. The alternative with the highest amount of SO_X is alternative G-5A, with 0.74 ton, where the production of mulch, used for revegetation purposes and the treatment barriers, is the activity with the highest SO_X emissions. Alternative G-4 has the second highest SO_X emissions of all the alternatives evaluated. The amount of SO_X emitted by Alternative G-4 is 0.74 ton, where the production of mulch is the activity with the highest SO_X emissions for this alternative.

The activities that are the primary drivers for PM_{10} emissions are the laboratory services for Alternative G-2 and the production of mulch for the other Alternatives (G-3, G-4 G-5 and G-5A). The alternative with the highest PM_{10} emissions is Alternative G-5A, emitting 0.053 ton of PM_{10}; the alternative with the lowest PM_{10} emissions is Alternative G-2, releasing 0.011 ton of PM_{10}.

Energy consumption is highest for Alternative G-5A utilizing 11,000 MMBTU. Alternatives G-4, G-5 and G-3 consume 11,000 MMBTU, 7,300 and 6,700 MMBTU, respectively. The activity that consumes the most energy for these three remedial alternatives is the production of vegetable oil, which is used as EOS for the injection treatment through the lifetime of the project. The alternative with the lowest energy consumption is Alternative G-2, where 1,600 MMBTU are consumed due to the laboratory analytical services.

The water use for Alternative G-2 is 600 gallons of water, where the production of PVC is the activity with the highest water use. For Alternatives G-3, G-4, G-5 and G-5A, the injection waters used through the treatment is the activity that consumes the most water. Alternative G-5A has the highest consumption of water (276,000 gallons of water), followed by Alternatives G-4, G-5 and G-3 (267,000 gallons, 158,000 gallons, and 149,000 gallons, respectively).

Overall, Alternatives G-5A and G-4 have the highest relative impact in most of the categories evaluated in the analysis due to the number of activities that take place during the Alternatives. Alternative G-2 has the lowest relative impact overall; the activities that take place during this alternative are related to site visits and sampling. The use of laboratory analytical services is the dominant activity for Alternative G-2 and therefore is the driver for all impact categories. Alternatives G-5 and G-3 have a moderate to high relative impact for the categories evaluated. Details of the environmental footprint evaluation can be found on Appendix E.

Because no actions would be implemented in Alternative G-1, there would be no impacts on sustainability factors.

5.1.6 Implementability

Alternative G-1 would be the easiest to implement because there would be no action taken.

Alternative G-2 would be the second easiest of the remaining alternatives to implement because of the minimal amount of field work and monitoring that would be required. Alternatives G-3 and G-4 would be the next easiest to implement, although the one-pass trenching equipment is somewhat specialized. Alternatives G-5 and G-5A would be more difficult to implement than Alternatives G-3 and G-4 because they would require installation of injection wells into the overburden and the bedrock. For Alternatives G-5 and G-5A, the implementability of injecting ED into the bedrock is uncertain. For all four alternatives, contractors and equipment are readily available.

Engineering controls and LUCs would be required until groundwater PRGs are attained for Alternatives G-2 through G-5A. For Alternatives G-3 through G-5A, construction of the mulch PRB north of the EMD would allow for removal of the engineering controls when the PCE plume upgradient of the EMD achieves the PRGs and no unacceptable risk remains. For Alternatives G-4 and G-5A, construction of the mulch PRB at the upland edge would allow for removal of vapor intrusion LUCs in the upland area when the overburden PCE plume upgradient of the upland area achieves the recreational exposure vapor intrusion PRGs and no unacceptable vapor intrusion risk remains. LUCs can be readily prepared and implemented because the Navy retains ownership of the property.

Use of the property may be affected by the implementation of the alternatives. Alternatives G-3, G-4, G-5, and G-5A would temporarily impact site use during installation of the mulch PRBs and the injection wells for enhanced bioremediation and limit permanent use of the site over and near the PRBs. The bedrock injection wells would limit the types of uses of the site for Alternatives G-5 and G-5A. However, current plans call for the area to remain open space, with little or no development.

5.1.7 Cost

The capital and O&M costs and NPW of the alternatives are as follows.

Alternative	Capital	NPW of Annual Costs	NPW
G-1	$11,000	$109,000	$120,000
G-2	$180,000	$923,000	$1,103,000
G-3	$920,000	$1,692,000	$2,612,000
G-4	$1,107,000	$2,074,000	$3,181,000
G-5	$1,615,000	$1,987,000	$3,602,000
G-5A	$1,783,000	$2,357,000	$4,140,000

Detailed cost estimates are provided in Appendix G.

Note that while the cost basis used in this FS is 30 years, based on the anticipated life cycle of the alternatives (see Appendix F) the actual anticipated cost and net present worth will be greater since monitoring will continue throughout the entire life of the remedy.

5.2 SUMMARY OF COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Table 5-1 summarizes the comparative analysis of the groundwater remedial alternatives, respectively.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: Monitoring, Engineering Controls, and LUCs	Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs	Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
Overall Protection of Human Health and Environment	Would not offer protectiveness of human health and the environment because no action would occur. Migration of chemicals of concern (COCs) would continue and remain undetected.	Would be protective of human health and the environment. Would be less protective than Alternatives G-3 through G-5A. Engineering controls and LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be less protective than Alternatives G-4, G-5, and G-5A, but more protective than Alternative G-2. Mulch PRB near the EMD would control the plume migration and treat groundwater to levels protective of the EMD. Engineering controls and LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be less protective than Alternatives G-5 and G-5A but more protective than Alternatives G-2 and G-3. The two mulch PRBs would control the plume migration, treat groundwater to levels protective of the EMD, and reduce the PCE concentration beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Engineering controls and LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be the second most protective alternative. Enhanced bioremediation in the high concentration areas would significantly reduce source mass and the plume expansion in overburden and bedrock. The mulch PRB would control the plume migration and treat groundwater to levels protective of the EMD. Engineering controls and LUCs would prevent exposure until remediation is complete.	Would be protective of human health and the environment. Would be the most protective alternative. Enhanced bioremediation in the high concentration areas would significantly reduce source mass and the plume expansion in overburden and bedrock. The two mulch PRBs would control the plume migration, treat groundwater to levels protective of the EMD, and reduce the PCE concentration beneath the upland area so that vapor intrusion LUCs can eventually be lifted on the upland portion of the site. Engineering controls and LUCs would prevent exposure until remediation is complete.
Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBCs):						
Chemical-Specific	Would not comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply	Would eventually comply
Location-Specific	Would not comply	Would comply	Would comply	Would comply	Would comply	Would comply
Action-Specific	Not applicable	Would comply	Would comply	Would comply	Would comply	Would comply

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: Monitoring, Engineering Controls, and LUCs	Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs	Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
Long-Term Effectiveness and Permanence	Would not provide long-term effectiveness and permanence because no action would occur. Contaminant reduction or migration would remain undetected because no monitoring would occur.	Would be less permanent and effective than Alternatives G-3 through G-5A. Monitoring would evaluate the change in contaminant concentrations and verify that no COC migration is occurring. Engineering controls and LUCs would prevent exposure.	Would be as permanent and effective as Alternative G-4. Mulch PRB near the EMD would treat the overburden PCE plume and prevent contaminants from further migration. Monitoring would evaluate the remediation progress and verify that no COC migration is occurring. Engineering controls and LUCs would prevent exposure.	Would be as permanent and effective as the Alternative G-3. The mulch PRBs would treat the overburden PCE plume and prevent contaminants from further migration. Monitoring would evaluate the remediation progress and verify that no COC migration is occurring. Engineering controls and LUCs would prevent exposure.	Would provide the second greatest long-term effectiveness and permanence since both overburden and bedrock groundwater will be treated. Enhanced bioremediation would remove most of the contamination in the high concentration source areas, thus reducing contaminant migration and possibly reducing the duration that the PRB must be maintained. The mulch PRB would treat the overburden PCE plume and prevent contaminants from further migration. Monitoring would evaluate the remediation progress and verify that no COC migration is occurring. Engineering controls and LUCs would prevent exposure.	Would provide the greatest long-term effectiveness and permanence since both overburden and bedrock groundwater will be treated and one more PRB would be used than Alternative G-5. Enhanced bioremediation would remove most of the contamination in the high concentration source areas, thus reducing contaminant migration and possibly reducing the duration that the PRBs must be maintained. The mulch PRBs would treat the overburden PCE plume and prevent contaminants from further migration. Would be more effective than Alternative G-5 because the second PRB provides treatment of another portion of the plume and would reduce the overall duration of treatment and O&M requirements. Monitoring would evaluate the remediation progress and verify that no COC migration is occurring. Engineering controls and LUCs would prevent exposure.
Reduction of Contaminant Toxicity, Mobility, or Volume through Treatment	Would not reduce contaminant toxicity, mobility or volume through treatment because no treatment would occur.	Would not reduce contaminant toxicity, mobility or volume through treatment because no treatment would occur.	Would permanently reduce contaminant toxicity and volume by removing PCE from groundwater flowing through the mulch PRB.	Would permanently reduce contaminant toxicity and volume by removing PCE from groundwater flowing through the mulch PRBs.	Would permanently reduce contaminant toxicity and volume by removing an estimated 1,900 pounds of PCE through enhanced bioremediation in the high concentration source areas. The mulch PRB would permanently remove PCE from groundwater flowing through it.	Would permanently reduce contaminant toxicity and volume by removing an estimated 1,900 pounds of PCE through enhanced bioremediation in the high concentration source areas. The mulch PRBs would permanently remove PCE from groundwater flowing through it.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: Monitoring, Engineering Controls, and LUCs	Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs	Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
Short-Term Effectiveness	Would not result in any short-term risk to site workers or adversely impact the surrounding community or environment because no action would occur. The Remedial Action Objectives (RAOs) would never be achieved with the implementation of this alternative.	Would result in a possibility of exposing site workers to contaminated groundwater during monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be no risk to the surrounding community or the environment. Groundwater RAOs No. 1 through No. 3 would be achieved immediately upon implementation of LUCs and monitoring. Monitoring and LUCs would need to be maintained for approximately 70 years. Lowest relative impact on sustainability.	Would result in a possibility of exposing site workers to contaminated groundwater during PRB installation, replenishment with electron donor injection, and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight impact on the surrounding community or the environment during the transport of contaminated soil from the barrier for off-site disposal. Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The PRB installation would be completed in approximately 1 month. Replenishment with electron donor injection would be completed in approximately 2 weeks every 5 years after the PRB installation. The PRB would need to be maintained for approximately 70 years. Moderate to high relative impact on sustainability.	Would result in a possibility of exposing site workers to contaminated groundwater during PRB installation, replenishment with electron donor injection, and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight impact on the surrounding community or the environment during the transport of contaminated soil from the barriers for off-site disposal. Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of PRBs would be completed in approximately 1 month. Replenishment with electron donor injection would be completed in approximately 2 weeks every 5 years after the PRB installation. The PRBs would need to be maintained approximately 70 years. Higher relative impact on sustainability than Alternatives G-2 and G-3.	Would result in a possibility of exposing site workers to contaminated groundwater during installation of injection wells and PRB, electron donor injection, and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight impact on the surrounding community or the environment during the transport of contaminated soil from the barrier for off-site disposal. Installation of injection wells in the high concentration areas would impact the wetland, which must be mitigated by constructing additional wetland area at the site. Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of injection wells and injection of electron donor for enhanced bioremediation and the installation of the PRB would be completed in approximately 3 months. The initial injection in the source areas would be followed up with re-injection of EOS after 6 months and again 2 years later over a period of approximately 2 weeks each. Replenishment of the PRB with electron donor injection would be completed in approximately 1 week every 5 years after the PRB installation. The PRB would need to be maintained for approximately 55 years. Second highest relative impact on sustainability.	Would result in a possibility of exposing site workers to contaminated groundwater during installation of injection wells and PRB, electron donor injection, and monitoring activities. This risk would be reduced through compliance with appropriate site-specific health and safety procedures. There would be a slight impact on the surrounding community or the environment during the transport of contaminated soil from the barriers for off-site disposal. Installation of injection wells in the high concentration areas would impact the wetland, which must be mitigated by constructing additional wetland area at the site. Groundwater RAO Nos. 1 through 3 would be achieved immediately upon implementation of LUCs and monitoring. The installation of injection wells and injection of electron donor for enhanced bioremediation and the installation of PRBs would be completed in approximately 4 months. The initial injection in the source areas would be followed up with re-injection of EOS after 6 months and again 2 years later over a period of approximately 2 weeks each. Replenishment of the PRBs with electron donor injection would be completed in approximately 1 week every 5 years after the PRB installation. The PRBs would need to be maintained for approximately 55 years. Highest relative impact on sustainability.

TABLE 5-1

SUMMARY OF COMPARATIVE ANALYSIS OF GROUNDWATER REMEDIAL ALTERNATIVES
SOLVENT RELEASE AREA FEASIBILITY STUDY
FORMER NAS SOUTH WEYMOUTH, WEYMOUTH, MASSACHUSETTS

Evaluation Criterion	Alternative G-1: No Action	Alternative G-2: Monitoring, Engineering Controls, and LUCs	Alternative G-3: One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-4: Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs	Alternative G-5: Overburden and Bedrock Source Zones Enhanced Bioremediation, One Overburden PRB, Monitoring, Engineering Controls, and LUCs	Alternative G-5A: Overburden and Bedrock Source Zones Enhanced Bioremediation, Two Overburden PRBs, Monitoring, Engineering Controls, and LUCs
Implementability	Technical and administrative implementation would be extremely simple because there would be no action to implement.	Easy to implement monitoring with engineering controls and LUCs.	Installation of mulch PRB is readily implementable. Easy to implement monitoring, engineering controls and LUCs. Less difficult than Alternatives G-4, G-5, and G-5A. Administrative implementation of the LUCs would be simple.	Installation of mulch PRBs is readily implementable. Easy to implement monitoring, engineering controls, and LUCs. Less difficult than Alternatives G-5 and G-5A. Administrative implementation of the LUCs would be simple.	Enhanced bioremediation in the high concentration areas and installation of the mulch PRB are readily implementable. Easy to implement monitoring, engineering controls, and monitoring is implementable. Slightly less difficult compared to Alternative G-5A. Administrative implementation of the LUCs would be simple.	Enhanced bioremediation in the high concentration areas and installation of mulch PRBs are readily implementable. Easy to implement monitoring, engineering controls, and monitoring is implementable. Most difficult alternative to implement. Administrative implementation of the LUCs would be simple.
Costs: Capital NPW of Annual Costs NPW	 $11,000 $109,000 $120,000	 $180,000 $923,000 $1,103,000	 $920,000 $1,692,000 $2,612,000	 $1,107,000 $2,074,000 $3,181,000	 $1,615,000 $1,987,000 $3,602,000	 $1,783,000 $2,357,000 $4,140,000

ARAR = Applicable or Relevant and Appropriate Requirement.
COC = Chemicals of concern.
PRB = Permeable Reactive Barrier.
RAO = Remedial Action Objective.
PCE = Tetrachloroethene.
LUC = Land use control.
NPW = Net present worth.
TBC = To be considered.

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