FINAL

ENGINEERING EVALUATION/COST ANALYSIS

NON-TIME CRITICAL REMOVAL ACTION FOR THE BUILDING 965 AREA AT PARCEL 1A DEPARTMENT OF DEFENSE HOUSING FACILITY, NOVATO, CALIFORNIA

Contract No. N68711-01-D-6009
Task Order No. 0018
DCN: BATL-6009-0018-0005

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July 2009

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EXECUTIVE SUMMARY

This Engineering Evaluation/Cost Analysis (EE/CA) presents the results of the development and evaluation of removal action alternatives for a Non-Time-Critical Removal Action (NTCRA) for remediating environmental media impacted by the former release of volatile organic compounds (VOCs) in the Building 965 Area within Public Benefit Conveyance (PBC) Parcel 1A, Department of Defense Housing Facility (DoDHF) in Novato, California. This EE/CA has been prepared consistent with the requirements in *Guidance on Conducting Non-Time-Critical Removal Actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* (U.S. Environmental Protection Agency [U.S. EPA], 1993), the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) in 40 Code of Federal Regulations (CFR) Section 300.415(b)(4)(i) (EPA, 2004), and requirements of Division 20, Chapter 6.8, of the State of California Health and Safety Code.

Building 965 is located along the western boundary of the facility within Parcel 1A between Building 960 to the north and Building 969 to the south. From the mid-1970s to the early 1990s, the DON occupied the housing facility and various support operations, including the Public Works Center (PWC). Available documentation indicated that Building 965 was located within the PWC area and was previously used to support automotive maintenance activities. Currently, the DON is seeking to transfer PBC Parcel 1A, to NUSD in cooperation with the Department of Toxic Substances Control (DTSC) Office of Military Facilities (OMF) and the School Site Program.

Site Characterization

In April 1997, an environmental baseline survey (EBS) was conducted (PRC, 1997) in which a concrete pad suspected to have been used to wash vehicles was identified south of Building 965. In October 2006, NUSD conducted a Preliminary Environmental Assessment (PEA) for Parcels 1A and 1B at DoDHF Novato. This investigation involved the collection of soil gas samples, which resulted in the detection of petroleum hydrocarbons related to gasoline fuel and gasoline additives, such as benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl tert butyl ether (MTBE). In addition to chemicals associated with petroleum hydrocarbons, six chlorinated compounds (including vinyl chloride) were detected in soil gas. Specifically, vinyl chloride was detected at one location, ESG-7 (located immediately adjacent to the southern end of Building 965), at a concentration of 740 $\mu g/m^3$. Based on this result, the DON decided further investigation was required to confirm this detection and evaluate the occurrence of VOCs in soil gas in the Building 965 Area at Parcel 1A. In August 2007, the Navy collected soil gas from 19 locations and determined that VOCs were present at levels that posed a risk to human health via the indoor air pathway. Additionally, the sampling results indicated that the highest concentrations of VOCs were centrally located underneath the wash pad. The Navy conducted an additional sampling event in May 2008 to further delineate the extent of contamination in soil gas and to determine whether residual sources of VOC mass were present in soil and groundwater.

Overall, the August 2007 and May 2008 investigation activities resulted in the detection of six chemicals in soil gas at concentrations that exceeded DTSC and/or United States Environmental Protection Agency (U.S. EPA) risk based screening levels (RBSLs), including vinyl chloride, benzene, 1,3-butadiene, cis-1,2-DCE, TCE, and ethylbenzene. Of these six chemicals, vinyl chloride and benzene were consistently detected within the study area at levels that exceed DTSC and/or U.S. EPA RBSLs; however, RBSL exceedances of the remaining chemicals were isolated (ethylbenzene, TCE, and cis-1,2-DCE) or, as is suspected to be the case with 1,3-butadiene, anomalously detected. Soil and groundwater sampling results indicated that neither medium was serving as a source of VOC mass to soil, which suggests that subsurface impacts in the study area are the results of an “old” release in which soil gas has

reached equilibrium with VOC mass in soil and groundwater. In both sampling events, the highest concentrations of VOCs in soil gas were present directly underneath the wash pad.

Risk Evaluation

A risk assessment (RA) was conducted for the Building 965 Area using the soil gas data collected by the Navy in August 2007 and May 2008. Baseline risks/hazards were calculated for a residential receptor for the vapor intrusion pathway based on the soil gas concentrations measured during the August 2007 and May 2008 investigations (see Table ES-1). Results of the RA indicated that current conditions at the site potentially pose an unacceptable risk to human receptors via the vapor intrusion pathway. Based on the spatial distribution of elevated concentrations of VOCs in soil gas, a majority of baseline risks are attributable to elevated concentrations of select VOCs in soil gas underneath the wash pad (see Table ES-1).

Table ES-1. Baseline Risks Using Maximum Soil Gas Concentrations as the Exposure Point Concentrations

Chemical	Soil Gas Maximum Concentration[(a)] ($\mu g/m^3$)	Cal-EPA Toxicity		U.S. EPA Toxicity	
		Risk	Hazard	Risk	Hazard
Vinyl Chloride	15,000	5.E-04	0.2	6.E-05	0.2
1,3-Butadiene 26	0	3.E-05	0.2	5.E-06	0.2
cis-1,2-DCE	89,000	ND	3	ND	3
Benzene 1,	300	2.E-05	0.03	6.E-06	0.03
TCE 1	3,000	1.E-05	0.03	1.E-05	0.03
Ethylbenzene 1	1,000	2.E-05	0.01	ND	0.01
1,2-DCA 1	50	2.E-06	0.0005	2.E-06	0.0005
1,2-DCP 25	0	1.E-06	0.06	1.E-06	0.06
Total		**6.E-04**	**3**	**9.E-05**	**3**

(a) Soil gas sampling depth below grade used in the J&E model was based on the depth of the sample containing the maximum concentration.

ND – not detected/not determined

Development of Removal Action Objectives

Based on the results of the RA, removal action objectives (RAOs) have been developed to effectively reduce and manage potential risks posed to a future hypothetical resident via the vapor intrusion pathway. This NTCRA is intended to serve as the final action to address site risks in the Building 965 Area at Parcel 1A, which is consistent with the RAO that has been developed to reduce and/or manage human health risk to acceptable levels.

Analysis of Removal Action Alternatives

Based on the RAOs discussed above, this report identifies and evaluates four removal alternatives based on their effectiveness at achieving RGs, implementability, and cost. The removal action for the Building 965 Area at Parcel 1A is intended to address elevated concentrations of VOCs in the subsurface so that site closure can be achieved and the property can be considered suitable for transfer. The selected removal action alternative is anticipated to be the final action at the site. This document includes a detailed evaluation of the following four removal alternatives, which have been summarized in Table ES-2:

- **Alternative 1** – No further action (as required under the NCP)
- **Alternative 2** – Institutional Controls (ICs)
- **Alternative 3** – Source area removal excavation with ICs
- **Alternative 4** – Source area removal excavation with contingency SVE and ICs

Alternative 1 is not expected to be effective due to the potential unacceptable indoor air risk based on the planned future use of the site. Alternative 2, ICs, is expected to be moderately effective because ICs are expected to limit or prevent the potential exposure of future human health receptors to VOC concentrations through the inhalation of indoor air. While ICs would limit or prevent exposure, Alternative 2 does not include active treatment to remove or degrade chemical mass from the subsurface. Alternatives 3 is also considered moderately effective because while it provides active treatment to remove the areas of highest concentrations, there is no additional action included to address residual concentrations of VOCs that could remain in the subsurface after the excavation. Alternative 4 is considered highly effective because it includes active treatment to address the area of highest concentrations along with an SVE contingency to address residual concentrations of VOCs, specifically cis-1,2-DCE, a parent compound of vinyl chloride, that may not be removed by the excavation. To date, site characterization data has indicated that the area directly underneath the wash pad contributes significantly to the overall risk at the site. The proposed removal excavation would remove this area of the subsurface, thereby significantly reducing the presence of VOCs in the environment which would result in reductions to the overall risk at the site. The ICs that have been included in Alternatives 3 and 4 would only be implemented if it was determined necessary to address residual risk remaining after the completion of active treatment.

Alternative 4 includes a contingency to conduct SVE in the event that the removal excavation does not result in sufficient risk reduction to achieve RAOs. SVE would be implemented to remove additional VOC mass from the subsurface, thereby further reducing risks at the site.

Alternative 2, ICs, is considered highly implementable because ICs can be created to limit or prevent the exposure of receptors to unacceptable concentrations of VOCs in indoor air. Alternatives 3 and 4 include excavation as a means of actively addressing the areas of highest concentrations of VOCs in the subsurface. Excavation is considered highly effective because it represents a proactive approach to reducing risk and is also a mature, proven remediation technology. In addition, Alternatives 3 and 4 include the implementation of ICs, if determined necessary to address residual risk. Alternative 4 includes a contingency to conduct SVE, which is also expected to be highly implementable because it is a mature remediation technology widely used to address elevated concentrations of VOCs in soil gas.

Alternative 4 is considered both highly effective and highly implementable and, while it is the highest cost alternative, represents a comprehensive removal action approach which has the highest likelihood of addressing site-related impacts without the need for further action. Therefore, Alternative 4,

source area removal excavation with contingency ICs and SVE, is the recommended alternative for the NTCRA in the Building 965 Area at Parcel 1A.

Table ES-2. Summary of the Detailed Analysis of Removal Action Alternatives for Parcel 1A

Alternative Description	Qualitative Ranking		
	Effectiveness	Implementability	Cost
(1) No Action – Under the no action alternative, no remedial or removal actions of any kind would be implemented. The no action alternative provides a baseline against which the other alternatives are compared.	**LOW –** This alternative involves no active treatment or control of exposure pathways. Under this alternative risks to indoor air would potentially be unacceptable if a building were constructed over the area of interest.	Not rated because no action would be taken.	There are no costs associated with this alternative.
(2) Institutional Controls – ICs are restrictive measures placed on the use of land or area to prevent or limit exposure to hazardous substances left in place at a site. For instance, at Parcel 1A, the Navy would identify and implement appropriate ICs to mitigate potential unacceptable risks under a future construction worker's scenario, and to a residential scenario via indoor air pathway. Specific ICs would be appropriately documented through an amendment to the existing Finding of Suitability to Transfer (FOST) and update to the Land Use Covenant for Parcel 1A.	**MODERATE –** ICs would be effective in limiting human exposure to contaminated media and potential pathways of concern (e.g., inhalation of indoor air). Though it is likely that ICs would be effective as a stand alone remedy, continued monitoring would be required to verify the effectiveness and ensure that all exposure pathways are effectively being controlled.	**HIGH –** The implementability is high because while there is precedent for using ICs to address vapor intrusion risks and ICs could be maintained for as long as unacceptable levels of VOCs exist in soil gas at Parcel 1A. Additional ICs would require updates to the existing FOST and the negotiation of appropriate ICs with the state Agencies for Parcel 1A.	**LOW ($15,488/year) –** The total cost for Alternative 2 includes the administrative costs associated with conducting inspections of LUC implementation as well as annual monitoring to ensure that vapor mitigation measures are effectively eliminating the indoor exposure pathway.
(3) Source Area Removal Excavation with Contingency ICs – This alternative involves excavation of the primary source area and off-site disposal along with a contingency to implement ICs (see Alternative 2) if they are determined necessary to achieve RAOs. The excavation component would entail removing contaminated soil that is co-located with elevated soil-gas concentrations using heavy equipment, and transporting the soil to a permitted off-site disposal facility.	**MODERATE –** ICs could be effective in limiting human exposure to contaminated media and potential pathways of concern (e.g., inhalation of indoor air). In addition, excavation and off-site disposal would be effective at addressing VOCs in soil-gas by removing the soils potentially serving as a source to soil-gas, and concurrently allowing elevated soil-gas concentrations to dissipate.	**HIGH –** The implementability of ICs is considered high. In addition, the technical implementability for the excavation component of this alternative is also considered high because the quantity of soil requiring excavation is relatively small. Soil excavation is a mature remediation technology and based on the available soil data, the excavated soil would most likely be classified as non-hazardous waste.	**MODERATE ($310,193) –** The total cost for Alternative 3 includes the administrative costs associated with ICs, demolition and removal of the concrete pad, excavation of approximately 900 cubic yards of soil, transportation of excavated soil, off-site disposal in a Class II Landfill, backfilling and compacting the excavation area.

Table ES-2. Summary of the Detailed Analysis of Removal Action Alternatives for Parcel 1A (Continued)

Alternative Description	Qualitative Ranking		
	Effectiveness	Implementability	Cost
(4) Source Area Removal Excavation with Soil Vapor Extraction (SVE) – This alternative involves a removal excavation of the primary source area and ICs as described in Alternative 3, but also includes SVE to remove volatile compounds from unsaturated soils outside the footprint of the excavation. SVE removes chemical mass by creating a negative pressure in the vadose zone, which results in the removal and treatment of impacted soil vapor. As the SVE system operates asymptotic mass removal is typically realized at which point system operation is either optimized or discontinued, depending on whether or not cleanup goals have been met	**HIGH** – The excavation and LUC component of this alternative would be highly effective at addressing the area of the highest concentrations of VOCs in soil gas. The effectiveness of the SVE component is highly dependant on the permeability of the vadose zone soil within the treatment area. A higher permeability is favorable because it allows soil vapor to be easily extracted and treated. The results of the preliminary sampling activities indicated that the soil underneath the concrete pad is heterogeneous, but does contain porous intervals, which suggests that SVE could be effective.	**HIGH** – The technical implementability of conducting the excavation and implementing ICs would be high. The technical implementability of the SVE component would also be high because the treatment area would be easily accessible and because most equipment required for constructing the system is generally available. The construction of an SVE system would require obtaining a discharge permit from the Bay Area Air Quality Management District and also includes rebound/performance monitoring as a necessary component of SVE implementation.	**HIGH ($486,087)** – The total cost for Alternative 4 includes the administrative costs associated with ICs, demolition and removal of the concrete pad, excavation of approximately 900 cubic yards of soil, transportation of excavated soil, off-site disposal in a Class II Landfill, backfilling and compacting the excavation area, planning, permitting, SVE well installation, system construction, pre-design testing, appropriate security provisions, noise control measures, system operation and maintenance (O&M), and performance monitoring.

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ABBREVIATIONS AND ACRONYMS

AM	action memorandum
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene and xylenes
Ca-HSC	California Health and Safety Code
Cal-EPA	California Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
COC	chain of custody
COPC	contaminant of potential concern
DCE	dichloroethene
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
DoDHF	Department of Defense Housing Facility
DON	Department of the Navy
DOT	Department of Transportation
DTSC	Department of Toxic Substances Control
EBS	environmental baseline survey
EE/CA	engineering evaluation and cost analysis
EO	Executive Order
EPC	exposure point concentration
FOST	Finding of Suitability to Transfer
HI	hazard index
HQ	hazard quotient
LUC	land use control
mph	miles per hour
MTBE	methyl tert butyl ether
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NTCRA	Non-Time Critical Removal Action
NUSD	Novato Unified School District
OMF	Office of Military Facilities
PBC	Public Benefit Conveyance
PEA	Preliminary environmental assessment
PID	photo ionization detector
PPE	personal protective equipment

PWC	Public Works Center
RA	risk assessment
RAGS	Risk Assessment Guidance for Superfund
RAO	removal action objective
RBSL	risk based screening level
RCRA	Resource Conservation and Recovery Act
RfC	reference concentration
RME	reasonable maximum exposure
RSL	regional screening level
SARA	Superfund Amendments and Reauthorization Act
STLC	soluble threshold limit concentration
SVE	soil vapor extraction
TCE	trichloroethene
TCLP	toxic characteristic leaching procedure
TPH	total petroleum hydrocarbon
TTLC	total threshold limit concentration
UCL	upper confidence limit
URF	unit risk factor
USC	United States Code
U.S. EPA	United States Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
WET	waste extraction test

Section 1.0: INTRODUCTION

1.1 Purpose and Objectives

The United States Department of the Navy (DON) will conduct a Non-Time Critical Removal Action (NTCRA) in order to respond to releases of hazardous substances at the Building 965 Area within Public Benefit Conveyance (PBC) Parcel 1A, Department of Defense Housing Facility (DoDHF) in Novato, California (herein referred to as the "Building 965 Area" or the "site"). This Engineering Evaluation and Cost Analysis (EE/CA) identifies and evaluates proposed removal action alternatives for remediating environmental media impacted by the former release of volatile organic compounds (VOCs) at the site. The United States Department of Defense (DoD) has the authority to undertake this response action pursuant to Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 United States Code (USC) §9604; 10 USC §2701, et seq.; the National Oil and Hazardous Substances Contingency Plan (NCP)(40 Code of Federal Regulations [CFR] Part 300); and Federal Executive Order (EO) 12580 as amended, and United States Environmental Protection Agency (U.S. EPA), DoD, and DON guidance. Further, this removal action is consistent, to the maximum extent practicable, with Chapter 6.8 of the California Health and Safety Code (Ca-HSC).

The NCP provides authority for the lead Federal agency to take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release where the lead federal agency determines such action is necessary based on enumerated factors (40 CFR 300.415[b][1]). U.S. EPA has categorized removal actions in three ways: emergency, time-critical, and non-time critical based on the type of situation, the urgency and threat of the release or potential release, and the subsequent timeframe in which the action must be initiated.

As stated above, the DON has decided to initiate an NTCRA in response to VOCs in environmental media in the Building 965 Area, which has been determined to pose a potentially unacceptable risk to a future hypothetical resident via the indoor air exposure pathway and the planning process will take more than 6 months.

1.2 Statutory Framework

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and NCP define removal actions to include:

> *"…the cleanup or removal of released hazardous substances from the environment, such actions as may necessarily be taken in the event of the threat of release of hazardous substances into the environment, such action as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances, the disposal of removal material, or the taking of such other actions as may be necessary to prevent, minimize or mitigate damage to the public health or welfare or to the environment, which may otherwise result from a release or threat of release."*

The U.S. EPA's Office of Solid Waste and Emergency Response (U.S. EPA, 1993) has classified removal actions into three types based on the circumstance surrounding the release or threat of release: emergency, time critical, and non-time critical.

The DON is the lead federal agency for the removal action. As such, the DON has final approval authority, with state concurrence, over the recommended alternative and all public participation activities. The DON is working in cooperation with California Environmental Protection Agency (Cal-EPA) Department of Toxic Substances Control (DTSC) and the San Francisco Bay Area Regional Water Quality Control Board (Water Board), as well as the public in the implementation of this removal action. This EE/CA complies with the requirements of CERCLA, Superfund Amendments and Reauthorization Act (SARA), NCP at 40 Code of Federal Regulations (CFR) Part 300, Defense Environmental Restoration Program (DERP) at 10 USC §2701, et seq., and EO No. 12580.

This removal action has been determined to be appropriate because factors under 40 CFR § 300.415(b)(2)(i) and (iv) apply:

i) Actual or potential exposure to nearby human populations, animals, or the food chain from hazardous substances or pollutants or contaminants.

iv) High levels of hazardous substances or pollutants or contaminants in soils largely at or near the surface that may leach to groundwater.

1.3 Report Organization

This report is organized into the following sections: Section 2.0 describes the site conditions and provides a discussion of background information; Section 3.0 presents an overview of site characterization activities conducted by the DON in August 2007 and May 2008; Section 4.0 presents a risk evaluation that has been conducted based on the results of site characterization activities; Section 5.0 identifies removal action objectives (RAOs) and discusses applicable and relevant and appropriate requirements (ARARs) for the proposed removal action; Section 6.0 presents the identification and analysis of removal action alternatives by addressing the effectiveness, implementability, and cost of each alternative evaluated; Section 7.0 presents a comparative analysis of the removal action alternatives; and, Section 8.0 provides a list of references. The proposed action will be selected based on the analysis conducted as part of this EE/CA and will be specified in the Action Memorandum (AM) for the Building 965 Area at Parcel 1A. Seven appendices have been included to support this EE/CA, and are as follows:

- **Appendix A** provides a detailed discussion of ARARs for this removal action;
- **Appendix B** presents boring logs, soil gas probe construction diagrams, and sampling logs for the site characterization activities conducted in May 2008;
- **Appendix C** presents chain of custody (COC) forms for samples collected in May 2008;
- **Appendix D** provides a summary of all soil, groundwater, and soil gas results from site characterization activities (both August 2007 and May 2008 sampling) as well as analytical laboratory reports for samples collected in May 2008;
- **Appendix E** presents data validation results for samples collected in May 2008;
- **Appendix F** presents a detailed overview of the human health risk assessment;
- **Appendix G** provides cost information for selected technologies evaluated for the removal action; and
- **Appendix H** includes a white paper by Air Toxics, Ltd. describing anomalies associated with 1,3-butadiene detected in soil gas samples at sites where vapor intrusion is a concern.

Section 2.0: SITE CONDITIONS AND BACKGROUND

DoDHF Novato comprises approximately 13 acres with dimensions of approximately 1,100 ft by 500 ft bounded on the south by Main Entrance Road and on the north by railroad tracks operated by the Golden Gate Bridge, Highway, and Transportation District. The eastern boarder of the facility runs north-south from the intersection of Main Entrance Road and C Street, and the western border runs north-south approximately 500 ft west of the intersection of Main Entrance Road and C Street. Building 965 is located along the western boundary of the facility within Parcel 1A between Building 960 to the north and Building 969 to the south. From the mid-1970s to the early 1990s, the DON occupied the housing facility and various support operations, including the Public Works Center (PWC). Available documentation indicated that Building 965 was located within the PWC area and was previously used to support automotive maintenance activities. Currently, the DON is seeking to transfer remaining PBC Parcels, including Parcel 1A, to Novato Unified School District (NUSD) in cooperation with the DTSC Office of Military Facilities (OMF) and the School Site Program.

2.1 Physical Location

DoDHF Novato is located approximately 20 miles north of San Francisco, in Marin County, California (Figure 2-1). The facility is approximately 9,400 ft west of San Pablo Bay. Lanham Village is a residential housing area adjacent to DoDHF Novato, with its nearest structure being approximately 110 ft west of Building 965. In addition, a daycare and youth center are located approximately 540 ft southeast of Building 965. Figure 2-2 depicts the NTCRA work area in relation to nearby site features.

2.2 Site Characteristics

Currently, DoDHF Novato is scheduled for transfer of ownership under the Navy Base Realignment and Closure (BRAC) program. Portions of the facility have already been sold or transferred. Parcel 1A, which contains Building 965, is not used for any military or civilian activity at this time; however, the parcel is planned to be transferred to the NUSD in the near future for yet to be determined uses. Primary activities at DoDHF Novato include groundwater monitoring associated with ongoing groundwater cleanup activities at former underground storage tank (UST) Site 957/970.

2.2.1 Meteorology and Climate. The majority of precipitation at DoDHF Novato occurs between October and April, with the average annual rainfall being approximately 20 to 22 inches (National Oceanic and Atmospheric Administration [NOAA], 2005). Precipitation either returns to the atmosphere via evapotranspiration, runs off into Pacheco Creek and eventually into San Pablo Bay, or infiltrates into the subsurface and groundwater underlying the site. The daily high temperature averages approximately 62°F from November through April and approximately 78°F from May through October. The annual median daily high temperature is approximately 70°F. Freezing temperatures are generally never experienced and frozen precipitation is very rare. The dominant wind direction in the area is from the west or west northwest, with average annual wind speeds of approximately 10 miles per hour (mph).

2.2.2 Surface Water Hydrology. Pacheco Creek is the nearest surface water feature to the facility and is located approximately 800 ft to the northwest. The creek flows to the north along the western boarder of the facility in a subsurface culvert starting from Main Entrance Road and ending at the railroad tracks. Analytical results have indicated that groundwater does not enter the creek along the subsurface culvert. Therefore, the culvert does not serve as a preferential flow path for groundwater. At the railroad tracks, the creek surfaces and flows to the north northwest into Pacheco Pond and eventually into San Pablo Bay. Overall, higher flowrates are typically observed in Pacheco Creek during the winter months

(i.e., the wet season between October and April) compared to the summer months indicating that the creek is recharged by storm water runoff during and following rainfall events.

2.2.3 Geology and Hydrogeology. The site geology is Late Pleisocene to Holocene unconsolidated alluvial materials (i.e., sands, silts, gravels, and clays) encountered in varying portions and depths eroded from the Mendocino Range, located to the west of DoDHF Novato. Bedrock is encountered approximately 15 ft below ground surface (bgs) but increases in depth towards the north. The bedrock underlying the site is significantly less permeable than the alluvial materials and acts to enhance lateral groundwater flow within the alluvium and prohibit downward flow. Depth to groundwater is approximately 10 ft bgs, with some seasonal fluctuations observed throughout the year. The direction of groundwater flow is towards the north at approximately 100 ft per year.

2.2.4 Ecology. The area around Building 965 is covered by concrete and asphalt and, in general, does not contain adequate ecological habitat and is not considered an ecologically sensitive area. There are no known endangered or rare species of plants or animals in the area of Building 965 that could be affected by the proposed NTCRA.

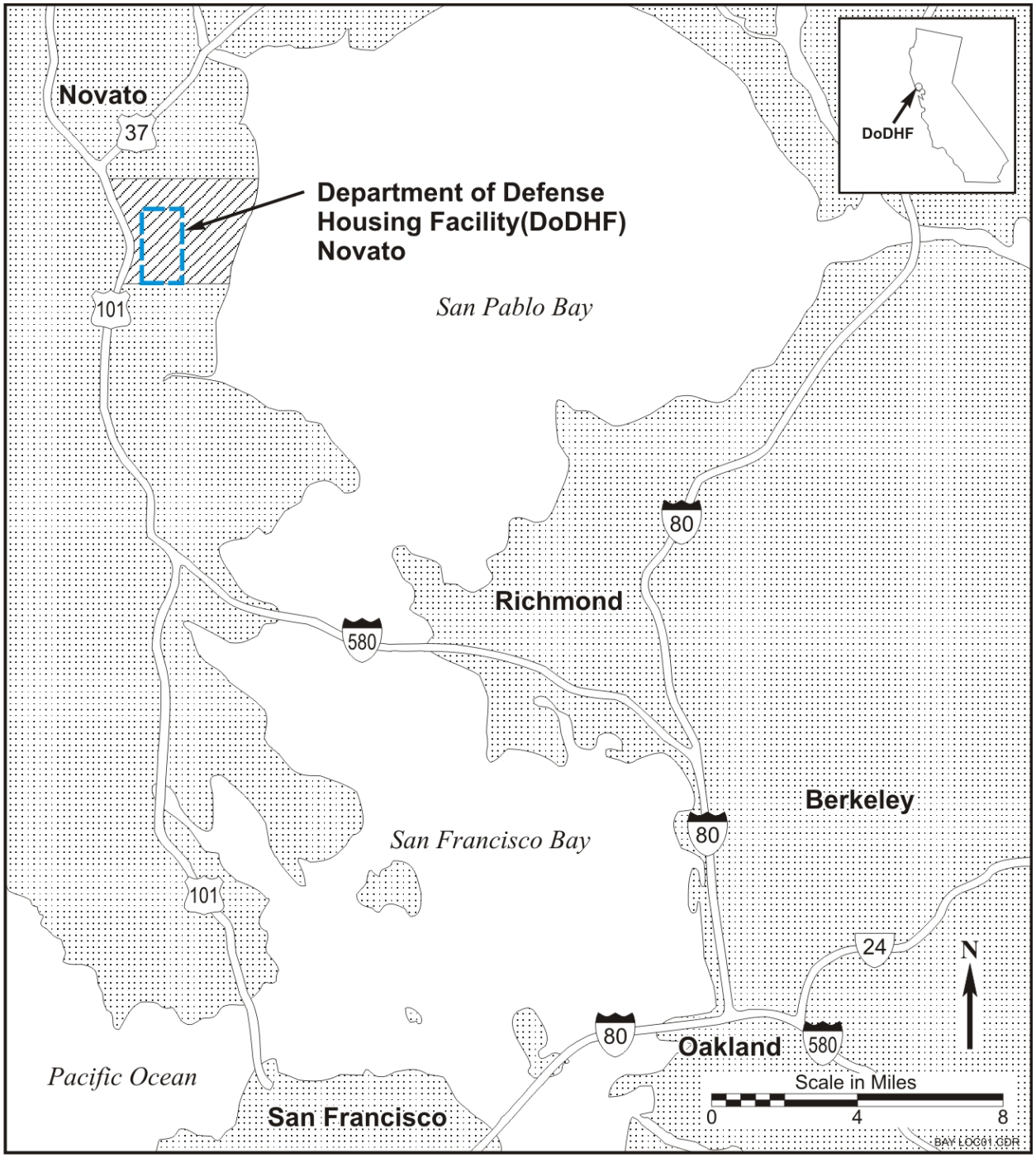


Figure 2-1. Location Map of DoDHF Novato, California

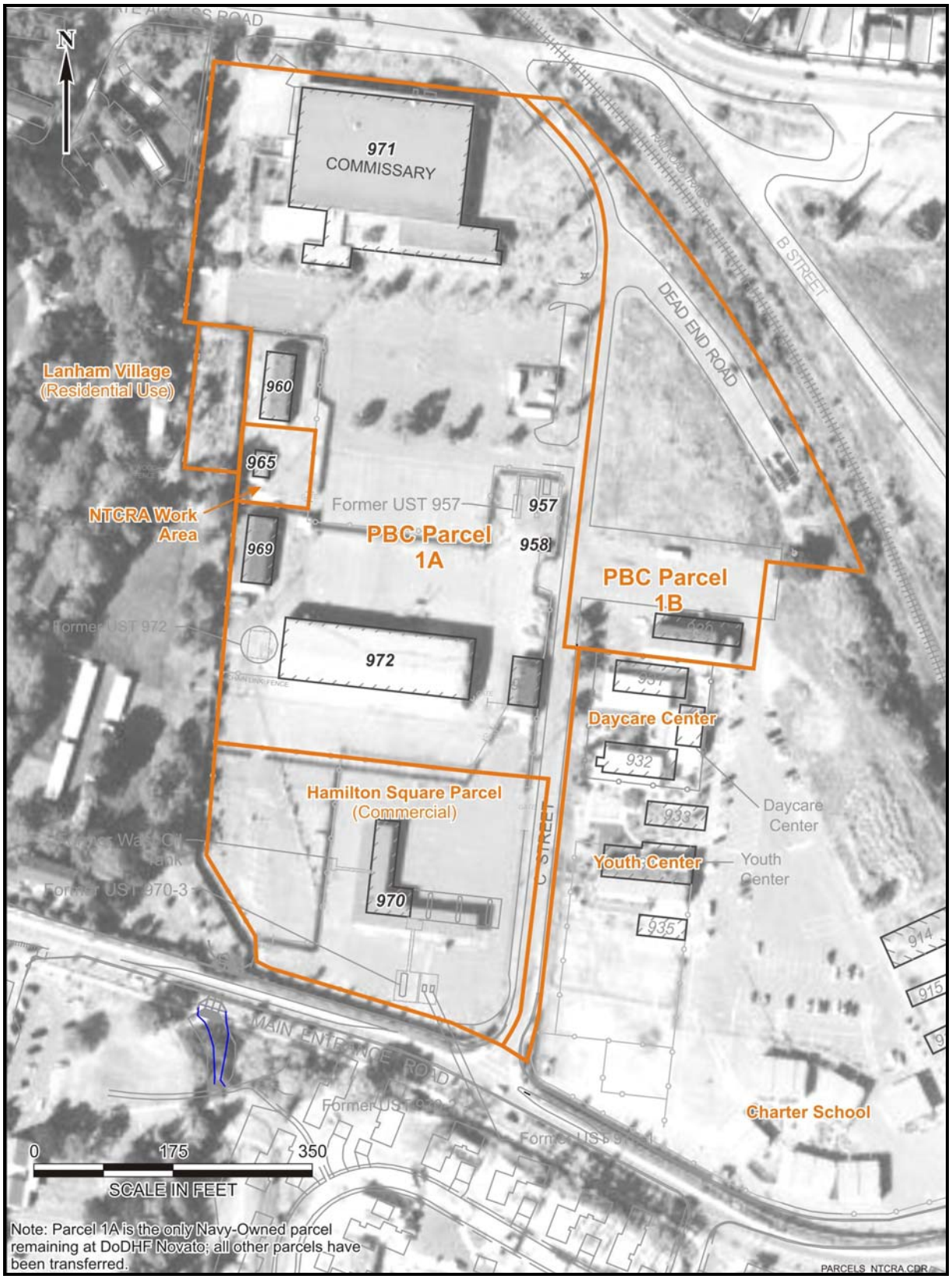


Figure 2-2. Depiction of the Non-Time Critical Removal Action Work Area in Relation to Nearby Site Features

Section 3.0: BUILDING 965 SITE CHARACTERIZATION

Historically, the Building 965 Area was initially investigated as part of the Environmental Baseline Survey (EBS) conducted by the Navy in April 1997. In October 2006, NUSD conducted a Preliminary Environmental Assessment (PEA) which included the collection of a single soil gas sample (ESG-7) in between the wash pad and Building 965, where vinyl chloride was detected at elevated concentrations. Recently, the Navy conducted an independent investigation of soil gas in the area of Building 965 to confirm the detection of vinyl chloride at ESG-7 and to delineate the extent of chlorinated VOCs in soil gas adjacent to Building 965. This initial Building 965 area specific VOC investigation was conducted in August 2007 to confirm the local results observed during the PEA and delineate the extent of VOC impacts in soil gas, if they were determined to be present. The results of the August 2007 VOC investigation confirmed the results of the NUSD's PEA at sample ESG-7, and successfully delineated the extent of vinyl chloride in shallow soil gas (i.e., above 5 ft bgs). In order to evaluate the potential soil gas impacts in the deeper portion of the vadose zone (i.e., below 5 ft bgs) and determine whether soil or groundwater may be serving as a source of VOC mass to soil gas, the Navy conducted an additional investigation in May 2008. The following sections summarize the results of the August 2007 VOC investigation and the May 2008 preliminary sampling event.

3.1 Historical Investigations in Parcel 1A

The following section presents a summary of historical parcel wide soil gas investigations that include the Building 965 Area.

Environmental Baseline Survey. In April 1997, an EBS was conducted for DoDHF Novato (PRC, 1997). The EBS states that Building 965 was most recently used as a housing maintenance shop for automobile maintenance activities. A concrete pad was identified south of Building 965 and is suspected to have been used to wash vehicles and equipment. As part of the screening level sampling program, three soil samples were collected from the Building 965 Area at depths ranging from 1 to 10 ft bgs. The samples were analyzed for metals, total petroleum hydrocarbons (TPH), and VOCs. The maximum concentration of TPH-motor oil detected in the soil was 510 mg/kg. None of the samples exceeded final screening criteria for metals. One soil sample contained low levels of acetone (at 0.08 mg/kg), which is a common laboratory contaminant. No other VOCs were detected in the three soil samples and as a result, no additional investigations were planned for the area. Based on the information known about the site, historical vehicle maintenance and washing operations in the vicinity of Building 965 is likely responsible for concentrations of petroleum hydrocarbons and chlorinated VOCs present in soil gas (PRC, 1997).

Novato Unified School District Study. In October 2006, the NUSD conducted a PEA for Parcels 1A and 1B at DoDHF Novato. The environmental consultant to NUSD collected 21 soil gas samples from 11 borings (Figure 3-1). Soil gas analytical results indicated the presence of 28 different VOCs in the samples (Table 3-1). The majority of these VOCs are petroleum hydrocarbons related to gasoline fuel and gasoline additives, such as benzene, toluene, ethylbenzene, and xylenes (BTEX) and methyl tert butyl ether (MTBE). However, six chlorinated compounds, including vinyl chloride, were detected at several sampling locations. Specifically, vinyl chloride was detected at ESG-7, which is located immediately adjacent to the southern end of Building 965, at a concentration of 740 $\mu g/m^3$. Based on this result, the DON decided further investigation was required to confirm this detection and evaluate the occurrence and nature of VOCs in soil gas in the Building 965 Area at Parcel 1A.

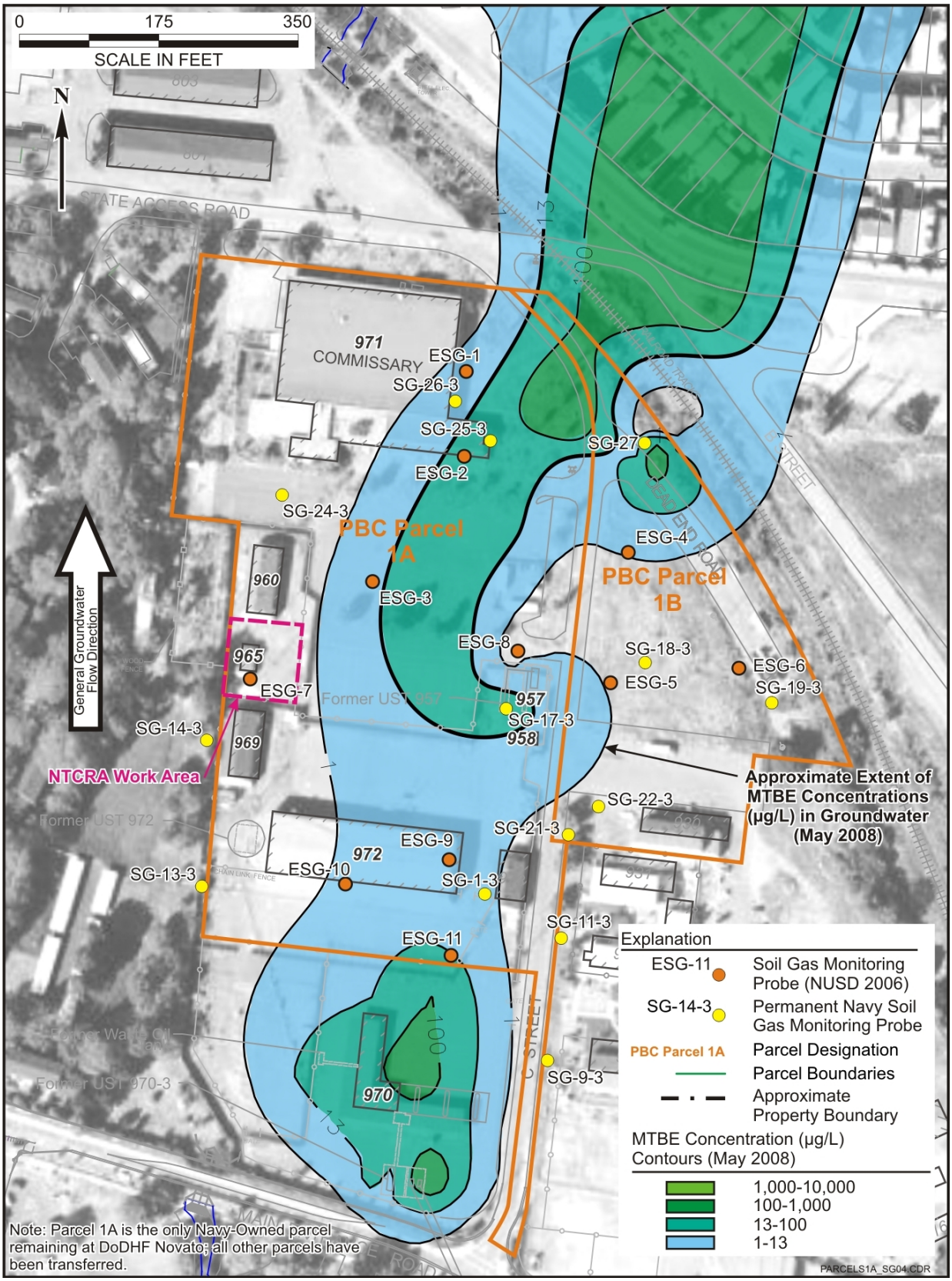


Figure 3-1. Historic Soil Gas Sampling Locations

Table 3-1. Summary of the Results of the NUSD Soil Gas Investigation

Chemical	Detection Frequency	Concentration Range (µg/m^3)		Average Detected Concentration (µg/m^3)
		Maximum	Minimum	
Acetone 9	5%	580	64	238
alpha-Chlorotoluene 5%		15	15	15
Benzene 67	%	140	4.8	27
Bromoform 5%		23	23	23
1,3-Butadiene 57	%	24	3.9	11
2-Butanone 95	%	85	7.4	30
Cyclohexane 7	1%	35,000	4.1	2,749
cis-1,2-Dichloroethene 24	%	410	5.1	150
trans-1,2-Dichloroethene 10	%	67	44	56
Carbon Disulfide	33%	18	4	9
Chloroethane 5%		1,800	1,800	1,800
Ethanol 67	%	150	7.4	38
Ethyl Benzene	76%	38	6.6	17
4-Ethyltoluene 62	%	40	6.2	17
Heptane 81	%	9,700	6.4	678
Hexane 9	0%	19,000	4.7	1,366
Methyl tert-butyl ether	52%	200,000	3.1	18,726
2-Proponal 10	%	17	11	14
Propylbenzene 5%		10	10	10
Tetrahydrofuran 38	%	6.2	2.6	4
Toluene 90	%	220	20	62
Trichloroethene 14	%	98	50	81
1,3,5-Trimethylbenzene 19	%	9.3	6.1	7
1,2,4-Trimethylbenzene 57	%	25	5.8	16
2,2,4-Trimethylpentane 1	00%	210,000	7.2	11,060
Vinyl Chloride	14%	740	4.9	372
m,p-Xylene 81	%	140	20	62
o-Xylene 71	%	36	6.2	20

3.2 August 2007 VOC Investigation

As shown in Figure 3-1, ESG-7, which is the location where vinyl chloride was detected at concentrations exceeding soil gas screening values, is located at the southern end of Building 965. This location coincides with a suspected former wash pad that was initially identified during the EBS (PRC, 1997) and later during a site walk conducted on June 13, 2007. Based on the available information, the study area for the additional VOC investigation was generally determined to consist of the area surrounding Building 965 and the suspected former wash pad located south of Building 965, within the fenced PWC maintenance area.

Navy VOC investigation activities were conducted from August 27, 2007 through August 29, 2007 and consisted of collecting 20 shallow soil gas samples (i.e., 3 to 5 ft bgs) in the vicinity of the suspected wash pad adjacent to Building 965 (Battelle, 2007). The Final VOC Investigation Summary Report (Battelle, 2008a) presented the results of this investigation during which, 20 chemicals were detected in shallow soil gas surrounding Building 965. All detected chemicals were associated with petroleum products or chlorinated solvents, which is consistent with the suspected historical activities at the site. Table 1 of Appendix D provides a summary of detectable concentrations of VOCs from the 20 shallow soil gas locations that were sampled along with the screening levels for each chemical.

Of the 14 petroleum-related compounds detected in soil gas, only benzene, 1,3-butadiene and ethylbenzene were detected above either the DTSC or U.S. EPA risk based screening levels (RBSLs) for the vapor intrusion pathway (refer to Table 1 in Appendix D). Of the six chlorinated solvent-related compounds detected in soil gas, vinyl chloride, trichloroethene (TCE), and cis-1,2-dichloroethene (cis-1,2-DCE) were detected above either the DTSC or U.S. EPA RBSLs for the vapor intrusion pathway (see Figure 3-2).

Soil gas results indicated that the highest concentrations of VOCs in soil gas were detected at SG-1A-4 (refer to Table 1 of Appendix D), which was centrally located underneath the wash pad. Based on these results, shallow and deep soil samples were collected directly adjacent to SG-1A-4 to determine whether VOCs were present in soil, and if so, at what depth intervals. As shown in Table 2 of Appendix D, 11 VOCs were detected in the shallow soil sample while only cis-1,2-DCE was detected in the deeper soil sample (and at a much lower concentration compared to the shallow soil sample).

In August 2007 groundwater sampling was attempted at three locations but samples could only be collected from two due to relatively tight, impermeable subsurface conditions that resulted in low yield. Groundwater was successfully collected from a temporary well installed at SG-1A-18 and from an existing monitoring well, MW-2D, which is positioned approximately 90 ft downgradient of SG-1A-4 (see Figure 3-5). Both of these sampling points were optimally located to detect VOCs in groundwater if they were present and migrating downgradient from the suspected source area underneath the wash pad; however, no VOCs were detected at either groundwater sampling location during the investigation (see Table 3 of Appendix D).

3.3 May 2008 Preliminary Sampling

Based on uncertainties associated with the August 2007 VOC investigation and requests from DTSC, the Navy conducted additional sampling to supplement the existing data. Four specific data needs were identified prior to conducting the investigation, which included (1) further investigation of potential impacts to groundwater, (2) vertical delineation of impacts to soil gas, (3) identification of residual sources of VOC mass in the subsurface, and (4) obtaining location-specific input parameters for the Johnson and Ettinger indoor air model (Battelle, 2008b).

In order to address these data needs, a phased sampling approach was implemented to ensure that the objectives of preliminary sampling activities were achieved. Preliminary sampling field activities occurred in May 2008 and involved collecting groundwater, soil, and soil gas samples from six locations (PS-1A-1, PS-1A-2, PS-1A-3, PS-1A-5, PS-1A-6, PS-1A-7), and only soil gas at 2 locations (PS-1A-8 and PS-1A-9) (see Figures 3-2, 3-5, and 3-7). At each of the first six locations, a Geoprobe® was used to collect samples from two adjacent boreholes. The first borehole was advanced using continuous coring techniques. At each location, a geologic profile was logged, head space testing was conducted, and a temporary monitoring well was installed. Previous attempts to collect soil gas within the deeper portion of the vadose zone (i.e., 5 ft bgs and below) were unsuccessful, which was likely attributable to the presence of impermeable clays and silts. Therefore, in order to maximize the likelihood of collecting soil gas from the deeper portion of the vadose zone, the results of the geologic profile were used to determine the depth intervals coinciding with porous intervals at which permanent soil gas monitoring probes were installed. Additionally, the headspace testing results were used to determine the depth locations at which the highest concentrations of VOCs would be expected, which were assumed to correspond to the intervals exhibiting the highest photo ionization detector (PID) response during the headspace test. Lastly, physical properties were analyzed in two soil cores, one collected from a sandy/gravelly interval and the other collected from a clayey interval. The results of preliminary sampling activities have been summarized in Section 3.4.

3.4 Nature and Extent of VOCs in Soil Gas

Six chemicals were detected in soil gas at concentrations that exceeded DTSC and/or U.S. EPA RBSLs during soil gas sampling conducted in August 2007 and May 2008, including vinyl chloride, benzene, 1,3-butadiene, cis-1,2-DCE, TCE, and ethylbenzene. Of these six chemicals, vinyl chloride and benzene were consistently detected within the study area at levels that exceed DTSC and/or U.S. EPA RBSLs; however, RBSL exceedances of the remaining chemicals were isolated (ethylbenzene, TCE, and cis-1,2-DCE); 1,3-butadiene was not detected at elevated levels. During the 2007 sampling event, the mobile lab results were questionable regarding 1,3-butadiene. More precise measurements from the 2008 samples confirmed that the previous detections were anomalies. Elevated detections of benzene and ethylbenzene in soil gas are expected based on the known petroleum releases that are being addressed as part of the corrective action at UST Site 957/970, however, the detection of elevated concentrations of chlorinated solvents (TCE, cis-1,2-DCE, and vinyl chloride) had not been observed in the past and are also likely associated with historic operations in the immediate vicinity of Building 965. The extent of these chemicals in soil gas is discussed in detail below.

Vinyl Chloride. As was previously discussed, vinyl chloride represents one of the more widespread VOCs present in soil gas. As shown in Figure 3-2, the highest concentrations were present in soil gas directly underneath the former wash pad, where vinyl chloride concentrations were detected in SG-1A-4 (3.5 ft bgs) at 14,000 $\mu g/m^3$ and PS-1A-1 at 7,800 $\mu g/m^3$ in the shallow sample (3 to 3.5 ft bgs) and 15,000 $\mu g/m^3$ in the deep sample (6 to 6.5 ft bgs). In general, vinyl chloride concentrations in soil gas tend to extend in the northerly direction with a general decreasing trend. To the north, vinyl chloride is bound by low concentrations (i.e., less than RBSLs) in SG-1A-15, PS-1A-6, SG-1A-20, and SG-1A-16 and to the south by low or non-detect concentrations in SG-1A-19, SG-1A-7, and PS-1A-9. The source of vinyl chloride has been identified as the wash pad and the overall extent of vinyl chloride in soil gas is well defined. Figure 3-3 depicts the horizontal and vertical extent of vinyl chloride in soil gas in the Building 965 Area. As shown, the highest concentrations of vinyl chloride are co-located with the footprint of the wash pad, which likely corresponds to a majority of vinyl chloride mass in the vadose zone.

Benzene. Similarly to vinyl chloride, benzene was also relatively widespread in soil gas throughout the Building 965 Area. As shown in Figure 3-2, the highest concentrations of benzene were detected at the

same two locations as the highest concentrations of vinyl chloride, SG-1A-4 and PS-1A-1. Benzene was detected in SG-1A-4 (3.5 ft bgs) at 1,000 μg/m^3 and PS-1A-1 at 1,300 μg/m^3 in the shallow sample (3 to 3.5 ft bgs) and 890 μg/m^3 in the deep sample (6 to 6.5 ft bgs). Figure 3-4 depicts the horizontal and vertical extent of benzene in soil gas. As with vinyl chloride, the highest concentrations of benzene are co-located with the footprint of the wash pad. Concentrations of benzene above RBSLs generally extended in a north-northeasterly direction and, for the most part, were bound in all directions by concentrations that were below RBSLs. One exception is the detection of benzene at a concentration of 77 μg/m^3 at SG-1A-16. It should be noted that limited soil gas sampling will be conducted north of SG-1A-16 as part of performance monitoring to refine the understanding of the lateral extent of certain petroleum hydrocarbons in soil gas as part of field activities for the NTCRA.

1,3-Butadiene. Based on the results of various historical NUSD and Navy soil gas sampling events (i.e., NUSD PEA in 2006, the Navy VOC investigation in August 2007, and Navy Preliminary Sampling activities in May 2008) there have been some significant inconsistencies in the detection of 1,3-butadiene:

- NUSD PEA in 2006 (direct push with Summa canister) – detected in 12 of 21 samples
- Navy VOC Investigation in 2007 (direct push with syringes) – detected in six of 20 samples
- Navy Preliminary Sampling in 2008 (permanent soil gas probes with Summa canisters) – not detected.

In order to address the inconsistencies, Battelle contacted Heidi Hayes, the Technical Director for Air Toxics, Ltd. Ms. Hayes indicated that spurious detections of 1,3-butadiene are a widespread problem and indicated that other environmental clients have experienced similar issues at other sites where vapor intrusion is a concern. In fact, Air Toxics recently developed a White Paper (see Appendix H) evaluating the potential for disposable syringes to introduce VOCs into soil gas samples. Based on the results, 1,3-butadiene recovery was as high as 351% in cases where syringe samples were analyzed 5 minutes or less after sample collection, suggesting that 1,3-butadiene is potentially being introduced into the sample from an unknown source. The White Paper also noted that 1,3-butadiene anomalies may be attributable to interfering peaks that may contribute to the area of its quantitation mass ion, thus resulting in elevated recoveries.

The data collection and analytical procedures implemented by the Navy in May 2008 (i.e., collection of soil gas samples from permanent probes in Summa canisters for TO-15 analysis) provided the finest level of resolution to address the confounding factors that appear to be affecting the quantification of 1,3-butadiene in soil gas at the site. Based on these results, 1,3-butadiene was determined to not be present, thus indicating it is not a chemical of concern. As will be discussed in Section 6.0, performance monitoring will likely be conducted as part of the NTCRA in the Building 965 Area, at which time additional 1,3-butadiene data will be available to confirm the understanding of site conditions.

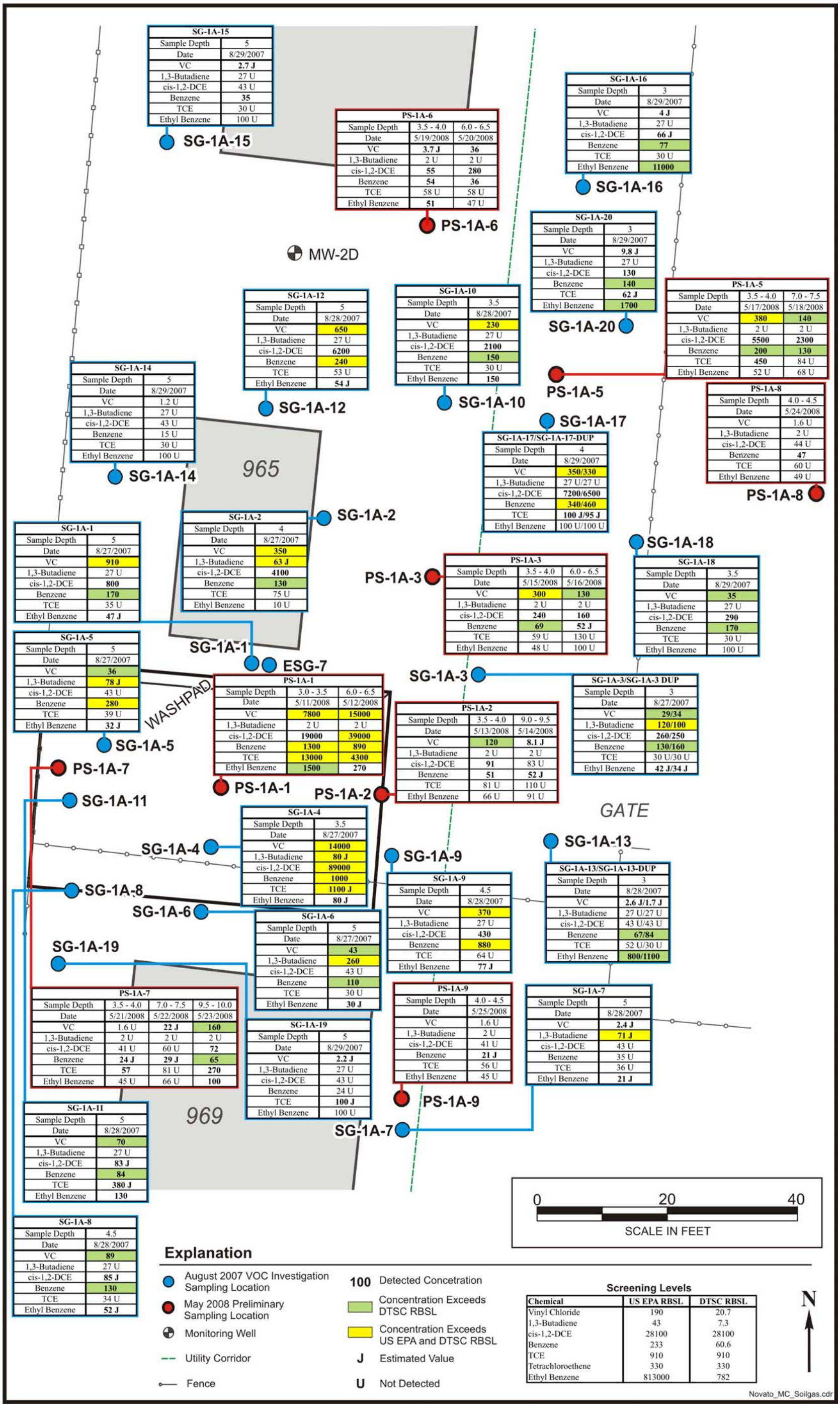


Figure 3-2. Site Map Depicting the Spatial Distribution of Analytical Results (μg/m^3) for Chemicals of Concern in Soil Gas

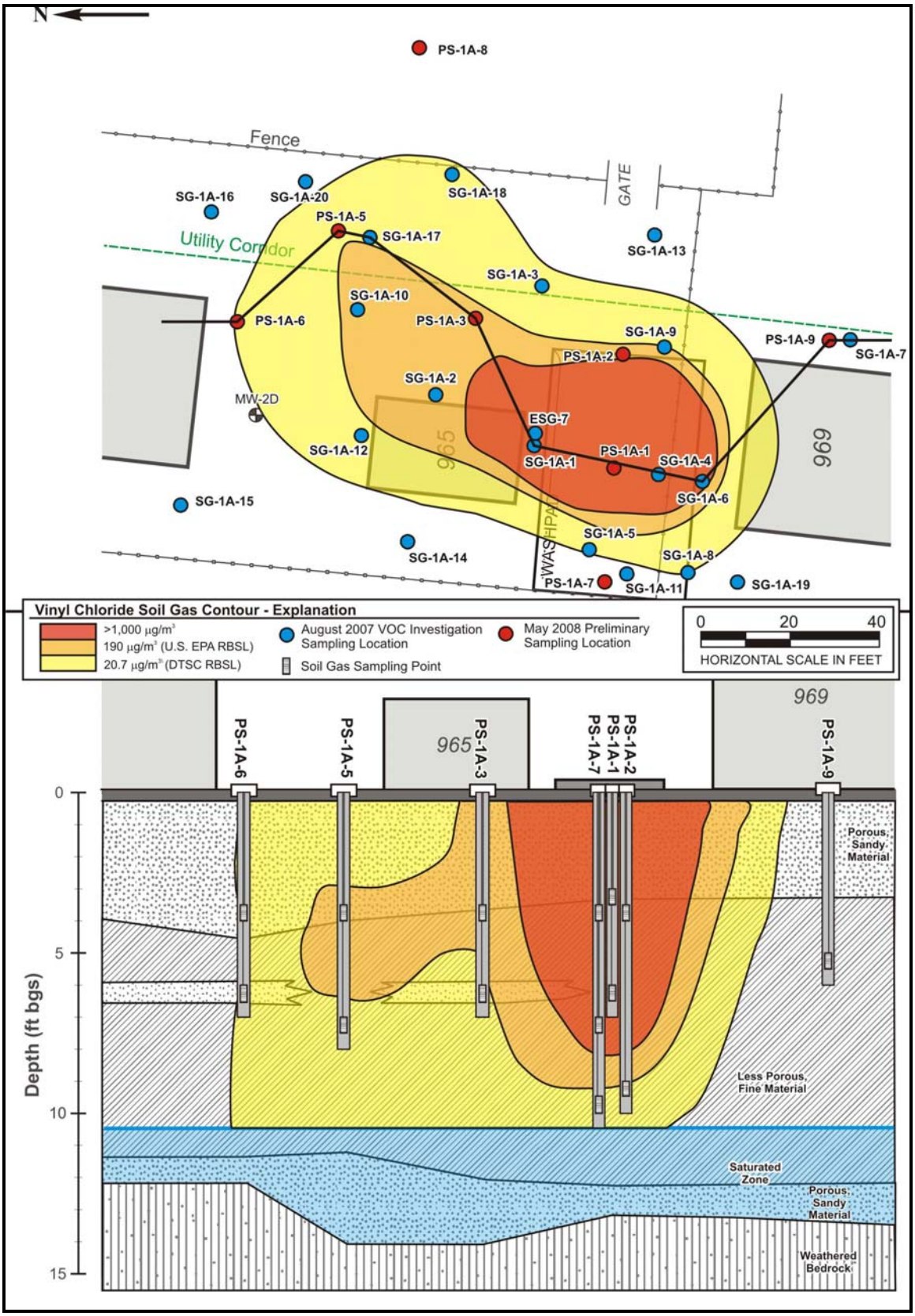


Figure 3-3. Depiction of the Lateral and Vertical Extent of Vinyl Chloride in Soil Gas

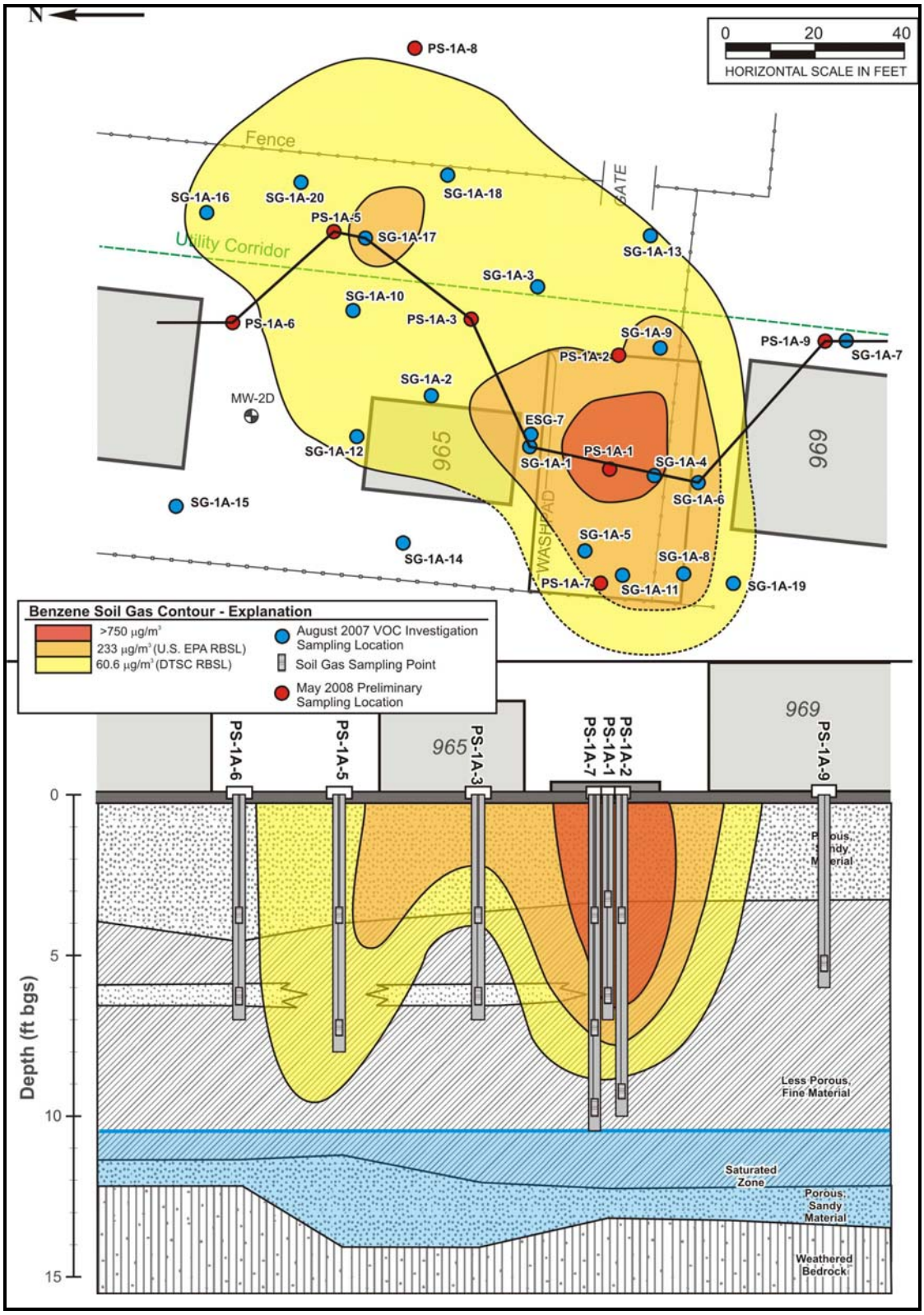


Figure 3-4. Depiction of the Lateral and Vertical Extent of Benzene in Soil Gas

TCE and cis-1,2-DCE. Concentrations of TCE and cis-1,2-DCE at levels that exceeded RBSLs were isolated to sampling locations underneath the wash pad, including SG-1A-4 and PS-1A-1 (see Figure 3-2). TCE was detected at a concentration 1,100 J μg/m^3 in SG-1A-4 and a concentration of 13,000 μg/m^3 and 4,300 μg/m^3 in the shallow sample (3 to 3.5 ft bgs) and deep sample (6 to 6.5 ft bgs), respectively, from PS-1A-1. All remaining detections of TCE and cis-1,2-DCE were below both the U.S. EPA and DTSC RBSLs (see Figure 3-2).

Ethylbenzene. Concentrations of ethylbenzene that exceed DTSC RBSLs were observed at four soil gas sampling locations, including PS-1A-1, SG-1A-13, SG-1A-16, and SG-1A-20. As shown in Figure 3-2, ethylbenzene exceedances are located throughout the Building 965 Area, including directly underneath the wash pad in PS-1A-1 (1,500 μg/m^3 from 3 to 3.5 ft bgs) and east of the wash pad in SG-1A-13 (800 μg/m^3 and 1,100 [duplicate] μg/m^3, respectively, from 3 to 3.5 ft bgs). The highest concentration of ethlybenzene was 11,000 μg/m^3 at 3 ft bgs in SG-1A-16, which is located in the northeast portion of the study area. Immediately south of SG-1A-16, ethylbenzene was also detected above the DTSC RBSL in SG-1A-20 at a concentration of 1,700 μg/m^3. NTCRA field activities will likely include limited sampling north-northeast of SG-1A-16 to more clearly define the extent of petroleum hydrocarbons in the northeast portion. It should be noted that ethylbenzene did not exceed the U.S. EPA RBSL (813,000 μg/m^3, which is nearly three orders of magnitude higher than the DTSC RBSL of 782 μg/m^3) at any sampling location in the Building 965 Area.

3.5 Evaluation of Potential Sources

While soil gas was the focus of the investigation activities in the Building 965 Area, limited soil and groundwater sampling was conducted to determine whether either media may be serving as a source of VOC mass to soil gas. The results from these samples did not indicate the presence of any significant source of VOCs in soil or groundwater. In general, the presence of low, estimated or non-detect concentrations of VOCs in both soil and groundwater suggest that the release is likely very old and the subsurface has reached a state of relative equilibrium. It is likely that the presence of the overlying pavement has contributed to the persistence of elevated concentrations of VOCs in soil gas. Furthermore, based on the distribution of VOCs around the wash pad, it is likely that vehicle rinsing was responsible for the transport of chemical mass into the subsurface. Conceptually, this transport mechanism implies that there were no direct releases of free product into the subsurface, but rather that rinsewater containing concentrations of VOCs accumulated in the vadose zone.

Groundwater. As part of the sampling activities conducted in August 2007, two groundwater samples were collected downgradient of the wash pad to evaluate potential groundwater impacts, one 50 ft north (MW-2D) and the other 50 ft northeast (SG-1A-18) of the wash pad. The results indicated that VOCs were not detected at either location. An attempt to collect groundwater directly underneath the wash pad (i.e., near SG-1A-4) was unsuccessful due to the relatively impermeable lithology.

Six additional groundwater samples (PS-1A-1, PS-1A-2, PS-1A-3, PS-1A-5, PS-1A-6, and PS-1A-7) were collected in May 2008 to gain a better understanding of whether groundwater may be serving as a potential source of VOC mass to soil gas. As shown in Figure 3-5, vinyl chloride and 1,3-butadiene were the only chemicals detected in groundwater at concentrations that exceeded DTSC RBSLs, with 1,3-butadiene being detected at only one location, PA-1A-7, at a concentration of 0.069 μg/L, compared to the DTSC RBSL of 0.029 μg/L. As shown in Figure 3-6, vinyl chloride was detected in two locations at levels that exceeded the DTSC RBSL of 0.373 μg/L. In general, these concentrations are very low and are not indicative of a potential source to soil gas or potential groundwater issue.

Soil. Soil sampling was also conducted as part of the May 2008 sampling event to evaluate whether soil may be serving as a source of VOC mass to soil gas. In order to maximize the likelihood of identifying VOC sources in soil, an exploratory core was advanced at a location immediately adjacent to the final soil sampling locations. These exploratory cores were logged by a geologist and subsequently subject to head space testing on a foot by foot basis using a PID. Depth intervals exhibiting an elevated PID response were chosen as the sampling interval for the adjacent soil boring. As shown in Figure 3-7, a majority of the detections of VOCs in soil that exceeded U.S. EPA and DTSC RBSLs were observed in soil samples collected from 2 to 3 and 4 to 5 ft bgs at PS-1A-1. As shown in Figures 3-8 and 3-9, soil contours have been developed for vinyl chloride and benzene, respectively, because these were the two most widespread VOCs detected in soil gas. As shown, vinyl chloride was only detected in one sample (PS-1A-1) at a concentration of 1.4 μg/kg from 4 to 5 ft bgs. Similarly, benzene was only detected from 5 to 6 ft bgs at PS-1A-3. Based on the soil results, it is clear that the areas of elevated concentrations (i.e., greater than RBSLs) are localized underneath the wash pad and it is unlikely that there are any significant sources of VOC mass in soil at the Building 965 Area.

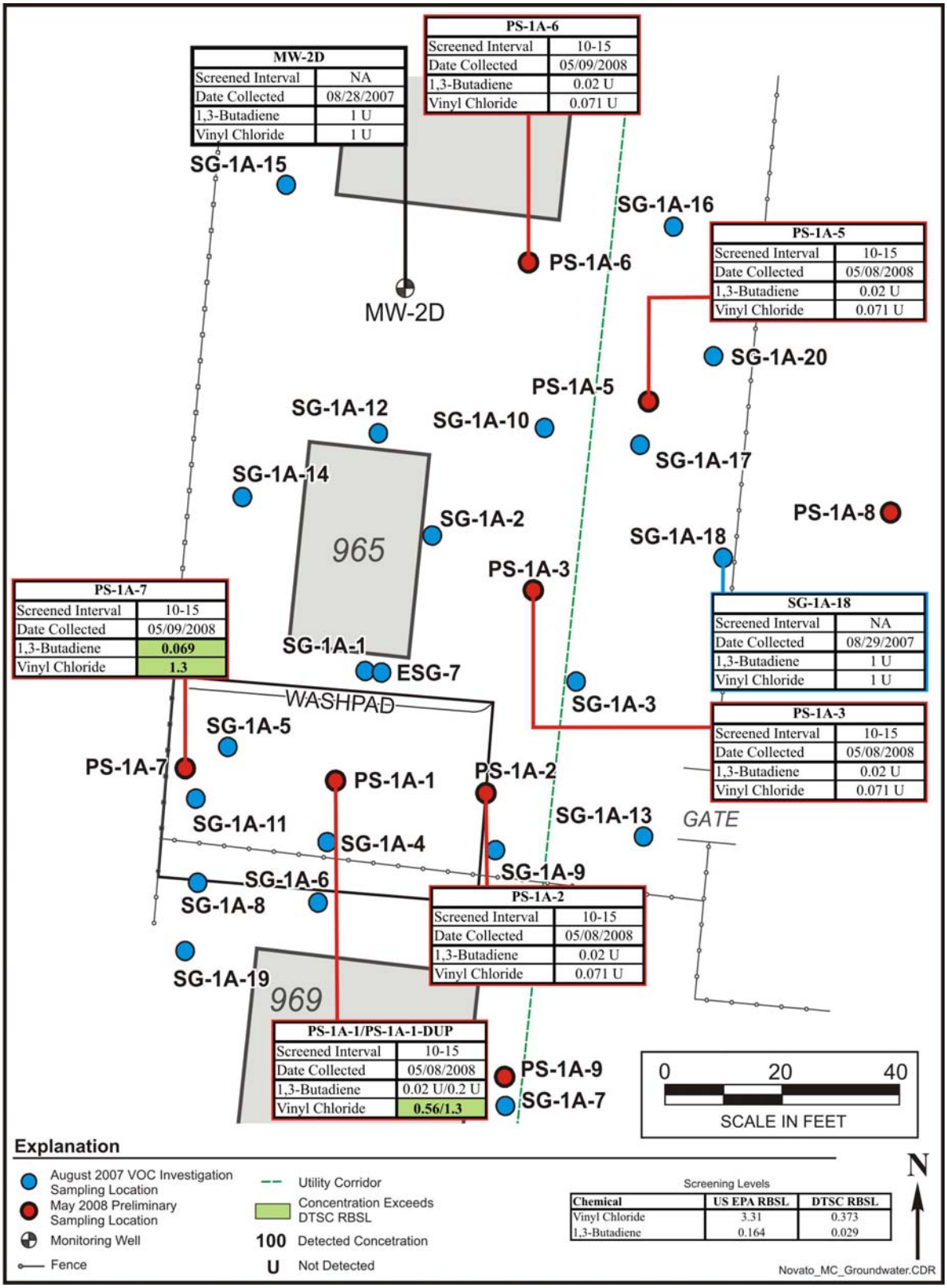


Figure 3-5. Site Map Depicting the Spatial Distribution of Analytical Results (µg/L) for Chemicals of Concern in Groundwater

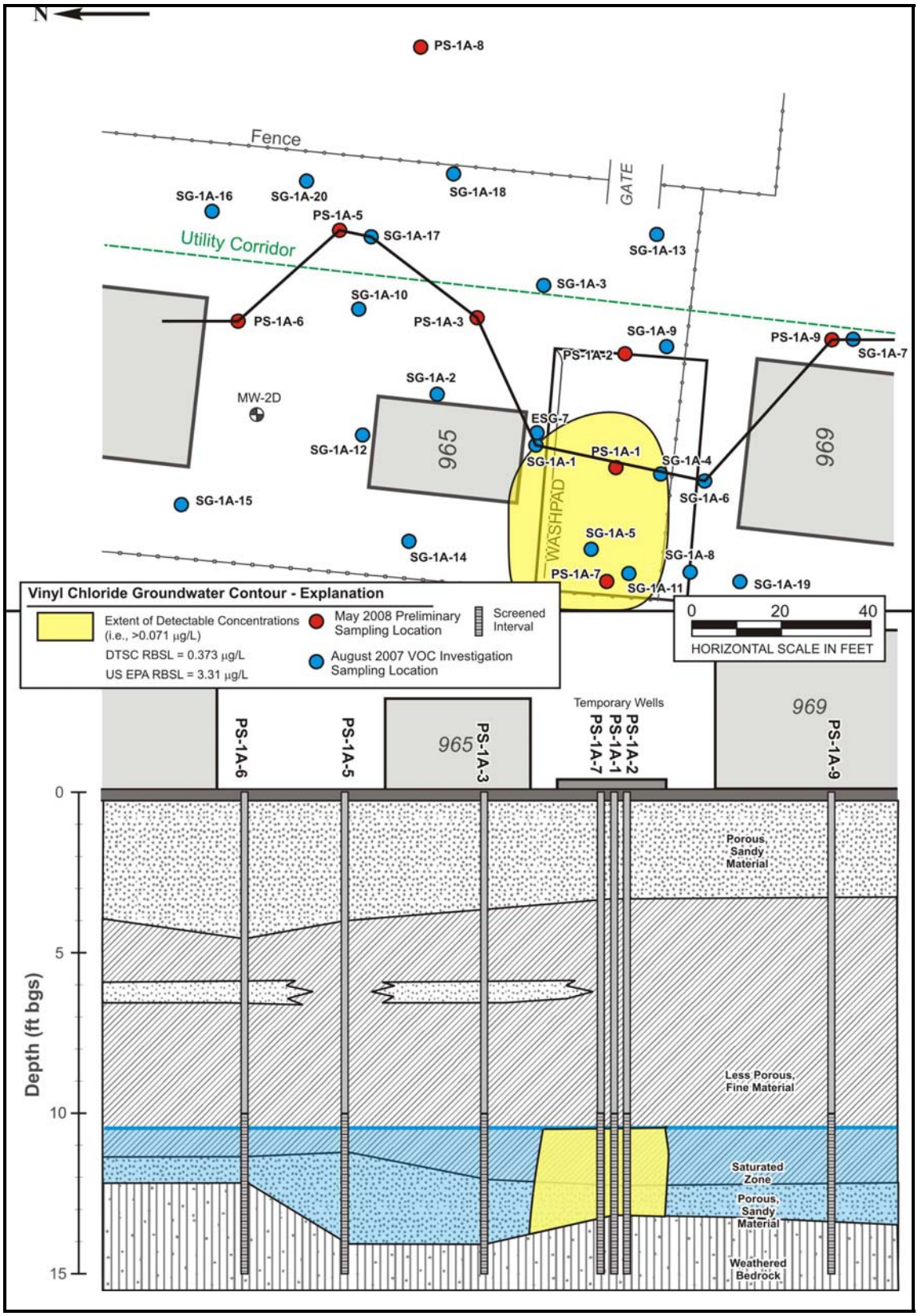
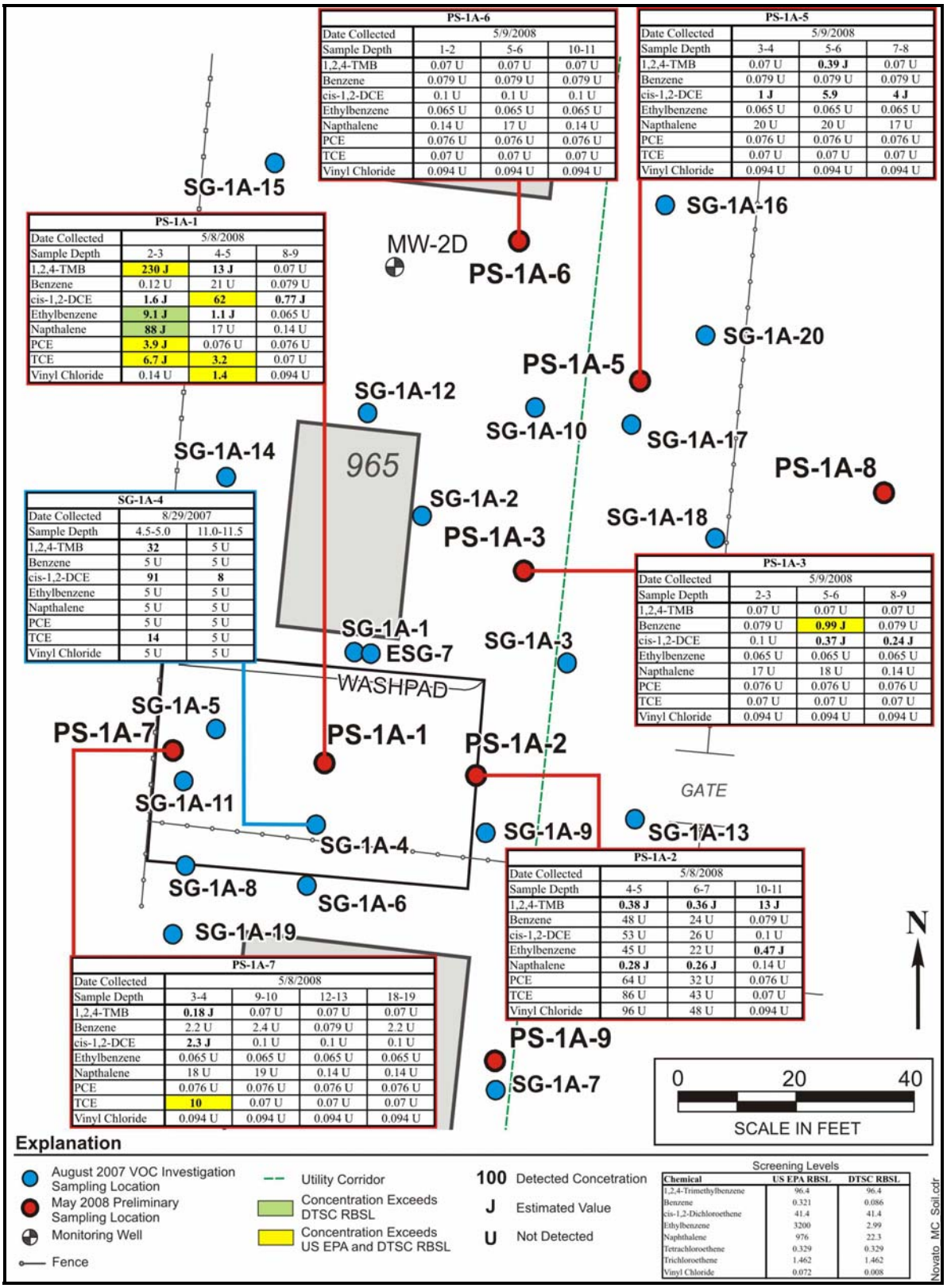


Figure 3-6. Depiction of the Lateral and Vertical Extent of Vinyl Chloride in Groundwater



PS-1A-6			
Date Collected	5/9/2008		
Sample Depth	1-2	5-6	10-11
1,2,4-TMB	0.07 U	0.07 U	0.07 U
Benzene	0.079 U	0.079 U	0.079 U
cis-1,2-DCE	0.1 U	0.1 U	0.1 U
Ethylbenzene	0.065 U	0.065 U	0.065 U
Napthalene	0.14 U	17 U	0.14 U
PCE	0.076 U	0.076 U	0.076 U
TCE	0.07 U	0.07 U	0.07 U
Vinyl Chloride	0.094 U	0.094 U	0.094 U

PS-1A-5			
Date Collected	5/9/2008		
Sample Depth	3-4	5-6	7-8
1,2,4-TMB	0.07 U	**0.39 J**	0.07 U
Benzene	0.079 U	0.079 U	0.079 U
cis-1,2-DCE	**1 J**	**5.9**	**4 J**
Ethylbenzene	0.065 U	0.065 U	0.065 U
Napthalene	20 U	20 U	17 U
PCE	0.076 U	0.076 U	0.076 U
TCE	0.07 U	0.07 U	0.07 U
Vinyl Chloride	0.094 U	0.094 U	0.094 U

PS-1A-1			
Date Collected	5/8/2008		
Sample Depth	2-3	4-5	8-9
1,2,4-TMB	**230 J**	**13 J**	0.07 U
Benzene	0.12 U	21 U	0.079 U
cis-1,2-DCE	**1.6 J**	**62**	**0.77 J**
Ethylbenzene	**9.1 J**	**1.1 J**	0.065 U
Napthalene	**88 J**	17 U	0.14 U
PCE	**3.9 J**	0.076 U	0.076 U
TCE	**6.7 J**	**3.2**	0.07 U
Vinyl Chloride	0.14 U	**1.4**	0.094 U

SG-1A-4		
Date Collected	8/29/2007	
Sample Depth	4.5-5.0	11.0-11.5
1,2,4-TMB	**32**	5 U
Benzene	5 U	5 U
cis-1,2-DCE	**91**	**8**
Ethylbenzene	5 U	5 U
Napthalene	5 U	5 U
PCE	5 U	5 U
TCE	**14**	5 U
Vinyl Chloride	5 U	5 U

PS-1A-3			
Date Collected	5/9/2008		
Sample Depth	2-3	5-6	8-9
1,2,4-TMB	0.07 U	0.07 U	0.07 U
Benzene	0.079 U	**0.99 J**	0.079 U
cis-1,2-DCE	0.1 U	**0.37 J**	**0.24 J**
Ethylbenzene	0.065 U	0.065 U	0.065 U
Napthalene	17 U	18 U	0.14 U
PCE	0.076 U	0.076 U	0.076 U
TCE	0.07 U	0.07 U	0.07 U
Vinyl Chloride	0.094 U	0.094 U	0.094 U

PS-1A-2			
Date Collected	5/8/2008		
Sample Depth	4-5	6-7	10-11
1,2,4-TMB	**0.38 J**	**0.36 J**	**13 J**
Benzene	48 U	24 U	0.079 U
cis-1,2-DCE	53 U	26 U	0.1 U
Ethylbenzene	45 U	22 U	**0.47 J**
Napthalene	**0.28 J**	**0.26 J**	0.14 U
PCE	64 U	32 U	0.076 U
TCE	86 U	43 U	0.07 U
Vinyl Chloride	96 U	48 U	0.094 U

PS-1A-7				
Date Collected	5/8/2008			
Sample Depth	3-4	9-10	12-13	18-19
1,2,4-TMB	**0.18 J**	0.07 U	0.07 U	0.07 U
Benzene	2.2 U	2.4 U	0.079 U	2.2 U
cis-1,2-DCE	**2.3 J**	0.1 U	0.1 U	0.1 U
Ethylbenzene	0.065 U	0.065 U	0.065 U	0.065 U
Napthalene	18 U	19 U	0.14 U	0.14 U
PCE	0.076 U	0.076 U	0.076 U	0.076 U
TCE	**10**	0.07 U	0.07 U	0.07 U
Vinyl Chloride	0.094 U	0.094 U	0.094 U	0.094 U

Chemical	US EPA RBSL	DTSC RBSL
1,2,4-Trimethylbenzene	96.4	96.4
Benzene	0.321	0.086
cis-1,2-Dichloroethene	41.4	41.4
Ethylbenzene	3200	2.99
Naphthalene	976	22.3
Tetrachloroethene	0.329	0.329
Trichloroethene	1.462	1.462
Vinyl Chloride	0.072	0.008

Figure 3-7. Site Map Depicting the Spatial Distribution of Analytical Results (µg/kg) for Chemicals of Concern in Soil

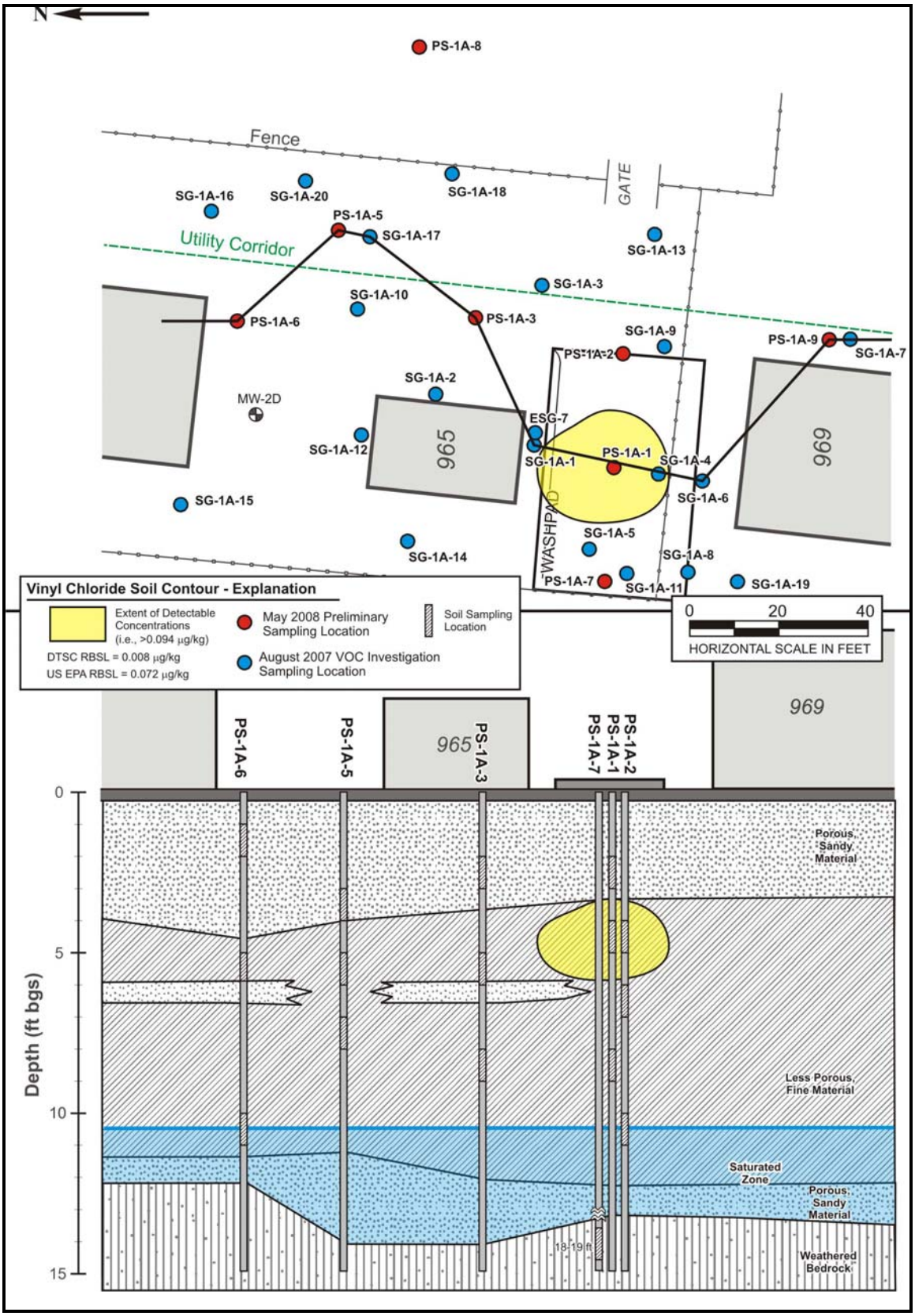


Figure 3-8. Depiction of the Lateral and Vertical Extent of Vinyl Chloride in Soil

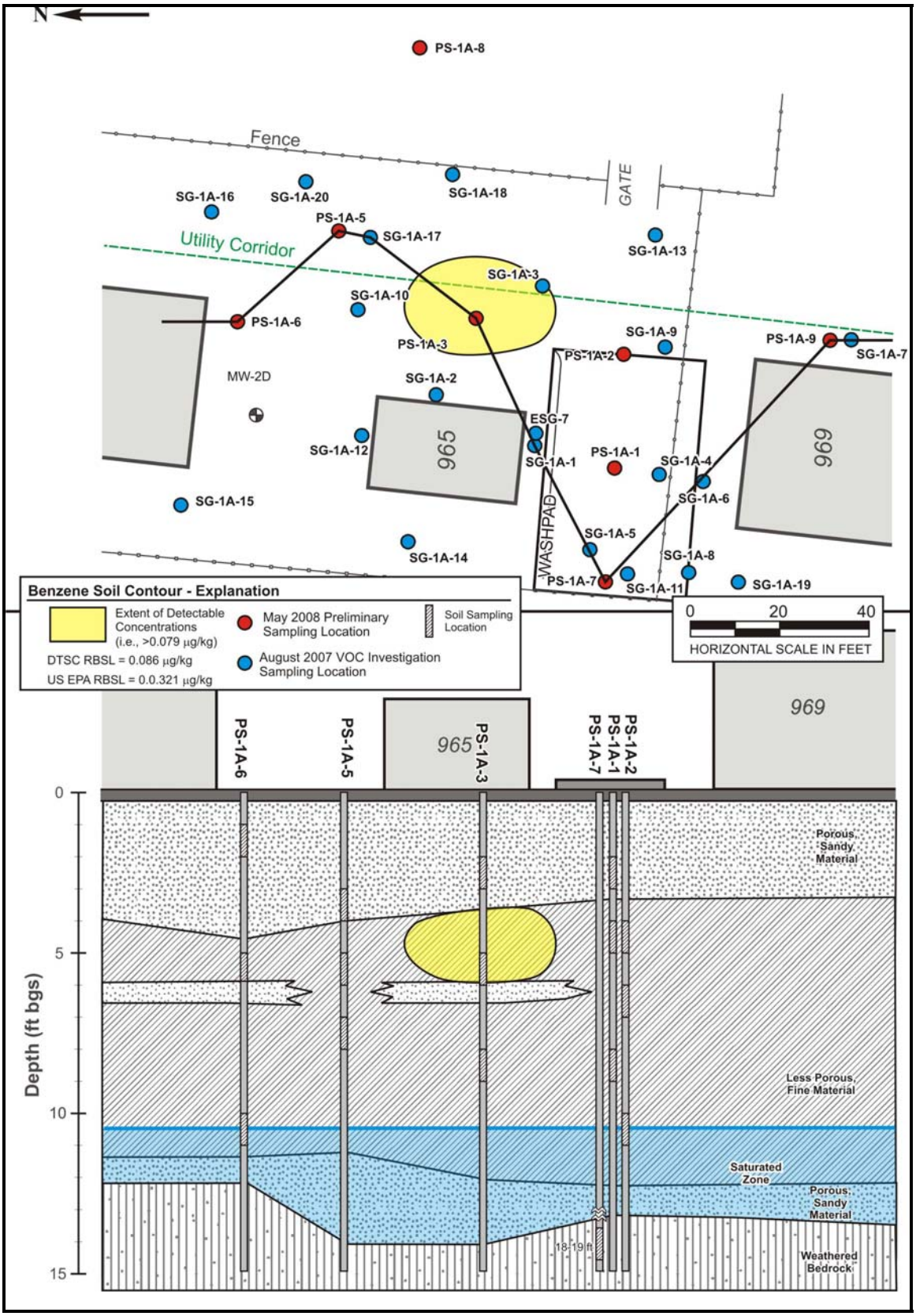


Figure 3-9. Depiction of the Lateral and Vertical Extent of Benzene in Soil

Section 4.0: RISK EVALUATION

This section summarizes the methodology and the results of the risk assessment (RA) that was conducted to help determine the conditions that currently exist (i.e., baseline conditions) based on potential exposure of human receptors to chemicals in soil gas that migrate indoors in the area of Building 965 within Parcel 1A at DoDHF Novato (i.e., study site). A summary of the RA is presented here. Appendix F contains the detailed evaluation.

The RA was conducted using the soil gas data collected by the Navy during the VOC investigation of August 2007 (Battelle, 2008a) and the Preliminary Sampling Activities starting on May 8, 2008 (Battelle, 2008b). Baseline risks/hazards were calculated for a residential receptor for the vapor intrusion pathway based on the soil gas concentrations measured during the August 2007 and May 2008 investigations. The groundwater and soil data collected during the Preliminary Sampling Activities in May 2008 also were assessed collectively to help estimate baseline conditions.

The RA was conducted according to U.S. EPA's *Risk Assessment Guidance for Superfund* (RAGS) Volume I, *Human Health Evaluation Manual* (Part A) (U.S. EPA, 1989) and supplemental U.S. EPA guidance. In addition, guidance provided by Cal-EPA's DTSC at http://www.dtsc.ca.gov has been incorporated where applicable.

4.1 Summary of Baseline Risk/Hazard for Soil Gas

All of the soil gas data collected during August 2007 (Battelle, 2008a) and during the Preliminary Sampling Activities starting on May 8, 2008, are provided in Appendix D. Concentrations detected in soil gas were compared to chemical-specific RBSLs for vapor intrusion. RBSLs for soil gas were derived by DTSC using the DTSC-modified J&E spreadsheets for soil gas with site-specific soil parameters and DTSC default parameters to back-calculate a value in soil gas equal to 1×10^{-6} risk level or 1.0 hazard quotient (HQ). The Abbreviated Work Plan (Battelle, 2007) contains the site-specific parameters and DTSC default input parameters used to calculate the RBSLs, as well as the RBSLs DTSC derived for soil gas for the VOC investigation. For chemicals that were detected but for which an RBSL had not been derived by DTSC, the same DTSC-modified J&E spreadsheets used by DTSC to derive the risk-based values were used to determine an RBSL. Appendix D provides a comparison to the chemical-specific RBSLs. Concentrations exceeding the RBSLs have been shaded on these tables. The majority of the chemicals detected in soil gas were much lower than their respective RBSLs as shown on these tables. Therefore, only those chemicals of potential concern (COPCs) exceeding their RBSL (i.e., termed primary risk drivers) were used to complete the baseline risk/hazard evaluation. Table F-1 of Appendix F summarizes the data for the primary risk drivers in soil gas data (these data comprise the baseline dataset).

The concentrations of chemicals in the exposure medium at the exposure point are termed exposure point concentrations (EPCs). The EPC represents the average exposure contracted over the exposure period; therefore, the EPC is estimated by using an average value and not the maximum observed concentration (U.S. EPA, 1989, 1992, and 2007). The average concentration is regarded as a reasonable estimate of the concentration likely to be contacted over time (U.S. EPA, 1989). The EPCs for this evaluation were calculated using the ProUCL (version 4.00.02) software package developed by U.S. EPA (2007) and represent an upper confidence limit (UCL) of the population mean (i.e., measure of the central tendency of a data distribution). ProUCL 4.0 contains statistical methods to address various environmental issues for both full data sets without nondetects and for data sets with nondetects (also known as left-censored data sets). Table F-2 of Appendix F provides the summary statistics produced by ProUCL for all of the 2007 soil gas data.

4.2 Potential Receptors and Exposure Pathways

The exposure assessment evaluates cancer risks and noncancer health hazards to a residential receptor for a reasonable maximum exposure (RME). U.S. EPA (1989) defines the RME as the highest exposure that is reasonably expected to occur at a site. Risk decisions are based on the RME consistent with the NCP (U.S. EPA, 1985). Exposure assumptions used for the residential receptor incorporate a longer exposure duration (i.e., 30 years) and a more frequent period of exposure (i.e., 350 days) than would be assumed for a student or teacher who utilizes a potential school. Inhalation of indoor air (i.e., vapor intrusion) is the only exposure pathway evaluated because vapor intrusion is the most significant exposure pathway driving risk for VOCs (Cal-EPA, 2005), and other exposure pathways were determined to be insignificant or not complete as described below.

4.2.1 Insignificant or Incomplete Exposure Pathways. An estimation of the risk/hazard associated with incidental ingestion, dermal contact and inhalation of ambient air was determined by comparing maximum concentrations detected in soil to U.S. EPA Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites (U.S. EPA, 2008). For each chemical detected, risk ratios were derived by dividing the maximum concentration detected by the corresponding RSL. For carcinogenic compounds, risk ratios were multiplied by 10^{-6} to estimate the cancer risk and then summed to provide an estimate of total risk. Similarly, risk ratios for noncarcinogenic chemicals were used as an estimate of the HQ and subsequently summed to estimate the hazard index (HI). Estimated cancer risks and noncancer health hazards were well below 1×10^{-6} and 1.0, respectively. As explained in the Final Revised Risk Assessment for Former UST Site 957/970 (Battelle, 2001), direct contact with groundwater for the PBC Parcel 1A study area is very unlikely because groundwater is not currently used for any purpose (e.g., drinking, showering, cooking, irrigation), nor is it likely to be used in the future due to high total dissolved solids and low yield, and potable water is already supplied to Parcel 1A and the surrounding area by the municipality. Therefore, aside from risk associated with vapor intrusion, all other risks from potential groundwater pathways will not be evaluated further. Table F-3 of Appendix F contains the risk ratio comparisons.

Based upon the methodology used to calculate inhalation risks/hazards, child cancer risks are less than the risks calculated for the adult and child health hazards are equal to those of the adult; therefore, a separate child receptor was not included in the RA.

4.3 Indoor Air Risks/Hazards for Baseline Conditions

Indoor air risks/hazards associated with soil gas were calculated using the DTSC-modified J&E spreadsheets for soil gas with site-specific soil parameters obtained in May 2008 and DTSC default parameters. Consistent with the manner in which estimations of cancer risks were evaluated at Former UST Site 957/970 in previous risk assessments (Battelle, 2001; 2006), two sets of risk estimates are provided to take into account Cal-EPA derived, DTSC-recommended cancer toxicity values and U.S. EPA cancer toxicity values for benzene, 1,3-butadiene, ethylbenzene, and vinyl chloride. Table F-4 of Appendix F summarizes the two sets of toxicity values (e.g., inhalation unit risk factor [URF]) for these four chemicals in addition to providing the URFs and noncancer toxicity values (e.g., reference concentrations [RfC]) for the other COPCs. The more recent site-specific soil parameters are summarized in Table F-5 (Appendix F). The original soil parameters used in the Final Revised Risk Assessment for Former UST Site 957/970 (Battelle, 2001) also are provided in Table F-5 for comparison purposes.

Cancer risks and noncancer health hazards are summarized in Table 4-1 for the baseline exposure scenario. The NCP risk management range of 10^{-4} and 10^{-6} for carcinogenic risk (U.S. EPA, 1990) and 1.0 for the noncancer risk are used to evaluate the relative magnitude of risk calculated for the

area of Building 965 within Parcel 1A. Chemical-specific HQs are summed to calculate the HI. The HI is the value compared to the U.S. EPA noncancer criterion of 1.

Calculated cancer risks for the residential receptor (Table 4-1) indicate that the total cancer risk is 3×10^{-4} based on Cal-EPA toxicity values and 4×10^{-5} based on U.S. EPA toxicity values, which are only slightly above and within the NCP risk management range, respectively. Benzene, 1,3-butadiene, and vinyl chloride are the primary contributors to a combined risk above 1×10^{-6}. Noncancer HQs are below 1.0 for all chemicals and the HI is equal to 1.0 (Table 4-1).

Table 4-1. Summary of Cancer Risks/Noncancer Health Hazards for the Baseline Scenario

COPC	EPC (ug/m3)	Cal-EPA Toxicity		U.S. EPA Toxicity	
		Risk	Hazard	Risk	Hazard
Vinyl Chloride	7208 3	.E-04	0.1	3.E-05	0.08
1,3-Butadiene	81.6 1.E	-05	0.1	2.E-06	0.07
cis-1,2-DCE	32721 N	D	0.9	ND	0.85
Benzene	538 7.E	-06	0.02	2.E-06	0.02
TCE	1283 1	.E-06	0.002	1.E-06	0.002
Ethylbenzene	3674 4	.E-06	0.003	ND	0.003
1,2-DCA	78 8	.E-07	0.0002	8.E-07	0.00022
1,2-DCP	99 4.E	-07	0.02	4.E-07	0.02
Total		3.E-04 1		4.E-05	1

EPC – exposure point concentration; determined using U.S. EPA's ProUCL, version 4.0. Soil gas sampling depth below grade was about 5 ft bgs, which is the average depth of the samples used to calculate the EPC.
ND – not detected/not determined

4.4 Risk/Hazard Associated with Vapor Intrusion from Groundwater Detections

Chemicals detected in groundwater were evaluated for the vapor intrusion to indoor air pathway given that groundwater is shallow. The risks estimated using groundwater data can be used for bounding purposes to aid in risk management decisions.

Estimates of cancer risk and noncancer health hazards were determined by comparing maximum concentrations detected in groundwater to RBSLs. RBSLs were derived by DTSC HERD using the DTSC-modified J&E spreadsheet with site-specific soil parameters obtained from the Final Revised Risk Assessment for Former UST Site 957/970 (Battelle, 2001) and DTSC default parameters in conjunction with Cal-EPA toxicity values to back-calculate a value in groundwater equal to 1×10^{-6} risk level or 1.0 hazard quotient. An additional set of RBSLs were derived for benzene, ethylbenzene, 1,3-butadiene, and vinyl chloride using U.S. EPA toxicity values. Tables F-7 and F-8 (Appendix F) provide the detailed risk ratio comparisons.

For RBSLs derived using Cal-EPA toxicity values, the total cancer risk was estimated to be 6×10^{-6}. 1,3-butadiene and vinyl chloride were the primary contributors to the total cancer risk. The noncancer health hazard index was less than 1.0. For RBSLs derived using U.S. EPA toxicity values, the total cancer risk was estimated to be 1×10^{-6}. None of the chemicals individually exceeded 1×10^{-6}. The noncancer health hazard index was less than 1.0.

4.5 Risk/Hazard Associated with Vapor Intrusion from Chemicals Detected in Soil

Estimates of cancer risk and noncancer health hazards via risk ratio comparisons to RBSLs also were determined for chemicals detected in soil. RBSLs were derived using the DTSC-modified J&E spreadsheet with site-specific soil parameters obtained from the Final Revised Risk Assessment for Former UST Site 957/970 (Battelle, 2001) and DTSC default parameters in conjunction with Cal-EPA and U.S. EPA toxicity values to back-calculate a value in soil equal to 1×10^{-6} risk level or 1.0 hazard quotient. Table F-9 of Appendix F summarizes the maximum concentrations detected in soil and provides estimates of cancer risk and noncancer health hazards via risk ratio comparisons to RBSLs for chemicals expected to be primary risk drivers (Appendix D provides a summary of all chemicals detected in soil and comparison to RBSLs). Estimates of cancer risk and noncancer health hazards have been provided for baseline in order to support risk management decisions for the site. At baseline conditions, estimates of total risk range from 2×10^{-4} to 4×10^{-5}, depending on the toxicity source. The noncancer HI is 4.

4.6 Uncertainties Associated with Baseline Risk Estimates

A qualitative evaluation of uncertainty is included in Appendix F (Table F-10). However, due to the uncertainties associated with predicting indoor air quality for future buildings, the uncertainty associated wih the EPC is provided here.

DTSC recommends using maximum soil gas concentrations (Cal-EPA, 2005) along with other conservative default input parameters (e.g., average vapor flow into building, crack to total area ratio, building ventilation rate). Navy policy does not support calculating indoor air risks using maximum concentrations in order to determine the extent of the NTCRA. However, the Navy has addressed DTSC's uncertainty with regard to indoor air quality by evaluating the indoor air risks for the primary risk drivers using maximum soil gas concentrations. Table 4-2 provides a summary of the risks associated with the maximum soil gas concentration.

Total risks based on maximum concentrations are about two to three times higher than risks based on the ProUCL EPC (e.g., 6×10^{-4} using maximum versus 3×10^{-4} using ProUCL EPCs for Cal-EPA toxicity and 9×10^{-5} using maximum versus 4×10^{-5} using ProUCL EPCs for U.S. EPA toxicity). Based on the comparison of the total risks associated with a central tendency value as the EPC (Table 4-1) and a maximum concentration as the EPC (Table 4-2), risks estimated based on a measure of the central tendency of the data distribution do not differ very much from the risks associated with maximum concentrations, most likely because of the conservative nature of the indoor air model and use of conservative input parameters. Therefore, the uncertainty related to the use of UCLs and maximum concentrations for determining risk is minimal and does not result in significant differences in risk estimates.

However, consistent with U.S. EPA guidance (U.S. EPA 1989, 1992, 2007) and Navy policy (DON, 2001), the RME approach for assessing risks, including an EPC estimated as an average value and not the maximum observed concentration, will be followed to assess the risk/hazard from vapor intrusion, which will be used to assist with making risk management decisions for the NTCRA.

Table 4-2. Baseline Risks Using Maximum Soil Gas Concentrations as the Exposure Point Concentrations

Chemical	Soil Gas Maximum Concentration[(a)] (ug/m3)	Cal-EPA Toxicity		U.S. EPA Toxicity	
		Risk	Hazard	Risk	Hazard
Vinyl Chloride	15,000	5.E-04	0.2	6.E-05	0.2
1,3-Butadiene 26	0	3.E-05	0.2	5.E-06	0.2
cis-1,2-DCE	89,000	ND	3	ND	3
Benzene 1,	300	2.E-05	0.03	6.E-06	0.03
TCE 1	3,000	1.E-05	0.03	1.E-05	0.03
Ethylbenzene 1	1,000	2.E-05	0.01	ND	0.01
1,2-DCA 1	50	2.E-06	0.0005	2.E-06	0.0005
1,2-DCP 25	0	1.E-06	0.06	1.E-06	0.06
Total		**6.E-04**	**3**	**9.E-05**	**3**

(a) Soil gas sampling depth below grade used in the J&E model was based on the depth of the sample containing the maximum concentration.

ND – not detected/not determined

4.7 Conclusions of the Risk Assessment

Results of the RA support the conclusion that current conditions at the site potentially pose significant risks to human receptors via the vapor intrusion pathway. This assessment examined receptors, exposure pathways, and chemicals most likely to pose the greatest risk. Although the RA provides the basis for evaluating the value of a NTCRA, it is not intended to be a complete baseline risk assessment that includes an assessment of risks for all chemicals, receptors, and exposure pathways. The Navy anticipates completing a parcel-wide risk assessment update for Parcel 1A before transfer of the property, following the NTCRA of the wash pad.

Section 5.0: REMOVAL ACTION OBJECTIVES AND APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

As discussed in Section 4.0, the current concentrations of VOCs in soil gas potentially pose significant risks to human receptors via the vapor intrusion pathway. Based on the existing information and the conclusions of the human health risk assessment, appropriate RAOs that have been developed for this NTCRA are presented in this section. In addition, this section discusses the identification of ARARs, which have been discussed in detail in Appendix A.

5.1 Removal Action Objectives

This NTCRA is intended to serve as the final action to address site risks in the Building 965 Area at Parcel 1A, which is consistent with the RAO that has been developed: to reduce and/or manage human health risk to acceptable levels.

5.2 Applicable or Relevant and Appropriate Requirements

Section 121(d) of the CERCLA of 1980 (CERCLA, 42 U.S.C. § 9621[d]), as amended, states that remedial actions at CERCLA sites must attain (or the decision document must justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations determined to be legally applicable or relevant and appropriate. Although Section 121 of CERCLA does not itself expressly require that CERCLA removal actions comply with ARARs, the EPA has promulgated a requirement in the NCP mandating that CERCLA removal actions ". . . shall, to the extent practicable considering the exigencies of the situation, attain applicable or relevant and appropriate requirements under federal environmental or state environmental or facility siting laws" (40 CFR, § 300.415[j]). As the lead federal agency, the DON has primary responsibility for identifying potential ARARs at the Building 965 Area at Parcel 1A, DoDHF Novato, CA. As the lead agency, DTSC has the responsibility for identifying the state ARARs.

According to CERCLA ARARs guidance (EPA, 1988), a requirement may be "applicable" or "relevant and appropriate," but not both. Identification of ARARs is a site-specific determination involving a two-part analysis: first, a determination of whether a given requirement is applicable; then if it is not applicable, whether it is relevant and appropriate. A requirement is deemed applicable if the specific terms of the law or regulation directly address the COCs, remedial action, or place involved at the site. If the jurisdictional prerequisites of the law or regulations are not met, a legal requirement may nonetheless be relevant and appropriate if the circumstances of the site are sufficiently similar to circumstances in which the law otherwise applies, and it is well suited to the conditions of the site.

To constitute an ARAR under CERCLA, a requirement must be determined to be substantive, rather than procedural or administrative. Therefore, only the substantive provisions of requirements identified as ARARs in this analysis are considered to be ARARs. Permits are considered procedural or administrative requirements. Provisions of generally relevant federal and state statutes and regulations that were determined to be procedural or nonenvironmental, including permit requirements, are not considered to be ARARs. CERCLA Section 121(e)(1), 42 U.S.C. § 9621(e)(1), states that "No Federal, State, or local permit shall be required for the portion of any removal or remedial action conducted entirely on-site, where such remedial action is selected and carried out in compliance with this section." The term "on-site" is defined for purposes of this ARAR discussion as "the areal extent of contamination and all suitable areas in very close proximity to the contamination necessary for implementation of the removal action" (40 CFR § 300.5).

In addition to ARARs, the NCP provides that where ARARs do not exist, agency advisories, criteria, or guidance are "to be considered" (TBC) useful "in helping to determine what is protective at a site or how to carry out certain action or requirements." The NCP preamble states, however, that provisions in the TBC category "should not be required as cleanup standards because they are, by definition, generally neither promulgated nor enforced, so they do not have the same status under CERCLA as do ARARs." Pursuant to EPA guidance, ARARs generally are classified in three categories: chemical-specific, location-specific, and action-specific requirements. These classification categories were developed to help identify ARARs, some of which do not fall precisely into one group or another. These categories of ARARs are defined as follows:

- **Chemical-Specific ARARs**. Laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.
- **Location-Specific ARARs**. Requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the placement of remedial action and may impose additional constraints on the cleanup action. For example, location-specific ARARs may refer to activities in the vicinity of wetlands, endangered species habitat, or areas of historical or cultural significance.
- **Action-Specific ARARs**. Requirements that apply to specific actions that may be associated with site remediation. Action-specific ARARs often define acceptable handling, treatment, and disposal procedures for hazardous substances. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Examples of action-specific ARARs include requirements applicable to landfill closure, wastewater discharge, hazardous waste disposal, and emission of air pollutants.

Appendix A of this EE/CA provides a detailed discussion and evaluation of potential federal and state of California ARARs from the universe of regulations, requirements, and guidance. This sets forth the DON determinations regarding the potential ARARs for the proposed removal action alternatives retained for detailed analysis in this EE/CA. The identification of ARARs is an iterative process, and the final determination of ARARs will be made by the DON in the AM, after public review of this EE/CA as part of the response action selection process.

The solicitation and request for preliminary identification of state action-specific, chemical-specific, and location-specific ARARs were presented by the DON in a letter dated October 20, 2008. A letter was sent to California DTSC soliciting ARARs based on preliminary removal actions and treatment technology options detailed to the agency by the DON. On November 25, 2008, the DON received correspondence from DTSC listing potential ARARs for Building 965 Area, which included input from the Bay Area Air Quality Management District (BAAQMD) and San Francisco Bay Regional Water Quality Control Board (RWQCB).

In preparing the ARARs analysis presented in Appendix A, the DON undertook the following measures, consistent with CERCLA and the NCP:

- Reviewed potential state ARARs for similar removal action excavation projects to determine whether they satisfy CERCLA and NCP criteria that must be met in order to constitute state ARARs;

- Evaluated and compared federal ARARs and their state counterparts to determine whether state ARARs are more stringent than the federal ARARs; and
- Reached a conclusion as to which federal and state ARARs are the most stringent and/or "controlling" ARARs for the planned excavation activities.

Section 6.0: IDENTIFICATION AND ANALYSIS OF REMOVAL ACTION ALTERNATIVES

This section describes the screening and evaluation process for removal action technologies for the Building 965 Area at Parcel 1A. Removal options are screened in Sections 6.1 and 6.2 based on site-specific factors to eliminate removal technologies that constrain effectiveness, implementability, or cost-effectiveness at the site, and to streamline the technology evaluation process for the technologies retained for a detailed evaluation. The removal options that are accepted for further evaluation are discussed Section 6.3 based on technology effectiveness, implementability, and cost.

6.1 Removal Technology Screening

A range of contaminant removal options were considered for the Building 965 Area at Parcel 1A. The purpose of the initial screening was to identify and eliminate removal technologies from further consideration that have site-specific factors that may constrain effectiveness, implementability, or cost-effectiveness at the site. Consequently, several of the options that were initially considered, were not included for detailed evaluation as removal alternatives in Section 6.3.

6.1.1 No Action. The no action response is retained for consideration during the development and analysis of alternatives as required by the NCP (40 CFR 300.430[e][6]). The no action response does not provide any additional remediation, containment, or security measures to reduce potential risk to human health or the environment at the site. The inclusion of the no action alternative is intended to serve as a baseline against which other technologies are evaluated.

6.1.2 Institutional Controls. ICs are restrictive measures placed on the use of land or area to prevent or limit exposure to hazardous substances left in place at a site. Typically, ICs are implemented as engineering and/or legal controls that are often used in conjunction with active remediation activities, such as treatment or containment. Often it is necessary to implement multiple ICs to provide overlapping assurances of protection of future receptors. For instance, if ICs were implemented at Parcel 1A, the Navy would identify and implement appropriate measures to mitigate potential unacceptable risks to both future construction workers and residential users that may be exposed to the exposed subsurface soil gas or indoor air overlying areas of impacted soil gas, respectively.

A disadvantage of ICs is that ultimately they result in restrictions that effectively limit the manner in which the site can be used in the future. The details relating to appropriate ICs would need to be negotiated with the regulatory agencies, and then be appropriately documented through an amendment to the existing Finding of Suitability to Transfer (FOST). ICs are readily implementable, and were retained for further consideration in evaluating the removal options for this site.

6.1.3 Containment. Containment of elevated concentrations of VOCs in soil gas is a potential technology that could be implemented to prevent exposure. Containment actions would be implemented to prevent potential human and/or ecological contact by constructing an engineered containment measure over areas of elevated concentrations of VOCs in soil gas. A typical containment option would consist of capping target areas of the site using a vapor barrier in conjunction with pavement (i.e., asphalt or concrete) or an engineered soil cap. Data collected in the Building 965 Area suggests that there are no continuing sources and the current understanding of the site indicates that the presence of overlying pavement likely resulted in the accumulation of VOC mass in soil gas. Containment represents a continuation of the mechanism that caused the accumulation of unacceptable levels of VOCs in soil gas and without a continuing source it is likely that the VOC concentrations would dissipate over time (if the overlying pavement were removed). For these reasons, containment has not been retained for further evaluation.

6.1.4 Soil Vapor Extraction. Soil vapor extraction (SVE) is a treatment technology that effectively removes VOC mass from soil and soil gas in the vadose zone. SVE removes chemical mass by creating a negative pressure in the vadose zone, which results in the removal and treatment of impacted soil vapor. In the case of the Building 965 Area at Parcel 1A, data suggest that there is no continuing source of VOC mass and it is reasonable to assume that SVE would achieve significant reductions in soil gas concentrations within two to three months. As the SVE system operates, asymptotic mass removal is typically realized at which point system operation is either optimized or discontinued, depending on whether or not cleanup goals have been met. Implementation of an SVE system would require aboveground treatment to remove VOCs from the extracted vapor prior to being discharged to the environment. Additionally, given the proximity of the site to nearby residents at Lanham Village, it would be necessary to implement acoustic controls or operate the system on a modified schedule to address noise nuisances associated with operating the system.

Performance monitoring would be a necessary component of implementing the SVE system. Performance monitoring would consist of conducting periodic monitoring during system operation and subsequent rebound monitoring after system shutdown. Performance monitoring conducted during system operation would serve two primary purposes, the first would be to obtain soil gas data that could be compared to cleanup goals and the second is to ensure that asymptotic conditions are not encountered prior to meeting cleanup goals. Rebound monitoring would be conducted for a predetermined time period (to be negotiated with regulatory agencies) to ensure that residual VOC mass does not result in unacceptable increases in soil gas concentrations after shutdown of the system. Given the potential effectiveness of SVE, this technology has been retained for further evaluation.

6.1.5 Pavement Removal. Currently, a majority of the Building 965 Area located specifically within the area of elevated concentrations, is covered with pavement. Based on the data collected at the site, it has been determined that there is no continuing source of VOC mass. Additionally, it is speculated that the presence of overlying pavement has served as a barrier, effectively limiting the rate at which VOC mass can be transferred from the vadose zone to soil gas. Based on this understanding of the site, it is logical to conclude that removing the existing pavement would likely result in decreases in the concentrations of VOCs in soil gas. While pavement removal does not represent a formal remedial technology, removal would be expected to contribute to the overall remedial effectiveness in the Building 965 Area. Given the passive nature of the remedial approach, pavement removal would not be expected to achieve any appreciable mass reduction in the short term, however it is likely that over time VOC concentrations in soil gas would dissipate. This alternative would include limited performance monitoring which would likely consist of sampling soil gas for VOCs on an annual basis to assess the effectiveness of the action. Given that pavement removal is not a formal remediation technology, but may contribute to the overall remedial effectiveness at the site, it has been included as a general component of site preparation for other active treatment technologies.

6.1.6 Source Area Removal. Source area removal would consist of addressing the area of highest concentrations of VOCs by excavating vadose zone soil underneath the former wash pad. By conducting source area removal activities, the areas of highest concentrations in soil gas will incidentally be addressed thereby effectively reducing potential risks posed to a future hypothetical resident via the vapor intrusion pathway. The technology would consist of excavating soil down to the groundwater in the vicinity of the former wash pad south of Building 965. The excavated material will be stockpiled and characterized prior to offsite disposal. The excavation area will be backfilled, compacted, and restored to a condition that is deemed acceptable to both the DON and NUSD. As part of this option, the excavated area will be backfilled with clean, imported soil and compacted to required standards. After the soil is excavated, it will be stockpiled and characterized for subsequent disposal in an appropriate landfill.

Air monitoring would be required for this option to ensure worker health and safety. Mechanical excavation using standard earthmoving equipment, such as a backhoe, is feasible because the vertical extent of the excavation would be relatively shallow (average depth 8 to 9 ft bgs) and covers a relatively small area. All excavated material would be disposed of in an appropriate landfill. Considering the relatively low concentrations of VOCs detected in soil, it is likely that the excavated waste would qualify as non-hazardous material. Considering the overall effectiveness and the high degree of implementability, source area removal has been retained for further evaluation.

6.2 Removal Technology Screening Results

The removal action for the Building 965 Area at Parcel 1A is intended to address elevated concentrations of VOCs in the subsurface so that site closure can be achieved and the property can be transferred to NUSD. To achieve this objective, the following removal alternatives were selected from the screening process and have been evaluated in detail in Section 6.3:

Alternative 1 – No action (as required under the NCP)
Alternative 2 – ICs
Alternative 3 – Source area removal excavation with contingency ICs
Alternative 4 – Source area removal excavation with contingency SVE and contingency ICs

6.3 Detailed Evaluation of Removal Alternatives

In this section, four removal alternatives are evaluated in detail based on their effectiveness at achieving RGs, implementability, and cost. For comparison, the no action alternative is also evaluated as required under the NCP.

To evaluate effectiveness, consideration was given to the overall protection of human health and the environment, compliance with ARARs and other guidance, and both the long-term and short-term effectiveness of the alternative. Appendix A provides the evaluation of ARARs which was conducted to support this removal action. Evaluation of the implementability of each alternative included consideration of the technical feasibility, commercial availability, administrative feasibility, and State of California and public acceptance. State of California Agency and public input will be included as a result of the review process. The acceptance of an alternative will be fully addressed during the public comment period and during preparation of the AM. The Final version of this EE/CA will be made available for a 30-day public comment period and all comments received will be summarized and responses will be provided in the responsiveness summary, which will be included in the AM.

The cost evaluation is based upon estimates for capital and operational costs to implement each removal action alternative. Capital costs include the costs for design, construction, equipment, and mobilization. Operational costs include equipment rental, labor, analytical costs, transportation and disposal fees. Appendix G presents an itemized summary of costs for the four removal technology alternatives. The following subsections present a detailed evaluation of the four removal alternatives considered for the Building 965 Area at Parcel 1A.

Table 6-1 presents a summary of the detailed evaluation results which are described in detail in Sections 6.3.1 through 6.3.4.

Table 6-1. Summary of the Detailed Evaluation

Alternative Description	Qualitative Ranking		
	Effectiveness	Implementability	Cost
(1) No Action	○	Not Applicable	None
(2) Institutional Controls	◑	●	● ($15,488/year)
(3) Source Area Removal Excavation with ICs	◑	●	◑ ($310,193)
(4) Source Area Removal Excavation with Contingency Soil Vapor Extraction (SVE) and ICs	●	●	○ ($486,087)

○ - Low Performance
◑ - Moderate Performance
● - High Performance

6.3.1 Alternative 1 – No Action. The NCP (40 CFR 300.430[e][6]) requires that a no action alternative be evaluated. Under this alternative, no action would be taken to reduce potential risks to human health and the environment. The no action alternative involves no removal of soils and results in no disturbance to the existing environment.

6.3.1.1 Effectiveness. The risks associated with the no action alternative are summarized in the baseline risk assessment presented in Section 6.0. The no action alternative is not considered to provide long-term or short-term effectiveness and permanence because contaminated material would remain at the site and because it does not adhere to the ARARs identified for this removal action.

6.3.1.2 Implementability. The no action alternative is technically easy to implement, but is unacceptable because it does not protect human health and the environment.

6.3.1.3 Cost. No costs are associated with Alternative 1.

6.3.2 Alternative 2 – Institutional Controls. ICs are legal and administrative mechanisms used to implement land use restrictions that are used to limit the exposure of future landowner(s) or user(s) of the property to hazardous substances present on the property, and to ensure the integrity of the remedy. For instance, at Parcel 1A, the Navy would identify and implement appropriate ICs to mitigate potential unacceptable risk to residents via the indoor air pathway. Implementation of ICs includes requirements for monitoring and inspections, and reporting to ensure compliance with land use or activity restrictions.

The Navy has determined that it will rely upon proprietary controls in the form of environmental restrictive covenants as provided in the "Memorandum of Agreement Between the United States Department of the Navy and the California Department of Toxic Substances Control" (DON and DTSC, 2000) (hereinafter referred to as the "Navy/DTSC MOA").

More specifically, land use and activity restrictions will be incorporated into two separate legal institutional control instruments as provided in the Navy/DTSC MOA:

- Restrictive covenants included in one or more Quitclaim Deeds from the Navy to the property recipient.
- Restrictive covenants included in one or more "Covenants to Restrict Use of Property" entered into by the Navy and DTSC as provided in the Navy/DTSC MOA and consistent with the substantive provisions of California Code of Regulations (Cal. Code Regs.) tit. 22 § 67391.1.

The "Covenant(s) to Restrict Use of Property" will incorporate the land use restrictions into environmental restrictive covenants that run with the land and that are enforceable by DTSC and any other signatory state entity against future transferees and users. The Quitclaim Deed(s) will include the identical land use and activity restrictions in environmental restrictive covenants that run with the land and that will be enforceable by the Navy against future transferees.

In addition to being set forth in the "Covenant(s) to Restrict Use of Property" and Quitclaim Deed(s) as described above, restrictions applied to specified portions of the property will be described in findings of suitability for transfer (FOST) and findings of suitability for early transfer (FOSET).

Access. The Deed(s) and Covenant(s) shall provide that the Navy and DTSC and their authorized agents, employees, contractors and subcontractors shall have the right to enter upon Parcel 1A at DODHF Novato to conduct investigations, tests, or surveys; inspect field activities; or construct, operate, and maintain any response or remedial action as required or necessary under the cleanup program, including but not limited to monitoring wells, pumping wells, treatment facilities, and cap/containment systems.

Implementation. The Navy shall address and describe institutional control implementation and maintenance actions including but not limited to frequency and requirements for periodic inspections during development and post development, monitoring, and reporting in the removal action work plan (see "Navy Principles and Procedures for Specifying, Monitoring and Enforcement of Land Use Controls and Other Post-ROD Actions" attached to January 16, 2004 Department of Defense memorandum titled "Comprehensive Environmental Response, Compensation and Liability Act [CERCLA] Record of Decision [ROD] and Post-ROD Policy").

The Navy is responsible for implementing, maintaining, reporting on, and enforcing land use controls. Although the Navy may later transfer these procedural responsibilities to another party by contract, property transfer agreement, or through other means, the Navy shall retain ultimate responsibility for remedy integrity.

Activity Restrictions that Apply throughout Parcel 1A. The following sections describe the institutional control objectives to be achieved through activity restrictions throughout Parcel 1A at DODHF Novato in order to ensure that any necessary measures to protect human health and the environment and the integrity of the remedy have been undertaken.

Restricted Activities. The following restricted activities throughout Parcel 1A at DODHF Novato must be conducted in accordance with the "Covenant(s) to Restrict Use of Property" and Quitclaim Deed(s):

a. Alteration, disturbance, or removal of any component of a response or cleanup action (including but not limited to pump-and-treat facilities, revetment walls and shoreline protection, and soil cap/containment systems); groundwater extraction, injection, and monitoring wells and associated piping and equipment; or associated utilities.

b. Extraction of groundwater and installation of new groundwater wells.

c. Removal of or damage to security features (for example, locks on monitoring wells, survey monuments, fencing, signs, or monitoring equipment and associated pipelines and appurtenances).

Activity Restrictions Relating to VOC Vapors within Parcel 1A. Any proposed construction of enclosed structures must be approved in accordance with the "Covenant(s) to Restrict Use of the Property" and Quitclaim Deed(s) prior to the conduct of such activity within the area requiring institutional controls (ARIC) for VOC vapors in order to ensure that the risks of potential exposures to VOC vapors are reduced to acceptable levels that are adequately protective of human health. The ARIC for VOC vapors will include portions of Parcel 1A exhibiting elevated concentrations of VOCs in soil gas, but may be modified by the Navy and DTSC as the impacted areas that are producing unacceptable vapor inhalation risks are reduced over time or in response to further soil, vapor, and groundwater sampling and analysis for VOCs that establishes that VOC vapors do not pose an unacceptable potential exposure risk to inhalation of indoor air.

6.3.2.1 Effectiveness. If properly implemented and maintained, ICs would be effective in limiting human exposure to contaminated media and potential pathways of concern (e.g., inhalation of indoor air). Though it is likely that ICs would be effective, continued monitoring would be required to verify the effectiveness and ensure that all exposure pathways are being controlled. Considering the relatively high levels of vinyl chloride underneath the wash pad, ICs may not be appropriate as a standalone remedy in the wash pad area.

6.3.2.2 Implementability. The implementability is moderate because while the regulatory agencies may not find ICs favorable as a standalone remedy for the Site, ICs can effectively address risks to the vapor intrusion pathway. However, considering the future use of Parcel 1A as a potential school, active remediation may be required in addition to ICs to remove the source of VOC mass to soil gas. Additionally, the existing FOST, which is currently under development, would need to be updated. Public acceptance of ICs is considered moderate because this alternative does not include action at the site that may be disruptive to nearby residents. Conversely, the public may consider ICs as a passive approach to addressing risk at the site.

6.3.2.3 Cost. The total cost of Alternative 2 is estimated to be $15,488 per year. The total cost for Alternative 2 includes the administrative costs associated with conducting inspections of LUC implementation, annual monitoring (i.e., indoor air sampling) to ensure that vapor mitigation measures are successfully eliminating the indoor exposure pathway, as well as reporting costs. While the annual costs appear low, cumulative costs could be moderate to high. A cost estimate, including inspection/reporting costs, is provided in Appendix G.

6.3.3 Alternative 3 – Source Area Removal Excavation with ICs. Alternative 3 involves conducting a source area removal excavation as well as ICs (as described in Section 6.3.2), which would be implemented to address low level residual impacts if it were determined that the post excavation risks are unacceptable. While a source area removal excavation is expected to result in significant reductions in site risks, it still may be necessary to implement ICs to manage residual risk.

The following features of work would be conducted as part of a source area removal excavation:

Excavation, Confirmation Sampling, and Backfilling. Figure 6-1 presents a conceptual overview of the proposed excavation in the area of the former wash pad. Within this area, heavy earth-moving equipment, such as a track-mounted excavator and track- or wheeled-loaders, would be used to break up

and remove concrete at the surface, and to excavate the impacted soil down to the groundwater surface. The soil removal excavation would progress vertically and laterally to effectively reduce potential risks, and remove areas of elevated concentrations that may pose a potential source of VOC mass to the vapor intrusion pathway. The excavation sidewalls would be sloped or benched to maintain sidewall stability and avoid the need for shoring.

Confirmation sampling of soil would be conducted along the excavation floor and sidewalls to ensure that concentrations of VOCs in soil would not pose continuing source of VOC mass to soil gas after the excavation was backfilled. A licensed land surveyor would survey the final spatial limits of the excavation after confirmation results are received, but prior to placement and compaction of backfill. Prior to the initiation of backfilling, the exposed bottom of the excavation would be moisture conditioned and the excavation would be backfilled with imported clean soil.

Temporary Storage of Excavated Soil Stockpiles. During the removal action, the excavation and stockpile areas would be delineated with barricades, caution tape, and warning signs to restrict unauthorized access. Potential exposure and protection procedures for site workers would be addressed in a site-specific health and safety plan. The risk of exposure for site personnel to soil contaminants would be minimized by proper selection of personal protective equipment (PPE); establishing support, contaminant reduction, and exclusion zones; applying suppressants to reduce dust emissions and minimize potential volatilization of VOCs in the excavation and associated stockpiles; and monitoring dust using direct-reading instruments.

A medium-sized tracked excavator (Caterpillar® 235 or equivalent) would be used to excavate the soil and place it in stockpiles adjacent to the working area of the excavation. Once a waste profile has been established with the landfill, a large capacity front-end loader would transfer the stockpiled soil to 23-ton end dump trucks for transport and disposal. Stockpiles would remain on-site until the laboratory analyses are received and the final waste profile has been approved by both the landfill and the DON. Plastic sheeting would be used to protect the ground surface beneath the loading area and to prevent leaching from the excavated soils. The stockpiles would be periodically wetted and regularly monitored to ensure that fugitive dust emissions are being controlled. Stockpiles would be covered with Visqueen (plastic) sheeting and secured with sand bags to reduce volatilization and manage stormwater discharge (if necessary).

Sampling and Analysis of Soil Stockpiles for Waste Characterization. Soil stockpile samples would be subject to appropriate testing and analyses to determine the waste classification of the soil for disposal purposes. Waste classification tests for California facilities include the Toxic Characteristic Leaching Procedure (TCLP) and California Waste Extraction Test (WET) to determine if the waste is Resource Conservation and Recovery Act (RCRA)-hazardous or California-hazardous, respectively. Both the TCLP and WET stipulate concentration limits are for numerous chemical constituents; however, the tests can be performed for only selected constituents (i.e., rather than the entire list of regulated constituents) if site data or prior knowledge of site operations are available to justify an abbreviated analytical list. Therefore, all available soil analytical results from previous investigations at Parcel 1A were compiled and evaluated to determine the appropriate analyses to perform on stockpile samples. Based on the evaluation of available data, benzene, trichloroethene, and vinyl chloride are the primary chemicals that need to be considered for waste classification purposes. Table 6-2 summarizes the preliminary screening criteria that would be used to classify stockpiled waste.

Table 6-2. Preliminary Waste Classification Criteria

Chemical	California-Hazardous Criteria		RCRA-Hazardous Criteria
	TTLC (mg/kg)	STLC (mg/L)	TCLP (mg/L)
Benzene NE		NE	0.5
Trichloroethene 2,	040	204	0.5
Vinyl Chloride	NE	NE	0.2

NE = not established
STLC = soluble threshold limit concentration
TTLC = total threshold limit concentration
TCLP = Toxicity Characteristic Leaching Procedure

Transportation of the Excavated Soil to an Off-Base Disposal Facility. Although all excavated soil is expected to be non-hazardous, for planning purposes it is assumed that all RCRA-hazardous and California-hazardous soil will be transported under a waste manifest to a waste management facility for treatment and/or disposal. Non-hazardous soil will be disposed of at a Class III landfill permitted to accept inert waste. All required placards will be placed on vehicles prior to leaving the site. All federal and California Department of Transportation (DOT) guidelines and regulations will be followed. Each transport truck is expected to haul 18 yd^3 (23 tons) of soil to the disposal facility. Transportation of the excavated soil will occur only after the stockpile sampling results are received and the waste is classified according to the sampling results.

Site Restoration. The excavation will be backfilled flush with the adjacent pavement and will match the original surface contours. However, because redevelopment of an unknown nature will occur on the entire Parcel after the property is transferred, the excavation area will not be re-paved.

Performance Monitoring. Approximately one month after the completion of the removal excavation, soil gas sampling will be conducted within and around the removal excavation to evaluate potential rebound within the excavation footprint and to evaluate whether the excavation resulted in reductions of VOC concentrations in soil gas outside the excavation area. For costing purposes, it has been assumed that two performance monitoring events would be conducted following the excavation. The first of which would occur one month after completion of the excavation which would be followed by another round of performance monitoring three months after the completion of the excavation. Due to the lack of VOC sources in soil or groundwater, the potential for significant contaminant rebound in soil vapor is considered low. However, the results of the first two rounds of performance monitoring will be evaluated to determine whether additional rounds of performance monitoring are necessary to ensure that rebound does not occur. If the results from the first two rounds of performance monitoring indicate that concentrations of VOCs in soil gas are stable or decreasing, then the Navy would not consider additional performance monitoring being necessary. Nevertheless, the Navy will discuss the potential need for additional performance monitoring data with the regulatory agencies after receiving the first two rounds of data.

Institutional Controls. The removal excavation discussed above is expected to result in significant reduction in the overall risk to human health at the Site, but it is possible that residual risks may be unacceptable based on the planned future use of Parcel 1A. Therefore, after the completion of the final round of performance monitoring, the Navy (in consultation with the regulatory agencies) will determine whether ICs are necessary to manage residual risks at the site. If it is determined that ICs are required to address residual concentrations of VOCs, the Navy will work closely with the agencies to update the FOST and create appropriate ICs so that the human health risks of inhalation of indoor air at Parcel 1A are considered acceptable.

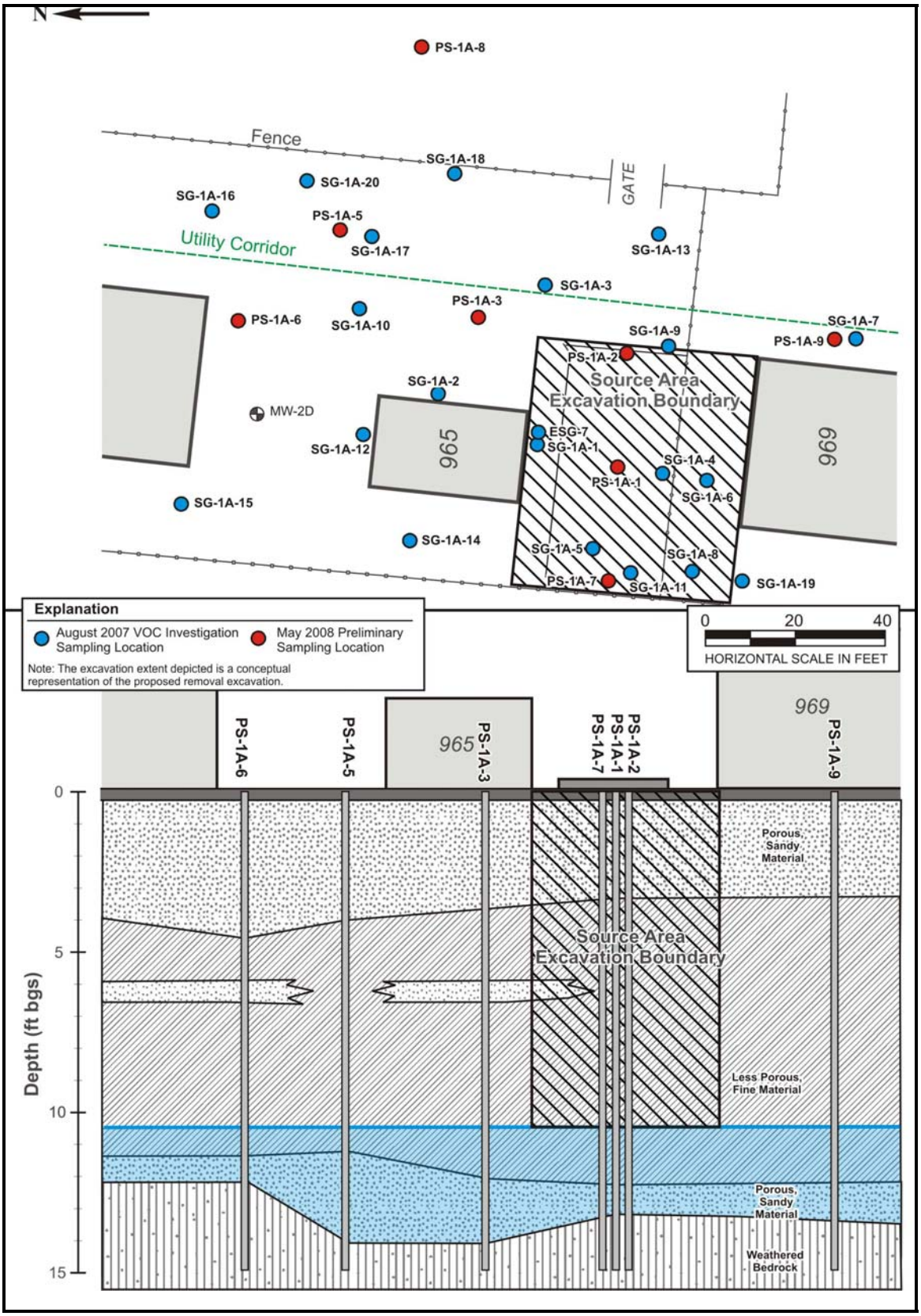


Figure 6-1. Alternative 3 – Source Area Removal Excavation with ICs

6.3.3.1 Effectiveness. Alternative 3 would provide a moderate degree of effectiveness and permanence because contaminants are removed from the subsurface and the impacted soil is replaced with clean, imported fill, thus providing a permanent solution for protecting human receptors and resulting in a significant reduction of risk at the site. Excavation and off-site disposal would be effective at addressing VOCs in soil-gas by removing the soils that potentially serve as a source to soil gas, and by removing areas in which elevated soil gas concentrations posing a potential unacceptable risk to a future hypothetical resident via the indoor air pathway. However, there is no additional active treatment included to address residual concentrations of VOCs that could remain the subsurface after the excavation. The inclusion of ICs as a component of the alternative provides a passive mechanism to address residual risks if VOC concentrations persist in soil gas outside the excavation boundary.

6.3.3.2 Implementability. This alternative can be implemented rather easily because the footprint of the excavation would coincide with the general location of the former wash pad. In addition, the necessary equipment, materials, and labor to perform an excavation and dispose of the contaminated soil are common and readily available. Licensed disposal facilities capable of accepting the contaminated soil and groundwater currently exist within the State of California. Because the majority of the impacted soil and groundwater will be permanently removed from the site, future soil and groundwater remedial/removal activities are not expected to be necessary. In addition, the progression of the excavation would be relatively straightforward because minimal underground utilities exist in the area of the former wash pad and the total depth of excavation is only anticipated to be 8 to 9 ft bgs. The excavation area contains ample working space, includes open, paved areas that could be used to stockpile excavated soil, and would be easily accessible to trucks during disposal activities. While ICs may not be an effective standalone remedy at the site, Alternative 3 includes ICs as a contingency measure to accompany active remediation, which likely increases overall effectiveness of the remedy.

6.3.3.3 Cost. The total cost for Alternative 3 is $310,193 and includes the administrative costs associated with ICs, demolition and removal of the concrete pad, excavation of approximately 900 yd^3 of soil, transportation of excavated soil, off-site disposal (Class II Landfill), backfilling and compaction, and performance monitoring after completion of the excavation.

6.3.4 Alternative 4 – Source Area Removal Excavation with Contingency SVE and ICs. This alternative involves conducting a removal excavation along with contingency SVE and ICs (as described in Section 6.3.2). The removal excavation is expected to result in significant reduction in the overall risk to human health in the Building 965 Area, but it is possible that residual risks may be above 1×10^{-6} based on the planned future school use of Parcel 1A after completion of the excavation.

Depending on the results of post-excavation monitoring, this alternative includes the implementation of any one of the following options: (1) no further action required, (2) contingency SVE system to remove volatile compounds from unsaturated soils outside the footprint of the excavation (see Figure 6-2); (3) implementation of ICs as a result of post-excavation monitoring; or (4) a combination of items (2) and (3). Two rounds of performance monitoring will be conducted after the completion of the removal excavation to determine the effectiveness of the removal excavation and potential soil gas rebound in and around the excavation footprint. The first round will be conducted one month after the excavation followed by another round three months after the excavation. After the completion of each round of post-excavation performance monitoring, the Navy (in consultation with the regulatory agencies) will determine whether the ICs or SVE contingencies are necessary to manage residual risks. The contingency decision-making process will specifically consider whether the SVE system can achieve appreciable reductions in risks from potential exposure to vapors to levels below 1×10^{-6} and whether residual concentrations of VOCs in soil gas can be effectively managed using ICs requiring vapor barriers or other vapor management technologies. If it is determined that ICs cannot effectively manage residual risk and

SVE could achieve appreciable reductions in risk in the area (e.g., more than an order of magnitude) while bringing them below 1×10^{-6}, then the contingency SVE system would be installed and operated.

Contingency SVE. SVE removes chemical mass by creating a negative pressure in the vadose zone, which results in the removal and treatment of impacted soil vapor. The goal of the SVE system, if required, would be to remove concentrations of VOCs from vadose zone so that residual risk is acceptable for unrestricted land use. System operation would be discontinued if the following condition is met:

1. VOC removal results in risks to human health that are within acceptable limits for unrestricted use (i.e., below 1×10^{-6}).

If one of the two following conditions are encountered during SVE system operation, the Navy will consult with the regulatory agencies to discuss potential shutdown of the SVE system:

2. Soil gas concentrations in performance monitoring probes reach and remain at asymptotic conditions (i.e., the slope of time-series soil gas results in performance monitoring probes approaches zero).
3. The SVE system has operated for a four to six month time-frame.

Institutional Controls. If it is ultimately determined that ICs are required to address residual concentrations of VOCs, the Navy will work closely with the agencies to amend FOST IV-D and create appropriate ICs (like those described in Section 6.3.2) for Parcel 1A.

6.3.4.1 Effectiveness. As discussed in Section 6.3.3.2, the excavation and contingency ICs would be highly effective at addressing the area of the highest concentrations of VOCs in soil gas. The effectiveness of the SVE component is highly dependant on the permeability of the vadose zone soil within the treatment area. A higher permeability is favorable because it allows soil vapor to be easily extracted and treated. Additionally, more uniform, permeable soil decreases the likelihood of encountering areas of low permeability through which soil vapor may not be easily transmitted. The results of the preliminary sampling activities indicated that the soil underneath the concrete pad is heterogeneous, but does contain porous intervals, which suggests that SVE could be effective. Additionally, there were no significant residual sources of VOC mass to soil gas, which is also favorable for higher short-term effectiveness of SVE.

6.3.4.2 Implementability. As discussed in Section 6.3.3.3, the technical implementability of conducting the excavation component of this alternative would be high. The technical implementability of the SVE component would be moderate because the treatment area would be easily accessible and because most equipment required for constructing the system (e.g., vacuum blower) is already present at the site. However, the construction of an SVE system would require obtaining a discharge permit from the Bay Area Air Quality Management District, which in the past has required a three to six month waiting period. Additionally, the operational period of the SVE system would be uncertain and rebound monitoring would likely be a necessary component of SVE implementation. Alternative 4 includes ICs as a contingency measure to accompany active remediation, which likely increases effectiveness of the overall remedy.

6.3.4.3 Cost. The total cost for Alternative 4 is $486,087 and includes the demolition and removal of the concrete pad, excavation of approximately 900 yd^3 of soil (see Figure 6-1), transportation of excavated soil, off-site disposal (Class II Landfill), backfilling and compacting the excavation area, planning, permitting, SVE well installation (see Figure 6-2), system construction, pre-design testing, appropriate security provisions, noise control measures, operation and maintenance, and performance monitoring.

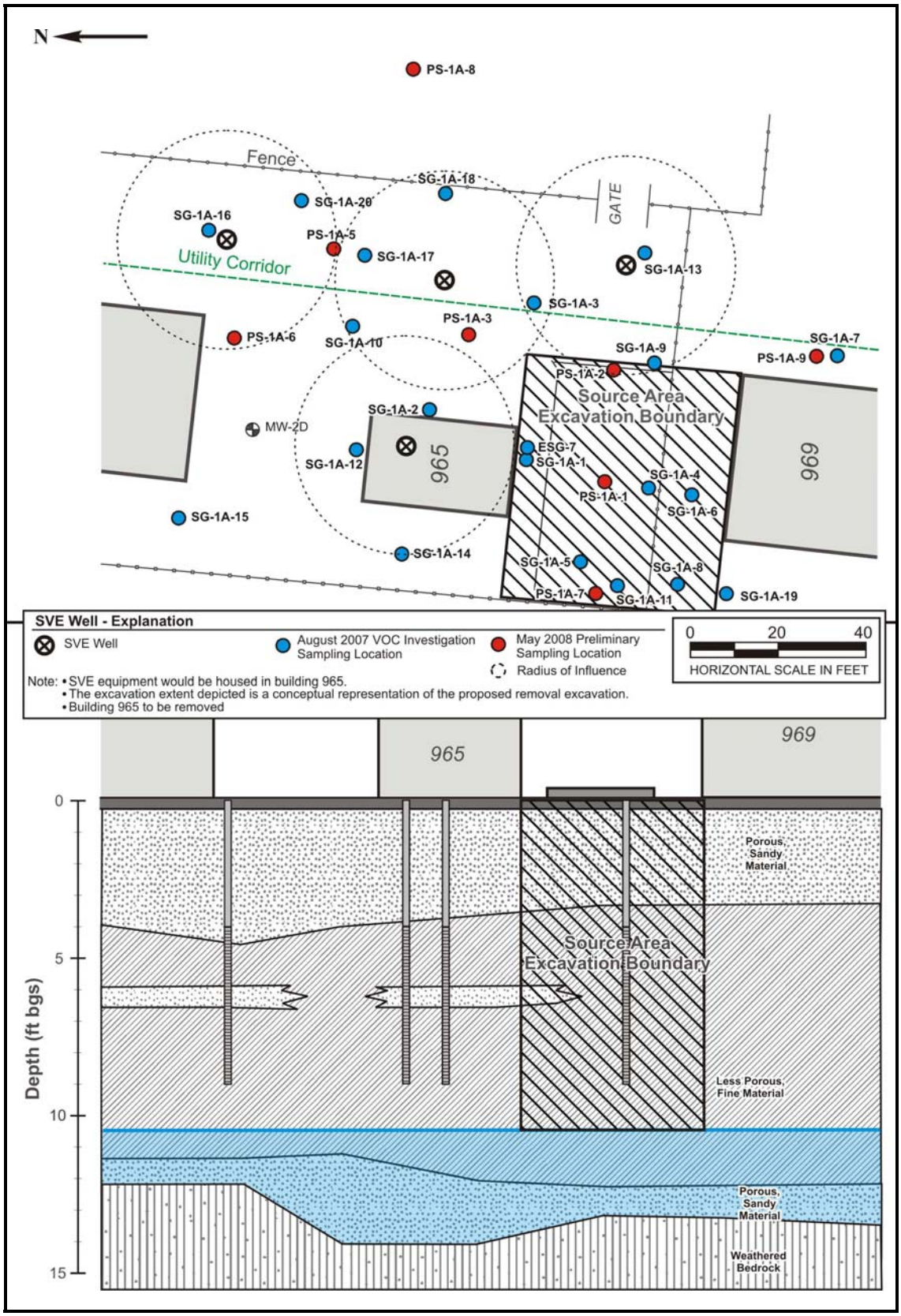


Figure 6-2. Alternative 4 – Source Area Removal Excavation with Contingency SVE and ICs

Section 7.0: COMPARATIVE ANALYSIS OF REMOVAL ALTERNATIVES

The following section provides a comparative analysis of the removal action alternatives evaluated in Section 6.0 based on effectiveness, implementability, and cost.

7.1 Effectiveness

Alternative 1 is not expected to be effective due to the potential unacceptable indoor air risk based on the planned future use of the site. Alternative 2, ICs, is expected to be moderately effective because ICs are expected to limit or prevent the potential exposure of future human health receptors to VOC concentrations through the inhalation of indoor air. While ICs would limit or prevent exposure, Alternative 2 does not include active treatment to remove or degrade chemical mass from the subsurface. Alternatives 3 is also considered moderately effective because while it provides active treatment to remove the areas of highest concentrations, there is no additional action included to address residual concentrations of VOCs that could remain the subsurface after the excavation. Alternative 4 is considered highly effective because it includes active treatment to address the area of highest concentrations along with an SVE contingency to address residual concentrations of VOCs, specifically cis-1,2-DCE, a parent compound of vinyl chloride, that may not be removed by the excavation. To date site characterization data has indicated that the area directly underneath the wash pad contributes significantly to the overall risk at the site. The proposed removal excavation would remove this area of the subsurface, thereby significantly reducing the presence of VOCs in the environment which would result in reductions to the overall risk at the site. The ICs that have been included in Alternatives 3 and 4 would only be implemented if it was determined necessary to address residual risk remaining after the completion of active treatment.

Alternative 4 includes a contingency to conduct SVE in the event that the removal excavation does not result in sufficient risk reduction to achieve RAOs. SVE would be implemented to remove additional VOC mass from the subsurface, thereby further reducing risks at the site.

7.2 Implementability

Alternative 2, ICs, are considered highly implementable. ICs have been used to control the exposure of receptors to unacceptable concentrations of VOCs in indoor air; however, Alternative 2 does not include active treatment to actively remove or degrade VOC mass in the subsurface. Alternatives 3 and 4 each include excavation as a means of actively addressing the areas of highest concentrations of VOCs in the subsurface. Excavation is considered to be easily implemented because it represents a proactive approach to reducing risk and is also a mature, proven remediation technology. In addition, Alternatives 3 and 4 include to the implementation of ICs, if determined necessary to address residual risks after active treatment. While Alternative 2 involves implementing ICs as standalone remedy, Alternatives 3 and 4 would include ICs as a contingency measure to accompany various active remediation alternatives. Alternative 4 includes a contingency to conduct SVE, which is also expected to be highly implementable because it is a mature remediation technology and can be easily implemented at the site.

7.3 Cost

Table 7-1 presents a summary of the total cost for each of the alternatives evaluated in Section 6.0. As shown, Alternative 4 represents the highest cost option of the three active treatment alternative (i.e., Alternatives 3 and 4), with Alternative 3 being the lowest cost active treatment alternative.

Table 7-1. Cost of Removal Alternatives

Removal Action Alternative	Cost
Alternative 1 – No action	$0.00
Alternative 2 – ICs	$15,488
Alternative 3 – Source Area Removal Excavation with Contingency ICs*	$310,193
Alternative 4 – Source Area Removal Excavation with Contingency ICs and Soil Vapor Extraction*	$486,087
* Indicates that performance monitoring is included in the total for the alternative	

7.4 Conclusions

Alternative 4 includes excavation to address the area of highest concentrations and a contingency to conduct SVE in the event that the removal excavation does not result in sufficient risk reduction to achieve RAOs. Additionally, ICs are also included as a contingency measure to accompany active remediation if necessary. Alternative 4 is considered both highly effective and highly implementable and, while it is the highest cost alternative, represents a comprehensive removal action approach which has the highest likelihood of addressing site-related impacts without the need for further action. Therefore, Alternative 4, source area removal excavation with contingency ICs and SVE, is the recommended alternative for the NTCRA in the Building 965 Area at Parcel 1A.

Section 8.0: REFERENCES

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