FINAL
SITE CLOSURE REPORT
REQUEST FOR NO FURTHER ACTION

FORMER UST SITE 957/970
FORMER DEPARTMENT OF DEFENSE HOUSING FACILITY NOVATO
NOVATO, CALIFORNIA

Contract No. N62583-11-D-0515
Task Order No. 093
DCN BATL-0515-0093-0003

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ACRONYMS AND ABBREVIATIONS

BaPe	benzo(a)pyrene toxicity equivalent
bgs	below ground surface
BRAC	Base Realignment and Closure (Act of 1990)
BTEX	benzene, toluene, ethylbenzene, and total xylenes
CAP	Corrective Action Plan
COC	constituent of concern
COPC	chemical of potential concern
CPT	cone penetrating testing
CSM	conceptual site model
DEHS	Department of Environmental Health Services
DIPE	isopropyl ether
DoD	Department of Defense
DoDHF	Department of Defense Housing Facility
DQO	data quality objective
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resource
ETBE	ethyl tert-butyl ether
ESL	environmental screening level
HAAF	Hamilton Army Air Field
HHRA	human health risk assessment
IAS	in-situ air sparge
IC	institutional control
LEA	leading edge area
LNAPL	light nonaqueous-phase liquid
MCL	maximum contaminant level
MNA	monitored natural attenuation
MTBE	methyl tert-butyl ether
NEX	Naval Exchange
NFA	no further action
NUSD	Novato Unified School District
OWS	oil/water separator
PAH	polycyclic aromatic hydrocarbon
PBC	Public Benefit Conveyance
PMO	Program Management Office
PRG	preliminary remedial goal
PWC	Public Works Center
RAO	removal action objective
RBCA	risk-based corrective action
RBSL	risk-based screening level

RDWP	remedial design work plan
RI	remedial investigation
SCAPS	site characterization and analysis penetrometer system
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAME	tert-amyl methyl ether
TBA	tert-butyl alcohol
TBF	tert-butyl formate
TPH-D	total petroleum hydrocarbons-diesel
TPH-G	total petroleum hydrocarbons-gasoline
TPH-MO	total petroleum hydrocarbons-motor oil
TPH-O	total petroleum hydrocarbons-oil
U.S. EPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
VOC	volatile organic compound
Water Board	California State Water Resources Control Board

EXECUTIVE SUMMARY

Battelle has prepared this Closure Report for Former Underground Storage Tank (UST) Site 957/970 at Former Department of Defense Housing Facility (DoDHF), Novato, California under Environmental Services and Technologies Contract Number N62583-11-D-0515, Contract Task Order 093, administered by the U.S. Department of the Navy (Navy) Base Realignment and Closure (BRAC) Program Management Office (PMO) West. The Navy is submitting this document to request a no further action (NFA) decision for petroleum-related constituents in soil and groundwater associated with the Former UST Site 957/970 area.

Former UST Site 957/970 (the Site) DoDHF Novato, California, is located approximately 20 miles north of San Francisco in Marin County, California, and comprises an area of approximately 13 acres. The Site is the location of a former Navy Exchange (NEX) gas station and a former Naval Public Works Center (PWC) gas station that were in use from the mid-1970s to the early 1990s and operated USTs that stored gasoline. At the time the gas stations were closed, the three USTs that had supported the NEX gas station (UST 970-1, UST 970-2, and UST 970-3) and the single UST (UST 957) that had supported the PWC gas station were removed. Because groundwater at the site was thought to be impacted by fuel releases from both the NEX gas station and the PWC gas station, the respective site designations were merged and the label "Former UST Site 957/970" was adopted.

Remedial activities have been ongoing at the Site since characterization and source removal activities began in 1992. From 1998 to 2010, the Navy conducted in situ remediation in the former source area (1998-2009) and at the leading edge area (2009-2010) to treat petroleum hydrocarbons including benzene, toluene, ethylbenzene, xylenes (BTEX), total petroleum hydrocarbons (TPH) and methyl tert-butyl ether (MTBE). In addition, from 1998 to 2011, the Navy has conducted eight human health risk assessments throughout the environmental remediation process at the Site.

For the purposes of this report a risk-based screening evaluation was performed to determine potential risk from groundwater, soil, and soil gas based on the California Regional Water Quality Control Board, San Francisco Region (Water Board) *Low-Threat Underground Storage Tank Case Closure Policy* (Water Board, 2012). The results of the evaluation indicate that petroleum and petroleum constituents at the Site do not pose a significant risk to human health and the environment.

In October 2015, the Draft Site Closure Report requesting NFA was submitted to the Water Board and Department of Toxic Substances Control (DTSC). Through the regulatory review process, a data gap was identified for total petroleum hydrocarbons quantified as gasoline (TPH-G) data in groundwater. Specifically, the groundwater in the vicinity of Former UST Site 957 had not been analyzed for TPH-G since 2006. In an effort to address the TPH-G data gap, the Water Board requested that the Navy collect groundwater samples from monitoring wells within the vicinity of Former UST Site 957 and that these samples be analyzed for TPH-G. The Navy subsequently collected groundwater samples from eight monitoring wells in the Former UST 957 vicinity during the December 2015 annual groundwater sampling event to address the TPH-G data gap. The analytical results of the 2015 annual groundwater monitoring including the TPH-G data are presented in this Closure Report.

Multiple lines of evidence based on site-specific conditions presented in this Closure Report, and the results of the risk-based screening evaluation, support the Navy's position that the Site is a low threat to human health and the environment for petroleum and petroleum constituents. Therefore, the Navy requests NFA for petroleum and petroleum constituents at the Site.

Section 1.0: INTRODUCTION

Battelle has prepared this Closure Report for Former Underground Storage Tank (UST) Site 957/970 (the Site) at Former Department of Defense Housing Facility (DoDHF), Novato, California under Environmental Services and Technologies Contract Number N62583-11-D-0515 , Contract Task Order 093, administered by the U.S. Department of the Navy (Navy) Base Realignment and Closure (BRAC) Program Management Office (PMO) West. The Navy is submitting this document to request a no further action (NFA) decision for petroleum-related constituents associated with the Former UST Site 957/970 area.

1.1 Scope and Objectives

The scope and objectives of this Closure Report are as follows:

- Describe the geology, hydrogeology, and physical features of the Site
- Summarize past operations, investigations, remedial activities, and associated results
- Summarize the recently developed fate and transport groundwater model
- Evaluate the potential significance of residual levels of petroleum constituents in soil and groundwater at the site using a risk-based screening method
- Recommend NFA for petroleum constituents at the Site based on a multiple lines of evidence approach and the results of the risk-based screening evaluation.

1.2 Report Organization

This report is organized as follows:

- Executive Summary – summarizes the purpose of the Closure Report, overview of the work performed, results, and recommendation
- Section 1.0 (Introduction) – presents the purpose, scope, objectives, and organization of the report
- Section 2.0 (Site Background) – describes past site operations, geology, and hydrogeology
- Section 3.0 (Site Characterization and Remediation Activities) – discusses previous investigations, remedial activities, results, and the current fate and transport groundwater model
- Section 4.0 (Risk Evaluation) – describes screening criteria, data selection, evaluation methodology, and results
- Section 5.0 (Low-Risk Criteria Evaluation) – provides an assessment of low-risk determination
- Section 6.0 (Conclusions and Recommendations) – provides conclusions and significant findings and associated recommendations
- Section 7.0 (References) – lists documents cited in the text, tables, and figures
- Appendix A – Comprehensive Tabulated Groundwater Data

- Appendix B – Final 2014 Annual Site Status Report
- Appendix C – Letter from Marin County Department of Environmental Health Services
- Appendix D – Summary of Model Development and Results

The focus of this Closure Report is to provide the information needed to determine if the Site qualifies as a low-threat petroleum site as outlined in the California State Water Resources Control Board's *Low-Threat Underground Storage Tank Case Closure Policy* (Water Board, 2012), and should be recommended for closure with NFA.

Section 2.0: SITE BACKGROUND

This section summarizes the site history, regulatory framework in which past remedial activities have been implemented, institutional controls (ICs) associated with the Site, and the geology and hydrogeology of the Site.

2.1 Site Description

Former UST Site 957/970 DoDHF Novato, California, is located approximately 20 miles north of San Francisco in Marin County, California, and comprises an area of approximately 13 acres. The Site is the location of a former Naval Exchange (NEX) gas station and a former Naval Public Works Center (PWC) gas station that were in use from the mid-1970s to the early 1990s and operated USTs that stored gasoline. At the time the gas stations were closed, the three USTs that had supported the NEX gas station (UST 970-1, UST 970-2, and UST 970-3) and the single UST (UST 957) that had supported the PWC gas station were removed. Because groundwater at the site was thought to be impacted by fuel releases from both the NEX gas station and the PWC gas station, the respective site designations were merged and the label "Former UST Site 957/970" was adopted. A site location map depicting former UST Site 957/970 and the surrounding vicinity is provided in Figure 1. Pacheco Creek is the nearest surface water body, located approximately 800 ft northwest of the NEX gas station associated with Former UST Site 957/970 (Figures 1 and 2). Although the Navy continues to monitor petroleum constituents associated with former facilities, all former Navy property has been deemed suitable for transfer and is currently owned by the planned property recipients.

2.2 Site History and Tank Removal

The NEX gas station was located at the northwest corner of Main Entrance Road and C Street (Figure 2), where Building 970 and associated pump islands were in operation from the mid-1970s through the early 1990s. The NEX gas station was closed in the early 1990s and, subsequently, the three USTs supporting the station (970-1 [10,000-gallon UST], 970-2 [10,000-gallon UST], and 970-3 [10,000-gallon UST], collectively referred to as UST 970 complex) were excavated and removed from the site along with underlying and adjacent soil. The PWC gas station was located approximately 700 ft north of the NEX gas station and was the site of UST 957 (12,000-gallon UST), which was removed along with its associated underground piping and underlying/adjacent soil in 1992.

2.3 Regulatory Framework

The U.S. Navy is the lead agency administrating the remediation and closure of the Site, and it is Department of Defense (DoD) policy to achieve site closure with the agreement of local regulatory authorities. Because the source of gasoline constituents was a UST hydrocarbon release, the Regional Water Quality Control Board (Water Board) is the local regulatory authority with which this project has been coordinated. The California Department of Toxic Substances Control (DTSC) is involved as the lead state agency for closing former military installations and has oversight concerning risk assessment activities at the Site.

On July 19, 2000, the Water Board adopted Order 00-064 establishing a series of tasks (1 through 9) to be performed at the Site and a schedule by which those tasks would be performed to remediate petroleum constituents present at the Site. In response, the Navy developed a remedial approach to address source area contamination and effectively control the migration of methyl tert-butyl ether (MTBE) off Navy property, which was provided in the initial Corrective Action Plan (CAP)

(Battelle, 2002a) for Former UST Site 957/970. To date, the Navy has successfully completed all tasks associated with Order 00-064, as summarized in Table 1.

Tasks 1 and 2 required that a work plan for a remedial investigation (RI) be developed and implemented at the Site. A work plan for RI sampling was developed and sampling was performed in 2000, with the RI Report being issued in 2001 (Battelle, 2001a). The purpose of the RI was to gather additional data to augment historical data that existed at the time, and to fill data gaps so that the vertical and horizontal extent of petroleum constituents in soil and groundwater was adequately defined. During the RI soil sampling activities, a total of 40 soil borings were advanced in and around the NEX and PWC source areas, with shallow and deep samples generally being collected from each boring. Samples were analyzed for MTBE, benzene, ethylbenzene, toluene, xylenes (BTEX), total petroleum hydrocarbons quantified as gasoline (TPH-G), and total petroleum hydrocarbon quantified as diesel (TPH-D). Concentrations of petroleum constituents detected in soil samples were reported in the RI Report (Battelle, 2001a) and were assessed in the Final Revised Risk Assessment (Battelle, 2001b). The RI Report concluded that, due to the limited extent and degree of hydrocarbon-impacted soils at the Site, no additional treatment or removal of soils was necessary. Potential exposure to petroleum hydrocarbons in soil was limited by an asphalt cap and because they were generally greater than 6 feet below ground surface (bgs) in areas other than around the Building 970 footers (see discussion of Task 3 below). If, in the future, underlying soils were to be disturbed during redevelopment activities at the Site or Building 970 is scheduled to be demolished, the RI recommended that a soils management plan be developed, reviewed, and approved by the Navy and regulatory agencies and that impacted soils exceeding applicable screening levels be removed and properly disposed of by the party responsible for the activities.

Tasks 3 and 4 required the development and implementation of an interim remedial action work plan to address soils found to contain significant concentrations of petroleum constituents during the RI sampling activities conducted under Tasks 1 and 2. The findings of the RI indicated that no additional treatment or removal of soils in the former 957 and 970 source areas was necessary. Therefore, the interim remedial action carried out under Tasks 3 and 4 focused on the removal of hydraulic lifts, associated control lines, an oil/water separator (OWS), and any soils impacted with significant concentrations of petroleum constituents in Building 970. Tasks 3 and 4 were completed by preparing and implementing a plan to remove the subject infrastructure and soil because it may serve as a continuing source of petroleum constituents to soil and groundwater. Details about the removal activities carried out during the interim remedial action in Building 970 are summarized in Section 3.0 and can be reviewed in the *Draft Summary Report for Hydraulic Lift and Oil/Water Separator Removal from Building 970, Department of Defense Housing Facility (DoDHF) Novato, California* (Battelle and RRM, 2000). Verification soil sampling was performed at locations immediately beneath and around the removed subsurface infrastructure to confirm the absence of impacted soils or to define the degree and extent of impacted soils that had to be left in place. Samples were analyzed for the presence of total petroleum hydrocarbons quantified as oil (TPH-O), TPH-G, BTEX, MTBE, and metals. The only exceedance of industrial preliminary remedial goals (PRGs) was lead at one location. The hydrocarbon-impacted soils remaining were almost exclusively limited to small volumes underlying building footings and walls, which had to be left in place due to concerns related to structural safety.

The results of the final revised risk assessment and the recommendations from the hydraulic lift report (Battelle and RRM, 2000) indicated that no corrective action was required to protect human health and the environment from these soils. ICs were established to manage these soils and ensure that if these soils are disturbed, they will be managed properly and safely. Remedial action objectives (RAOs) for soil were therefore considered to have been achieved by the operation of the interim remedial action and the hydraulic lift removal activities. No further corrective action for soils was required to satisfy

Order 00-064 or to protect human health, the environment, or the water resources of the State of California.

Tasks 5 and 8 included the development of a Groundwater Monitoring Plan and Monitoring Well Protection Plan (Battelle, 2000b, 2000c). The groundwater monitoring plan described procedures for groundwater sampling of existing wells at the Site and surface water sampling of Pacheco Creek. Several groundwater monitoring plans have since been developed and approved by the regulators to adapt to changing conditions associated with groundwater contamination and remediation at the Site.

Task 6 required the preparation of a CAP that took into account all historical characterization data, risk assessments, and remedial activities performed at the Site. The Navy submitted the *Final Corrective Action Plan for Groundwater for Former Underground Storage Tank Site 957/970, Department of Defense Housing Facility, Novato, CA* (Battelle, 2002a), recommending a remedial strategy that included biosparging with a soil vapor extraction (SVE) contingency, monitored natural attenuation (MNA), and ICs to achieve the final cleanup goals at the Site. The Final CAP was approved by the Water Board and the remedial strategy was implemented.

Task 7 required that interim controls be placed on any soils that were excavated and groundwater that was extracted and discharged from the Site in order to protect human health and the environment. The Navy submitted the *Interim Site Control Plan for the Department of Defense Housing Facility, Novato, California* (Battelle, 2001c) to complete Task 7.

Task 9 required that Site Status Reports be developed on a quarterly basis and include all data gathered and observations made during each sampling event, a summary of findings, potentiometric maps, and tabulated groundwater level measurements and groundwater analytical reports for all petroleum constituents analyzed. Task 9 was subject to updates over time based on changes to site conditions and data quality objectives (DQOs), as long as the regulatory agencies approved of the updates. Due to changes in conditions at the Site and the fact that such a significant amount of data have been collected to provide a detailed understanding of site conditions, the regulatory agencies approved of annual groundwater sampling and one Annual Site Status Report starting in 2014.

2.3.1 Institutional Controls and Future Land Use. The Navy has transferred ownership of DoDHF Novato under the BRAC program as described in the Hamilton Army Airfield Reuse Plan: Final Reuse Plan (Hamilton Local Reuse Authority, 1996). The Navy segregated the property into various land parcels to support planned property transfer activities. Figure 2 illustrates the boundary of the four parcels that comprise or are within the immediate vicinity of Former UST Site 957/970. To date, all four parcels have been transferred with the planned future land uses reference below:

- Public Benefit Conveyance (PBC) Parcel 1A – school/residential
- PBC Parcel 1B – school/residential
- Commissary Triangle Parcel – community facilities
- Hamilton Square Parcel – commercial/industrial but the current property owner is moving ahead with plans to conduct additional remedial activities such that residential reuse will be allowed.

ICs were a component of the remedy selected in the Final CAP (Battelle, 2002a). The objectives of the ICs are twofold: 1) to ensure that commercial use of the land at the gas station site (immediate area surrounding Building 970) is maintained and that residential use is prohibited in that area; and 2) to ensure that future actions over the entire site do not affect the petroleum constituent

groundwater plumes. The primary legal mechanism used to implement land use controls are restrictions included in the quitclaim deeds for the subject property. The following restrictions and controls apply to the entire Site:

- Construction and/or operations on the property shall not interfere with the ongoing monitoring or assessment of work being conducted by or for federal, state, or local regulatory agencies. Removal and disposal of contaminated soil or groundwater by the transferee, its successor or assigns shall be conducted in accordance with all applicable federal, state, and local regulations governing removal, transport, and disposal of hazardous substances and hazardous waste.
- Disturbance of existing groundwater wells is prohibited unless specifically approved by the Navy and the Water Board. No groundwater production wells may be installed for residential, municipal, agricultural, or industrial use, without written approval of the Water Board. Monitoring and other test wells are not subject to this provision, including borings for the purpose of testing wells, wells for monitoring the quality of groundwater, and borings to define geology.

In addition to the above restrictions and controls, construction and occupation of residential structures or day-care centers is prohibited on the Hamilton Square Parcel. However, as stated above, the current property owner is moving ahead with plans to conduct additional remedial activities such that residential reuse will be permitted.

In addition to ICs, the Navy entered into an agreement with the State of California, through the DTSC and Water Board, allowing the state, pursuant to California Civil Code Section 1471, to enforce the restrictions on the use of property for the purpose of protecting human health, safety, and the environment. Such a covenant is based on the human health risk assessment models executed by the Navy and the DTSC. This covenant lists environmental restrictions and serves as the primary legal mechanism to enforce land use restrictions.

The *Final Revised Risk Assessment for Former Underground Storage Tank Site 957/970 at the Department of Defense Housing Facility, Novato, California* (Battelle and ERRG, 2011) concluded by recommending the use of ICs to restrict land use for property transfer to Novato Unified School District (NUSD) based on the low magnitude of risks remaining at Parcel 1A. A land use control in the form of a Covenant to Restrict the Use of Property was implemented around Parcel 1A to prevent indoor air exposure and access to groundwater and soil in the area. Details regarding the land use control restrictions in the Covenants to Restrict the Use of Property can be found on record with the County of Marin. Restrictions to subsurface soil and groundwater are summarized below:

Groundwater Management:

- prohibiting activities involving interaction with the groundwater beneath the Site

Soil Management:

- digging restrictions, prohibiting disturbance of the soil unless it is removed and disposed of following all applicable laws and regulations
- prohibiting residential building on the Site; and, ongoing monitoring of contaminated media

Continuing north of Navy property onto former Hamilton Army Air Field (HAAF) property, an area referred to as “Hamilton Meadows Subdivision” exists, and is developed for residential use and

includes recreational areas. The area northwest of Hamilton Meadows Subdivision is open land that is not currently in use. Land use planning documents provided by the City of Novato on its website (City of Novato, 2015) show that the Hamilton Master Plan adopted by the City of Novato presents plans for a 414-acre mixed-use community in this area which includes Community Park (Hamilton Community Park) designations for the former base landfill (Landfill 26) and adjacent former ammunition bunker area, comprising approximately 81 acres. The former landfill and buffer area are retained by the Army (48 acres) in this plan, and adjacent property was deeded to the City of Novato by the federal government for recreational use (http://novato.org/government/community-development/planning-division/planning-projects/hamilton-fields-sports-complex).

2.4 Geology

The Site lies within the Coast Range geomorphic province of northern California, which is characterized by subparallel mountain ranges, alluviated intermontane valleys, and active northwest-oriented strike-slip faults. Surface geology includes Quaternary sediments consisting of Bay Mud, alluvium, and colluvium that overlie Cretaceous Franciscan bedrock. The Franciscan bedrock is generally hard, massive, and slightly fractured. In several upland areas that surround the Site, the Franciscan bedrock outcrops and forms isolated hills (e.g., Ammo Hill and Reservoir Hill).

Site lithology information has been obtained through several cone penetrating testing (CPT) and well installation activities conducted from April 1998 through October 2010. At the Site, an alluvial unit consisting of clays, silts, sands, and gravels directly overlies a bedrock valley. In the southern area of the plume, boring logs indicate that the alluvial unit is highly heterogeneous, consisting of interfingered deposits of clay, silt, sand, and gravel. In the leading edge (northern) area of the plume, the alluvial unit consists of more homogeneous, discrete layers of sandy, silty, and clayey material. In this area, sand tends to immediately overlie the Franciscan bedrock. In turn, clayey materials comprising the Bay Mud unit tend to overlie the sands. In the Landfill 26 area, the alluvial unit is further overlain by a landfill refuse layer and cap material.

The uppermost bedrock unit at the Site is the Franciscan Formation, a blue-gray, fine- to medium-grained sandstone. It has been slightly altered by metamorphism, sealing its primary porosity. The sandstone is often weathered and fractured, creating secondary porosity, and the fractures are commonly filled by either calcite or silica material and is not believed to be a significant source or transmitter of groundwater at the Site. Previously mapped bedrock elevation reveals a bedrock valley beneath the Site (Battelle, 2014). This valley is narrow in the UST source areas and broadens moving northward toward the leading edge area. The bedrock outcrops on the east side of the bedrock valley, forming Reservoir Hill. North of the leading edge area of the plume, the bedrock also outcrops in the middle of the valley, forming Ammo Hill. Bedrock is encountered at approximately 15 ft bgs in the former UST source areas and approximately 23 ft bgs in the leading edge area.

2.5 Hydrogeology

The primary water-bearing zone at the Site is the alluvial unit directly overlying the bedrock unit. Groundwater flow is generally from south to north. Flow gradients are generally steeper in the southern portion of the plume area where the alluvial unit is thinner vertically and narrower west to east due to the structure of the bedrock valley. Flow gradients lessen to the north where the alluvial unit thickens and broadens, again due to the bedrock topography. Figure 3 presents potentiometric surface maps from 2011 through 2015. The bedrock outcrop at Ammo Hill north of the plume leading edge causes groundwater flow in the alluvial aquifer to diverge to the northwest and northeast. Thus, the bedrock topography exerts significant control on groundwater flow in the area. Groundwater recharge in the alluvial aquifer originates primarily from precipitation. In addition, significant groundwater flux is

believed to occur from portions of the alluvial aquifer that are upgradient of the Site. Groundwater in the alluvial unit is unconfined in the southern portion of the plume and confined by the Bay Mud in the northern portion of the plume. A handful of bedrock wells exist at the site, with water levels similar to those observed in adjacent alluvial wells. During sampling, the bedrock wells yield low water volumes, consistent with the belief that the bedrock is not a significant source or transmitter of groundwater at the site. Hydraulic conductivity values in the alluvium from slug test data range from 0.4 ft/day to 20.7ft/day. Slug test data from the bedrock unit suggest hydraulic conductivity values on the order of 0.2 ft/day exist at the site (Battelle, 2002a).

2.5.1 Potential Future Groundwater Use. Groundwater underlying the Former UST Site 957/970 and the leading edge area is located within the Novato Valley Groundwater Basin. The Water Board has designated all groundwater in the Novato Valley Groundwater Basin to be a potential water source for use as domestic or municipal supply which led to the maximum contaminant level (MCL) of 13 micrograms per liter (µg/L) for MTBE being identified as the final cleanup goal in the Final CAP (Battelle, 2002a). It is important to note, however, that although the Water Board has not formally acknowledged that groundwater at the site meets Resolution 88-63 criteria for a municipal beneficial use exemption (Water Board, 1988, amended in 2006), purge logs from several years of site investigations utilizing low-flow groundwater sampling techniques show relatively low groundwater yields and suggest that the aquifer would very likely meet beneficial use exemption 2 in Resolution 88-63 (i.e., a water well installed in this portion of the aquifer cannot supply a sustained yield of 200 gallons/day). Table 2 presents groundwater monitoring well completion specifications and well yield information from all groundwater monitoring wells currently sampled as part of the groundwater monitoring program. The well yield values were derived from the 2014 groundwater sampling purge logs used in the field during low-flow groundwater sample collection. Several of the monitoring wells on site often exhibit excessive drawdown (greater than 0.33 ft when pumped at low-flow pump rates between 100 and 200 mL/min) during groundwater sampling (Battelle, 2015). A review of the 2014 purge logs shows that of the 49 wells sampled using low-flow techniques, 36 exhibited drawdown (non-sustaining water levels) during low-flow purging and sampling activities.

In addition to the Water Board yield requirement in Resolution 88-63, the County of Marin has its own, more stringent, well yield requirements that would prevent a water supply well from being installed in the aquifer (County of Marin, 2015). Marin County requires a minimum sustained yield of 1 gallon per minute over three days for a sustained yield requirement of 2,160 gallons/three days of pumping (720 gallons/day) for one residence seeking a water supply from groundwater. Site specific monitoring well yield values range from 18 gallons/day to 76 gallons/day for wells pumped under standard low-flow conditions (Table 2), precluding the possibility of a water supply well being installed in the aquifer at this site.

Combined with aquifer conditions at the site not being capable of producing the required sustainable yield, several city, municipal, county, and state regulations relevant to site specific conditions including future land use plans, historical contamination at the site, and the shallow nature of the aquifer in the leading edge area, exist that would prevent a water supply well from being installed in the aquifer and utilized for drinking water. For example, no specific well construction criteria exist for Marin County, and, thus, the State Well Standards provided by the Department of Water Resources (DWR) are followed. As stated in the DWR well standards Bulletins 74-81 and 74-90 (DWR, 1991) Section 9.0, *the annular surface seal for an individual domestic water well shall extend from ground surface to a minimum depth of 20 ft bgs*. The Bulletin further states, *the minimum depth [of the annular seal] for a community water supply well shall extend to 50 ft bgs*. The maximum depth to bedrock underlying the plume in the leading edge area is approximately 35 ft bgs, with the depth to bedrock in the upgradient portion of the plume being as shallow as 20 ft bgs. The bedrock unit gets shallower moving west and south away from Landfill 26. Under the best case scenario, the sanitary seal requirement of 50 ft bgs provided in the DWR Well

Bulletin would require a water supply well to be set approximately 15 ft into bedrock in the area. The bedrock unit exhibits significantly lower yield than the overlying alluvial unit (Battelle, 2002a). Subsequent well yield testing required by the County of Marin mentioned above would most likely show that the sustainable yield requirement could not be met for water supply wells completed in the bedrock unit.

Despite these restrictions, if a well permit application was approved for installation of a water supply well, groundwater sampling would be required per Marin County Water Code, CCR -Title 22, Chapter 15, Articles 3, 4, 5.5, 16 Marin County Code: Sec. 7.28.10 which states:

> *The health inspector requires organic chemical testing when the well is considered vulnerable to a past or current potential contaminating activity. Such higher risk sites include those close to fuel tanks, certain commercial/ industrial activities or preparation areas for pesticides and herbicides. Unless geographical conditions suggest otherwise, a default radius of 600 feet is used to evaluate potential threats.)*

Because a few wells in the leading edge area remain above MCLs for MTBE in drinking water (the maximum being 320 µg/L at LEA-MW5), the application would not be approved and thus a well would not be approved for installation.

Installation of a water supply well in the leading edge area is further rendered unlikely because land use planning documents provided by the City of Novato on its website show that the Hamilton Master Plan adopted by the City of Novato presents plans for a 414-acre, mixed-use community which includes Community Park (Hamilton Community Park) designations for the former base landfill (Landfill 26) and adjacent former ammunition bunker area, comprising approximately 81 acres. The former landfill and buffer area are retained by the Army (48 acres) in this plan, and adjacent property was deeded to the City of Novato by the federal government for recreational use (City of Novato, 2015). Because the land over Landfill 26 and the adjacent area is zoned for recreational public use, the Marin Municipal Water District requires that all water supplying public facilities including open space and recreationally zoned areas must utilize existing municipal water supply hook-ups for a water supply for drinking water and fire suppression (Marin Municipal Water District, 2015). Therefore, in the unlikely event a water supply well in this area was permitted by the County, the water supply well installation request would not receive approval from the City of Novato or the Marin Municipal Water District during the initial planning stages.

Finally, no domestic, irrigation, or agricultural wells are currently impacted by the dissolved-phase gasoline constituents released from the Site. A public water supply is readily available via the Marin Municipal Water District and, therefore, nuisance as defined by Water Code Section 13050 does not exist at the site.

Section 3.0: SITE CHARACTERIZATION AND REMEDIATION ACTIVITIES

This section briefly describes the investigations and remedial activities conducted at the Site between 1992 and 2015. The potential sources of contamination that have been investigated include USTs, associated pipelines, a former fuel pump house, and the hydraulic lifts and associated infrastructure in former Building 970. The following investigations, remedial activities, and documents were completed:

- March 1992: UST 957 was removed (PRC Environmental Management Inc., 1992).
- November/December 1994 and January 1995: Screening level soil and groundwater sampling was conducted in the area surrounding former UST 957 using a Geoprobe™ (ERM-West Inc., 1998).
- December 1994: Permanent groundwater monitoring wells were installed in the area surrounding former UST 957 and sampled in January 1995 (ERM-West Inc., 1998).
- January 1995: UST 970-3 was removed by the Navy's PWC (ERM-West Inc., 1998).
- January 1995: Waste oil was removed from Tank 970 by PWC personnel (ERM-West Inc., 1998).
- May 1996: Groundwater sampling and CPT using the Navy's site characterization and analysis penetrometer system (SCAPS) at the NEX gas station area around Building 970 (PRC Environmental Management, Inc., 1996).
- July 1996: USTs 970-1 and 970-2 were removed (Navy PWC, 1996).
- October 1996: Monitoring well installation around 957/970 source areas (Battelle, 2000a).
- June/July 1997: Additional groundwater investigation was conducted due to a concern over MTBE concentrations (Battelle, 1998a).
- February 1998: A Tier 1 risk-based corrective action (RBCA) assessment was performed (Battelle, 1999a).
- March 1998: MTBE plume delineation (Battelle and RRM, 2000).
- April/May 1998: In situ air sparge (IAS) and SVE installation and startup (Battelle, 2002a).
- April/May 1998: An extensive groundwater monitoring well network was installed at the site (Battelle, 2000a).
- May 1998: A second limited investigation was performed using a CPT to delineate the boundaries of the MTBE groundwater plume (Battelle and RRM, 2000).
- June 1998: Soil gas from beneath Building 973 was collected and analyzed (Battelle and RRM, 2000).
- August 1998: Another investigation using a CPT was performed to further delineate the MTBE plume (Battelle and RRM, 2000).
- October 1998: IAS/SVE system expansion (Battelle, 2002a).
- November 1998: Conceptual site model (CSM) developed based on groundwater modeling effort and characterization data collected to date (Battelle, 2000a).

- January 1999: An Interim Project Report was prepared for the purpose of summarizing remedial progress and site activities conducted to date (Battelle and RRM, 2000).
- March 1999: A Tier 2 RBCA assessment was prepared by the Navy (Battelle, 1999a).
- October 1999: A revised and Final Tier 3 RBCA assessment was prepared by the Navy that included results of confirmation soil gas sampling and the expanded assessment of the ingestion of homegrown fruits and vegetables as a potential exposure pathway as requested by the Water Board (Battelle, 1999b).
- October 1999: IAS/SVE system was shut down.
- December 1999: Draft Ecological Risk Assessment prepared by the Navy indicating no unacceptable risks to ecological receptors (Battelle, 1999c).
- April 2000: Building 970 hydraulic lift and OWS removal (Battelle and RRM, 2000).
- June 2000: First round of surface water sampling at Pacheco Creek (Battelle, 2001d).
- July 2000: The Water Board issued Order No. 00-064, which identified requirements for the Site. The Order required additional soil and groundwater investigations, development of a CAP for plume containment and cleanup, and continuation of groundwater monitoring and reporting. In addition, the Order required interim controls on the excavation of soils or discharge of groundwater at the Site (Battelle, 2002a).
- September 2000: A Groundwater Monitoring and Monitoring Well Protection Plan was developed (Battelle, 2000c).
- September 2000: An "Interim Site Control Plan for the Department of Defense Housing Facility, Novato, California" (Battelle, 2001c) was prepared by the Navy in compliance with Order No. 00-064 Task 7.
- September 2000: RI sampling activities were performed in compliance with Order No. 00-064 Task 2 following procedures outlined in the RI Work Plan (Battelle, 2002a).
- January 2001: Results of the RI activities were presented in the Final RI Report prepared by the Navy and submitted to the Water Board in compliance with Order No. 00-064 Task 2 (Battelle, 2001a).
- March 2001: Final Revised Risk Assessment was conducted by the Navy (Battelle, 2001b).
- September 2002: Biosparging system was installed and initiated to treat elevated concentrations of MTBE on Navy-owned property. The system was ultimately shut down in January 2009 (Battelle, 2002b).
- May 2009: The *Final Corrective Action Plan Addendum, Former UST Site 957/970 at the Former Department of Defense Housing Facility, Novato, California* was issued for the Site (Battelle, 2009) updating the CSM and selecting air sparging to treat elevated concentrations near the leading edge of the MTBE plume.
- May 2010: Pre-air sparge design grab sampling event and well abandonment (Battelle, 2011).
- October/November 2010: Leading edge air sparge system and performance well monitoring well installation (Battelle, 2011).
- December 2011: Leading edge air sparge system was shut down and rebound monitoring initiated (Battelle, 2012)

- November 2013: Leading edge air sparging system permanently removed and associated wells abandoned (Battelle, 2014).
- Quarterly, semiannual, and annual groundwater sampling occurred from 1998 to 2014
- Remedial action in Hamilton Square Parcel (West Yost Associates, 2015)

Details of each activity are presented in Table 3. Appendix A presents a data compilation of analytical results for petroleum constituents in groundwater from January 1995 to November 2015. Appendix B provides the most recent 2014 Annual Site Status Report (Battelle, 2015).

The Final CAP (Battelle, 2002a) and Final CAP Addendum (Battelle, 2009) includes a description of the results of the above investigations and remedial actions performed at the Site from 1992 through early 2009 as well as a summary of the following information as part of the site evaluation for Former UST Site 957/970:

- Multiple human health risk assessments
- Ecological risk assessment
- Development and updates to the CSM.

Because past investigations and the associated results have been presented in detail in previous reports, they are not presented further in this Closure Report. Rather, the following subsections summarize pertinent information of the previous investigations and remedial actions at the Site, present the recommendations and conclusions found within the Final CAP Addendum (Battelle, 2009); and describe subsequent (i.e., post 2009) investigations and remedial actions performed at the site.

3.1 Corrective Action Plan Summary –Investigation and Remedial Activities, 1992 through 2010

The following subsections summarize relevant information of previous investigations and remedial actions conducted at the Site from 1992 to 2000 and presents the recommendations from the Final CAP Addendum (Battelle, 2009).

Previous investigations and remedial actions conducted at Former UST Site 957/970 suggested the presence of petroleum hydrocarbons in soil and groundwater at the site. The results of multiple site investigations indicated the primary constituents of concern (COCs) were MTBE, BTEX, TPH-G, and to a lesser extent, TPH quantified as motor oil (TPH-MO) and TPH-D. Based on the observed distribution of petroleum hydrocarbons and associated chemicals, the likely source of groundwater and soil contamination was determined to be leaking USTs 957 and 970 (1-3), Tank 970-Waste Oil, and Building 970 Hydraulic Lift and associated piping.

3.1.1 Source Identification and Removal. Sources were defined as structures (i.e., tanks and pipes) that leak hydrocarbons, or as the presence of free product (free-phase petroleum or fuel light nonaqueous-phase liquid [LNAPL]) resulting from the leaking structure. All tanks and associated piping at the Site have been removed. Two observances of free product have been recorded at the Site: (1) in the vicinity of UST 957 during a Geoprobe™ investigation conducted in late 1994 by ERM-West (ERM-West, 1995); and (2) measured in monitoring well 970-MW5 in August 1996 (ERM-West, 1998). However, the presence of free product has not been observed in any of the Site wells, soils, or purged groundwater since Battelle began activities at the Site in December 1997.

The tank and underground piping for UST 957 were removed in March 1992 (Figure 2). After tank removal, the underlying and adjacent soil was excavated. Underground piping from the UST to the pump island and vent lines from the tank were removed and the piping trenches were over excavated. Confirmation soil samples were collected from the north and south sidewalls of the UST excavation and analyzed for TPH-purgeable and BTEX compounds. Maximum TPH-purgeable concentrations from the soil samples were 220 mg/kg, and maximum BTEX concentrations were detected at 360 µg/kg, 560 µg/kg, 1,000 µg/kg, and 3,880 µg/kg, respectively. A groundwater sample was collected from within the UST excavation and analyzed for TPH-purgeable as gasoline and BTEX constituents. Maximum concentrations were detected for TPH-purgeable of 60 mg/L and BTEX constituents were detected at maximum concentrations of 4,400 µg/L (Battelle, 2002a). Soil samples were collected from the piping trenches at a frequency of one sample per 20 linear feet and analyzed for TPH-purgeable as gasoline. The maximum concentration detected in these samples was 1,200 mg/kg. All analytical results of soil and groundwater samples collected during UST 957 removal activities are available in the *Final Corrective Action Plan for Groundwater for Former Underground Storage Tank Site 957/970 Department of Defense Housing Facility Novato, California* (Battelle, 2002a). The removal and investigation of UST 957 is described further in the UST Removal and Preliminary Investigation (PRC Environmental Management, Inc., 1992).

UST 970-3 was removed on January 5, 1995. The location of the tank is shown in Figure 2. Following removal of UST 970-3 and associated piping, two soil samples and one water sample were collected from the excavation and analyzed for TPH-G and BTEX. As stated in the *Final CAP* (Battelle, 2002a), maximum concentrations of hydrocarbons or gasoline constituents detected in the soil samples were TPH-G at 18 mg/kg, benzene at 150 µg/kg, toluene at 130 µg/kg, ethylbenzene at 160 µg/kg, and xylenes at 1,700 µg/kg. Gasoline constituents detected in the groundwater sample included TPH-G at 45 mg/L, benzene at 1,900 µg/L, toluene at 4,800 µg/L, ethylbenzene at 490 µg/L, and xylenes at 6,200 µg/L. On February 7, 1995, another groundwater sample was collected from the excavation and analyzed for TPH-G and BTEX. The analytical results for the second groundwater sample indicated that TPH-G was present at 21 mg/L, benzene at 640 µg/L, toluene at 1,300 µg/L, and xylenes at 2,600 µg/L. On February 22, 1995, 3 feet of soil were removed from the north, west, and east sidewalls of the excavation and visibly contaminated soils were removed from the piping trench between the tank and pump islands. On February 23, 1995, confirmatory soil samples were collected from the north, south, and west sidewalls of the excavation. TPH-G was detected at a maximum concentration of 13 mg/kg, while BTEX compounds were detected at maximum concentrations of 1,200 µg/kg benzene, 70 µg/kg toluene, 550 µg/kg ethylbenzene, and 2,600 µg/kg xylenes.

On March 27, 1995, additional confirmatory soil samples were collected from the tank excavation and piping trench and analyzed for TPH-G and BTEX. Gasoline constituents reported in the excavation samples (Battelle, 2002a) included TPH-G (ranging from nondetect to 520 mg/kg), benzene (ranging from nondetect to 200 µg/kg), toluene (ranging from nondetect to 730 µg/kg), ethylbenzene (ranging from nondetect to 520 µg/kg), and xylenes (ranging from nondetect to 11,000 mg/kg). No gasoline or BTEX compounds were detected in the soil samples collected from the pipe trench. The excavation was backfilled and covered with asphalt with the approval of the Marin County Department of Health (ERM-West, 1998).

On January 9, 1995, PWC personnel removed Tank 970-Waste Oil (ERM-West, 1998). The 1000-gallon steel tank appeared to be in good condition upon removal. For additional information concerning the tank removal activities and results, refer to the *Final UST Investigation Report for Former Underground Storage Tank Site 957/970* (ERM-West, Inc., 1998).

UST 970-1 and UST 970-2, located 70 ft south of the NEX Service Station pumping islands and adjacent to and east of UST 970-3, were removed on July 3, 1996. The location of the USTs are

featured in Figure 2. Five soil samples were collected from the north, south, and east sidewalls of the excavation upon removal of the USTs. Analytical results from the investigation are provided in the Final CAP (Battelle, 2002a). Analytical results from soil samples showed maximum concentration for TPH-G of 6,800 mg/kg, for benzene 61,000 µg/kg, for toluene 340,000 µg/kg, ethylbenzene 67,000 µg/kg, xylenes 720,000 µg/kg, and MTBE 310,000 µg/kg. One groundwater sample was collected from the tank pit and analyzed for TPH-G (<50 mg/L), BTEX (110 µg/L, 510 µg/L <500 µg/L, and 3,500 µg/L, respectively), and MTBE (170,000 µg/L). Analysis of soil samples collected beneath the pump island piping found maximum concentrations of TPH-G (2,800 mg/kg), benzene (170 µg/kg), toluene (36,000 µg/kg), ethylbenzene (33,000 µg/kg), xylenes (310,000 µg/kg) and MTBE (22,000 µg/kg) (Battelle, 2002a). The excavation was backfilled and covered with asphalt with the approval of the Marin County Department of Health Services. Further detail on the removal of UST 970-1 and UST 970-2 can be found in the UST removal summary report (Navy PWC, 1996).

In 1998, a soil and groundwater sampling plan (Battelle, 1998b) was developed and executed to evaluate and confirm the extent of a hydraulic fluid release from the northernmost of two hydraulic lifts in Building 970 (PRC Environmental Management, 1997). Soil samples were collected from depths of 4.0 to 5.0 ft bgs and from 9.0 to 10.0 ft bgs. The soil sample collected at 4.0 to 5.0 ft bgs contained a 15,000 mg/kg concentration of TPH-MO, whereas the soil sample collected from 9.0 to 10.0 ft contained only a 12 mg/kg concentration of TPH-MO. Groundwater in the vicinity of the hydraulic lift was not investigated at that time (PRC Environmental Management, 1997).

As reported in the Final CAP (Battelle, 2002a), the highest hydrocarbon concentration in soil was detected at the 4.5- to 5.5-ft-depth interval in the location closest to the hydraulic lift. TPH-MO was detected in this sample at a concentration of 18,000 mg/kg. Naphthalene, phenanthrene, and pyrene were also detected in this sample. All analytes were below detection limits in the 6.5- to 7.5-ft-depth interval at the same location. A naphthalene concentration of 4,200 µg/kg also was detected at the 4.5- to 5.5-ft interval of the second closest sampling location to the hydraulic lift. Groundwater concentrations of TPH-MO ranged from below the detection limit to 5.6 mg/L in the vicinity of the hydraulic lift. Groundwater concentrations of TPH-D were approximately 1 mg/L or less at all sample locations.

Excavation and removal of subsurface features in and around Building 970 followed the *Final Work Plan for Hydraulic Lift and Oil/Water Separator Removal From Building 970* (Battelle and RRM, 2000), which was approved by the Water Board. As removal activities proceeded, additional subsurface features were identified that were not described in the Work Plan. These features were removed and sampled in accordance with procedures described in the Work Plan. Subsurface features removed from the Site include the following:

- Three hydraulic lifts and associated control lines
- Control line for a suspected former hydraulic lift and confirmation sampling at the location of the suspected former lift
- Two OWS systems (identified as OWS1 and OWS2) and associated influent and effluent piping
- Four floor drains associated with the influent line of OWS1
- Four buried drums (Drums 1 through 4) acting as collection tanks associated with the influent line of OWS2
- Effluent line of OWS2 running along the footer on the west side of Building 970
- Sanitary sewer lateral associated with the OWS1 and OWS2 systems

- Waste oil line associated with a former waste oil tank.

During removal activities, petroleum hydrocarbon-impacted soil was encountered near both OWS units, around two drums, and beneath and around the foundations in the northern and northwestern portions of Building 970. Verification soil sampling was performed at locations immediately beneath and around the removed subsurface facilities. Over excavation activities were performed to the extent practicable to remove affected soils encountered during removal activities. Complete removal of affected soil was constrained by the limited work area inside the building and the potential to undermine building foundations. Verification samples were collected to confirm the absence of impacted soils or to define the degree and extent of impacted soils left in place. Soil samples were collected from sidewalls and trench bottoms to confirm the remaining concentrations of TPH and metals. Over excavation activities were performed to the extent practicable to remove affected soils from those areas where the petroleum hydrocarbon soil cleanup levels and/or United States Environmental Protection Agency (U.S. EPA) Region 9 Residential PRGs were exceeded. For more detailed information regarding field and analytical procedures and removal activities refer to the *Draft Summary Report for Hydraulic Lift and Oil/Water Removal from Building 970* (Battelle and RRM, 2000).

Water Board Order 00-064 required that the highest concentrations of soil pollution detected in the RI as described in Order 00-064, Task 1, and performed and reported under Task 2 be addressed in the feasibility study portion of the Final CAP (Battelle, 2002a). Soil concentrations observed during the RI activities were reported in the RI Report (Battelle, 2001a) submitted in compliance with Order 00-064, Task 2, and were assessed in the Final Revised Risk Assessment submitted in June 2001 (Battelle, 2001b). Other petroleum impacts to soil were addressed in 1) the hydraulic lift removal activities that involved extensive excavation within and around Building 970, and 2) the Draft Summary Report for Hydraulic Lift and Oil/Water Separator Removal from Building 970 (Battelle and RRM, 2000) associated with those activities. These reports documented the nature and extent of hydrocarbons in soils in the former NEX service station area. The results of the Final Revised Risk Assessment and the recommendations from the hydraulic lift report did not indicate that corrective action was required to protect human health and the environment from these soils. ICs were established as described in Section 2.3.1 to manage these soils and ensure that if these soils are disturbed, they will be managed properly and safely. RAOs for soil were therefore considered to have been achieved by the operation of the interim remedial action and the hydraulic lift removal activities. With agreement from the regulatory agencies, no further corrective action for soils was required to satisfy Order 00-064 or to protect human health, the environment, or the water resources of the State of California.

3.1.2 In Situ Remediation, 1998 through 2010

3.1.2.1 Former Source Area. In May 1998 at Former UST Site 957/970, a coupled IAS/SVE system was installed to reduce the mass of hydrocarbon in selected areas having elevated COC concentrations. This remediation effort was designed to reduce the potential of the groundwater plume to migrate and reduce hydrocarbon concentrations. Significant mass removal was achieved through the operation of air sparging and SVE systems. An estimated 23,000 lb of gasoline were calculated to have been removed through the SVE system. In general, TPH-G, BTEX, and MTBE concentrations in the off-gas stream decreased substantially since system startup (Battelle, 2002a). The SVE system TPH-G removal rate had decreased to about 3 lb/day during periods of higher water table levels earlier in the year of operation. Because risk assessment activities indicated that concentrations at the Site did not exceed risk-based screening levels (RBSLs), the air sparging and SVE systems were shut down in early October 1999.

As a result of past RI activities and to comply with Water Board Order 00-064 (Task 6), the Final CAP (Battelle, 2002a) was developed where biosparging was recommended as the remedial action alternative for the Site. Following the Final CAP, the Final Remedial Design Work Plan (RDWP)

(Battelle, 2002b) was developed to implement the approved recommendation in the Final CAP (biosparging as the remedial alternative). The RDWP established a surface (Pacheco Creek) and groundwater monitoring program to monitor the petroleum constituents and biosparge system performance. The monitoring program was used to support MNA monitoring to inform an MNA exit strategy to attain groundwater RAOs.

In September 2002, a biosparging system was started and operated in the Former UST 957 Area. The main remedial objectives of the biosparging treatment system were to:

1. Stabilize and contain the higher concentration MTBE groundwater plume on the currently Navy-owned portion of the Site.
2. Remediate the highest concentrations of soil pollution detected.
3. Reduce and remediate the concentrations of MTBE in Site groundwater.
4. Reduce and remediate the concentrations of benzene in Site groundwater which exceed applicable RBSLs.

During the time period in which the biosparging system was temporarily turned off (March 2005 to March 2006), MTBE concentrations remained relatively stable. The biosparging system was subsequently reinstated and operated on a pulsed schedule from March 2006 to January 2009. In July 2007, the Navy formally requested permission to shut down the biosparging system (due to observed significant reduction in COCs) and initiate a rebound monitoring program. In August 2007, the Water Board subsequently requested a response plan in the event that MTBE concentrations at the leading edge of the plume did not begin to stabilize or decrease. In December 2008, the Navy presented plans for managing unstable to increasing MTBE groundwater concentrations at the leading edge area of the plume by submitting a CAP Addendum to address MTBE concentrations at the leading edge of the plume. In January 2009, the *Final Corrective Action Plan Addendum For Former Underground Storage Tank Site 957/970 Department Of Defense Housing Facility Novato, California* (Battelle, 2009) was finalized.

Overall, a 99% reduction in average MTBE concentrations was observed in November 2008. The results indicated that the primary performance goals for the biosparging system (i.e., 95% to 99% reductions in MTBE concentrations) listed in the Final CAP (Battelle, 2002a) were achieved.

The biosparging system (in combination with past treatment of IAS/SVE and natural attenuation) had reduced the maximum MTBE concentrations on Navy property and, in the process, essentially eliminated any remaining source of MTBE to downgradient portions of the plume.

3.1.2.2 Leading Edge Area. Remediation activities significantly reduced MTBE concentrations on Navy property, thereby limiting a continuing source of MTBE to northern portions of the plume; however, portions of the MTBE plume had already migrated off Navy property (and outside the treatment area) at the time of system construction and operation. Time-series groundwater results indicated that MTBE concentrations were stable to decreasing throughout the majority of the plume, but concentrations are unstable to increasing in five of 19 wells at the leading edge area of the MTBE plume located off Navy property. The occurrence of these increasing concentrations is indicative of a plume that is not stable or decreasing and thus did not meet the requirements for the implementation of MNA as the final remedy at the Site. As a result, *the Final Corrective Action Plan Addendum For Former Underground Storage Tank Site 957/970 Department Of Defense Housing Facility Novato, California* (Battelle, 2009) was developed and finalized to address unstable MTBE plume conditions in the leading edge area, which recommended air sparging and MNA with a phytoremediation contingency as the final corrective action for UST Site 957/970.

In December 2010, the Navy successfully installed an air sparge system in the leading edge area in accordance with the *Final Leading Edge Area Corrective Action Work Plan, Former UST Site 957/970 at the Former Department of Defense Housing Facility, Novato, California* (Battelle, 2010a). The field implementations of these activities are documented in the *Annual Site Status Report for the Year 2010, UST Site 957/970, Former Department of Defense Housing Facility, Novato, California* (Battelle, 2011).

As planned, the air sparge treatment system operated for a one-year period from December 2010 through December 2011. Based on the results from the final quarterly performance goal monitoring event conducted in November 2011, the effects of the air sparge treatment system were realized within the active treatment area with an average MTBE concentration reduction of 97.0% (exceeding RAOs of 75% MTBE reduction). In addition, asymptotic conditions were realized throughout the performance goal monitoring well network both inside and outside the active treatment area (Battelle, 2012), thus meeting RAOs outlined in the *Final Leading Edge Area Corrective Action Work Plan, Former UST Site 957/970 at the Former Department of Defense Housing Facility, Novato, California* (Battelle, 2010a). With regulatory approval, the system was shut down on December 6, 2011 after one year of operation and based on the subsequent successful rebound monitoring results in 2012 and 2013, the air sparging system in the leading edge area was permanently removed in November 2013 (Battelle, 2014).

3.2 Surface Water Monitoring –A Summary of the Surface Water Monitoring Program from 2000-2011

Surface water samples were collected from June 2000 to May 2011 from portions of Pacheco Creek running through the Site. Historical surface water sampling results are illustrated in Figure 4. Historical surface water sampling results indicate that MTBE has not been detected in Pacheco Creek (i.e., PC-SW-1, PC-SW-2, PC-SW-3, PC-SW-4, and PC-SW-5) or the culvert outlet (i.e., PC-SW-CE) since November 2004 (Figure 4), confirming that the MTBE groundwater plume was not impacting Pacheco Creek.

Based on these observations, the Navy recommended discontinuing surface water monitoring at the Site as presented in the *Annual Site Status Report for the Year 2010, UST Site 957/970, Former Department of Defense Housing Facility, Novato, California* (Battelle, 2011). In response, in April 2011, DTSC recommended collecting a sample from location PC-SW-CE during the semiannual monitoring event in May 2011 (i.e., wet season). Per DTSC recommendation, a surface water sample was collected from PC-SW-CE in May 2011 and MTBE was nondetect at that location (Figure 4), confirming that the MTBE groundwater plume was not impacting Pacheco Creek. Surface water sample collection from Pacheco Creek was discontinued after May 2011.

3.3 Groundwater Monitoring –A Summary of the Groundwater Monitoring Program from 2000-2015

Groundwater monitoring activities have been ongoing at Former UST Site 957/970 since 1994. However, this report focuses on groundwater monitoring activities conducted from 2000 through 2015 driven by Water Board Order 00-064. As mentioned previously, Water Board Order No. 00-064 (Task 9) required the development of Site Status Reports for presenting the results of groundwater and surface water monitoring activities at the Site. Site Status reports have been developed for Former UST Site 957/970 since 2000. Appendix A presents a summary of historical analytical results for relevant COCs from 1995 to 2015. The groundwater monitoring program has historically included the collection of water level measurements across the entire Site, and the collection of groundwater and surface water samples for chemical analysis of chemicals of potential concern (COPCs). Originally, groundwater and surface water analytical data were collected on a quarterly basis, however, as successful remediation and

MNA were realized across the extent of the MTBE plume, the sampling frequency and number of wells sampled decreased. Table 4 provides a summary of the analytical parameters for groundwater and surface water and frequency at which groundwater and surface water sampling took place at the site from 2000 through 2015.

In November 2000, 77 monitoring wells were sampled to adequately delineate the MTBE plume. By 2007, the number of monitoring wells in the monitoring well network peaked at 94. By 2015, multiple annual groundwater monitoring well network evaluations, driven by favorably changing site conditions (statistically significant decreasing trends in petroleum constituent concentrations), resulted in multiple well abandonment efforts being implemented and approved by the regulators, ultimately leading to the overall monitoring well network being reduced to 44 monitoring wells. Table 5 provides well summary information for these 44 monitoring wells that make up the current groundwater monitoring network.

As remedial actions and investigations progressed at the Site and concentrations of COCs decreased, the analytical program for the Site was reduced. Below is a summary of the groundwater analytical program for Former UST Site 957/970 over time (comprehensive groundwater analytical results are presented in Appendix A).

In 2000 and 2001, the primary constituents analyzed for in groundwater were BTEX, MTBE, and TPH-G and for surface water were BTEX and MTBE (Battelle, 2000b). In 2002, the groundwater sampling analysis plan was updated to include MTBE degradation products, tert-butyl alcohol (TBA), tert-butyl formate (TBF), ethyl tert-butyl ether (ETBE), tert-amyl methyl ether (TAME), and diisopropyl ether (DIPE). From 2002 to 2006, the groundwater sampling plan remained unchanged.

In October 2015, the Draft Site Closure Report requesting NFA was submitted to the Water Board and DTSC. Through the regulatory review process, a data gap was identified for TPH-G data in groundwater. Specifically, the groundwater in the vicinity of Former UST Site 957 had not been analyzed for TPH-G since 2006. In an effort to address the TPH-G data gap, the Water Board requested that the Navy collect groundwater samples from monitoring wells within the vicinity of Former UST Site 957 and that these samples be analyzed for TPH-G. The Navy subsequently collected groundwater samples from eight monitoring wells in the Former UST 957 vicinity during the December 2015 annual groundwater sampling event to address the TPH-G data gap. In the following subsections, the most current TPH-G, BTEX, and MTBE groundwater analytical results are summarized.

3.3.1 TPH-G. TPH-G was analyzed in groundwater at the Site from 2000 to 2006 In 2007, the groundwater sampling plan was updated and TPH-G was removed from the analyte list. As stated in the 2007 *Final Groundwater Monitoring Plan Update for Former UST site 957/970 at Department of Defense Housing Facility Novato, California* (Battelle, 2007):

> *Because gasoline constituents at the Site originated from a release of gasoline from USTs on site, during the initial phases of investigation, it was prudent to monitor the status of TPH-G in groundwater. However, the Site was monitored on a quarterly basis for over eight years and the dissolved plumes originating from the UST release(s) have been adequately defined. The monitoring program confirmed that MTBE and benzene are the primary gasoline range constituents of interest present in groundwater. This was reflected in the RAOs presented in the CAP (Battelle, 2002a), where MTBE and benzene are identified as the COCs for the Site. Based on this, and the fact that water quality goals are not promulgated for TPH-G, monitoring for benzene and MTBE in groundwater is acceptable to meet the RAOs and monitoring objectives for the Site.*

Therefore, with regulatory approval, the Navy discontinued TPH-G analysis in groundwater because analysis of MTBE and benzene was appropriate to ensure RAOs were met for the site. However, as discussed in the section above, TPH-G was sampled during the annual December 2015 sampling event to address the data gap identified by the Water Board during its review of the Closure Report. Figure 5 presents a contour map of the November 2006 TPH-G groundwater results collected as part of the groundwater monitoring program at the Site at that time and the December 2015 TPH-G results collected in the same vicinity as requested by the Water Board. Table 6 presents the TPH-G groundwater data from 2006 and 2015 compared to Tier 1 environmental screening levels (ESLs) for groundwater provided by the Water Board (Water Board, 2016).

Of the 34 monitoring wells sampled for TPH-G in 2006, 14 monitoring wells exhibited TPH-G concentrations above the groundwater ESL of 100 µg/L (Table 6). Of the 14 monitoring wells exhibiting TPH-G concentrations above the groundwater ESL of 100 µg/L, only five remain in the current groundwater monitoring well network (970-MW4, 970-MW5, MW-1A, MW-4A, and NA-7). The maximum TPH-G concentration observed in 2006 was in monitoring well NA-7, with a concentration of 4,200 µg/L. TPH-G was sampled in eight monitoring wells during the 2015 groundwater sampling event. Analytical results show TPH-G was detected in only two of the nine monitoring wells (970-MW4 at 55 µg/L and NA-7 at 4,400 µg/L) sampled. The remaining seven monitoring wells sampled were nondetect. Concentrations in 970-MW4 have decreased from 2,600 µg/L in 2006 to 55 µg/L in 2015. TPH-G concentrations observed in monitoring well NA-7 in December 2015 are consistent with concentrations of TPH-G exhibited in 2006 (4,400 µg/L and 4,200 µg/L, respectively). The 2015 TPH-G concentrations in NA-7 of 4,400 µg/L suggest some residual TPH-G is present at this location. However, it is important to note that downgradient well 957-MW4, screened (8 to 18 ft bgs) in the same interval as NA-7 (10 to 15 ft bgs) was nondetect, suggesting that the residual TPH-G is not migrating and natural bioattenuation mechanisms are occurring to degrade petroleum-related products and resulting in a low threat to human health and safety and to the environment. Figure 5 shows the TPH-G plume maps representing the 2006 and 2015 TPH-G concentrations in groundwater. The TPH-G plume has broken up and been significantly reduced in size since 2006, confirming that natural bioattenuation mechanisms are occurring to degrade petroleum-related products.

3.3.2 BTEX. BTEX constituents were analyzed in groundwater at the Site from 1995 to the present. However, as stated in the Annual Site Status Report for the year 2009 (Battelle, 2010b), BTEX constituents were removed from the analyte list of the majority of the wells in the groundwater monitoring program based on the following information:

- Benzene has not been detected off Navy property. The maximum concentration was detected in May 1998 at 14,000 µg/L in MW-1A; levels decreased to 15 µg/L in November 2009.
- Toluene was not detected above the MCL (1,000 µg/L) since January 1999 in monitoring well NA-6. The maximum concentration was detected in May 1998 at 8,900 µg/L in MW-1A; levels decreased to 1.7 µg/L in November 2009.
- Ethylbenzene was not detected above the MCL (700 µg/L) since February 2000 in monitoring well NA-1. The maximum concentration was detected in March 1998 at 3,200 µg/L in 970-MW4; levels decreased to 2.5 µg/L in November 2009.
- Xylenes were not detected above the MCL (10,000 µg/L) since March 1998 at 970-MW4 (at 12,000 µg/L), the maximum concentration detected at the site. At monitoring well 970-MW4, concentrations were nondetect in November 2009.

Figure 6 presents contour plume maps for BTEX constituents analyzed for during the last comprehensive groundwater sampling event (November 2009). Table 7 presents the comprehensive groundwater analytical results for BTEX in the context of the updated Tier 1 ESLs representing the groundwater final aquatic habitat goaland groundwater vapor intrusion human health risk levels for deep groundwater residential: fine to coarse scenario (Water Board, 2016). In November 2009, only two wells (MW-7A and NA-7) exhibited benzene concentrations above the Tier 1 ESL of 30 µg/L with concentrations at 51 µg/L and 39 µg/L, respectively. Monitoring well MW-7A is no longer in the monitoring well network and NA-7 represents the only monitoring well that continues to be sampled for BTEX. BTEX concentrations remain below current Tier 1 ESLs at monitoring well NA-7 with a November 2014 concentration of benzene at 7.2 µg/L, toluene at 0.71 µg/L, ethylbenzene at 1.4 µg/L and xylenes at 3.1 µg/L (Table 7). BTEX concentrations were nondetect at NA-7 during the December 2015 sampling event (Table 7).

3.3.3 MTBE. MTBE has been analyzed in groundwater at the Site from 1996 to the present. Figure 7 presents MTBE concentration contour maps for the years 2000, 2008 and 2015 showing an overall decrease in plume concentration and size. Table 8 presents the 2014 and 2015 groundwater analytical results for MTBE compared to the updated Tier 1 ESL representing the non-drinking water source nuisance odor level provided by the Water Board (Water Board, 2016). Overall MTBE concentrations in 2015 remained consistent or decreased in comparison to concentrations observed during November 2014 with the exception of nine monitoring wells. LEA-MW1 (20 µg/L to 45 µg/L) and MW-M8-BR (0.25U µg/L to 16 µg/L) are the only two monitoring wells among the nine wells to show a slight increase in MTBE concentration when compared to 2014 results as shown in Table 8. The remaining seven monitoring wells exhibited increases that ranged between 0.07 µg/L and 4 µg/L in concentrations. Historically, the maximum concentration of MTBE observed in groundwater was in monitoring wells 970-MW4 and 970-MW5 at 240,000 µg/L in 1996. The maximum concentration of MTBE is currently observed in the northern portion of the plume at 320 µg/L (22% decrease from 2014) in monitoring well LEA-MW5 (Figure 7). Overall, 47% of the 44 monitoring wells exhibited a decrease in MTBE concentration in 2015. Among the 44 monitoring wells, 14 wells exhibited a 45% reduction in concentration from November 2014. As the data indicate, the 2015 MTBE plume is continuing to shrink in area (Figure 7). No wells on site currently exhibit MTBE concentrations in groundwater exceeding the updated Tier 1 ESLs (Table 8).

MTBE mass estimates have been calculated at the Site since 1998 and presented in successive Annual Site Status Reports. As the result of multiple remedial systems, coupled with natural attenuation mechanisms occurring on site, the estimated total mass of MTBE in groundwater has decreased significantly from 287 kg (November 1998) to 12.8 kg (December 2015).

The remedial goal for MTBE of 13 µg/L was established in 2002, reflecting the MCL threshold for MTBE for a drinking water source (Battelle, 2002a) at that time. The State of California MCL threshold for MTBE has been updated to 5 µg/L (Water Board, 2016). MTBE concentrations currently exceed the updated State of California MCL in 20 of the 44 monitoring wells at the Site (Battelle, 2015) (Table 8). No domestic, irrigation, or agricultural wells are currently impacted by the dissolved-phase gasoline constituents released from the Site. A public water supply is readily available and, therefore, nuisance as defined by Water Code Section 13050 does not exist at the site. As stated in Section 2.5.1, site specific aquifer conditions observed over more than 15 years of groundwater sampling at the Site suggest:

- The yield of the aquifer would very likely meet beneficial use exemption 2 in Resolution 88-63 (i.e., a water well installed in this portion of the aquifer cannot supply a sustained yield of 200 gallons/day)

- The sustainable well yields required by Marin County are not achievable at this site (720 gallons/day)
- The sanitary seal requirements stated in the California State Well Bulletin of 50 ft bgs would place the screened interval of the wells in the bedrock unit, which exhibits even lower yields than the overlying alluvial unit.

Furthermore, land use planning documents provided by the City of Novato on its website show the area overlying the MTBE plume zoned for public recreation and open space, in which the Marin Municipal Water District requires all uses of water (used for drinking and or fire suppression) to be supplied by the District via a connection to existing water pipelines. Therefore, based on the site-specific conditions described above and the conceptual site model, the Tier 1 ESLs established by the Water Board for odor nuisance in non-drinking water are appropriate for MTBE.

3.3.4 MTBE Plume Stability. The Navy has continually evaluated statistical trends throughout the MTBE plume using parametric regression analysis, outlined in U.S. EPA (2005). Results from the November 2014 statistical evaluation were similar to previous evaluations and indicated that there is a distinct difference in MTBE concentration trends in the LEA compared to the southern area (i.e., outside of the leading edge area). The results of these evaluations have indicated that MTBE concentrations in monitoring wells located in the southern area of the plume have largely demonstrated statistically significant decreasing trends (Battelle, 2014). However, due to the northern migration of the residual MTBE mass, concentrations in some monitoring wells located in the leading edge area have demonstrated unstable to statistically significant increasing trends in seven monitoring wells (IT-GMP-15, IT-GMP-17, IT-GMP-18, IT-PZ-9, LEA-MW2, LEA-MW3, MW-M13) (Figure 7). However, it is important to note that the MTBE concentrations in all monitoring wells listed above (IT-GMP-15, IT-GMP-17, IT-GMP-18, IT-PZ-9, LEA-MW2, LEA-MW3, MW-M13) exhibited decreases in concentrations during the December 2015 sampling event. In general, the December 2015 MTBE concentration suggests trends are consistent with prior statistical trends. Overall, MTBE concentration trends over time indicate that MNA processes are most likely effectively controlling the mid-leading edge area plume migration at the northernmost edge of the leading edge area. Thus, overall, the MTBE groundwater plume is demonstrating stable conditions as confirmed in the groundwater modeling exercise described in Section 3.4. Overall, the MTBE plume is observed to be stable and not migrating along the northern most edge of the leading edge area plume as indicated by the orange line in Figure 7.

3.4 Numerical Groundwater Flow and Transport Model

An evaluation of MTBE fate and transport in groundwater at Former UST Site 957/970 was conducted in 2012 and is included in Appendix D The purpose of the evaluation was to estimate the time required for MTBE concentrations throughout the plume to fall below the California MCL of 13.0 µg/L (the remedial goal for the Site) under MNA conditions. The following section includes a brief description of the numerical groundwater flow and MTBE transport model and associated petroleum constituent transport estimates, and the summary of the evaluation. For more details on how the model was developed, see Appendix D.

A numerical groundwater flow and MTBE transport model, MODFLOW-SURFACT, which is a proprietary version of United States Geological Survey's (USGS's) MODFLOW, was constructed to assess future MTBE fate and transport. The CSM was first translated into a numerical flow and transport model. Then the model was used to reproduce key features of the observed MTBE distribution during the year 2012. Finally, once calibrated, the model was used to estimate future MTBE fate and transport to support site decision-making.

The flow model provides the foundation for the petroleum constituent transport model because constituents are transported advectively with groundwater flow. In addition, the transport model includes representation of physical processes specific to MTBE transport. The groundwater flow model was calibrated under steady-state flow conditions observed from June 2007 water levels. Two phases of history matching were then performed with the petroleum constituent transport model:

- Reproduction of travel times from the source areas to the plume leading edge
- Reproduction of petroleum constituent transport patterns in the northern half of the plume from 2002 to 2010.

During the latter transport model calibration step, MTBE degradation and sorption were increased north of the line at the leading edge of the plume shown in Figure 7, in order to successfully reproduce the empirically observed plume stability in this area from 2002 to 2010. Successful execution of these flow and transport model calibration steps lends confidence to the use of the model to estimate future petroleum constituent transport. The calibrated flow and transport model was then used to estimate future MTBE transport, starting with the November 2013 MTBE plume. The observed results were that model simulations estimate that maximum MTBE concentrations will decrease to the MTBE MCL in approximately 15 years.

A key feature in the development and calibration of the model is the observed stability of the MTBE plume along the orange line seen on the 2015 MTBE plume map in Figure 7. Upgradient of this line, similar MTBE impacts have been observed at monitoring wells screened at varying depths (Figure 8), with maximum concentrations along the plume centerline consistently in the hundreds of µg/L. In addition, the plume has migrated relatively quickly and steadily through the wells in this area. Historical sampling data indicate that MTBE arrived at IT-GMP-15, IT-PZ-9, IT-GMP-17, and IT-GMP-18 (located south to north along the plume centerline in the leading edge area) in 1998, 1998, 2000, and 2004, respectively (Battelle, 2013a). Following initial impact, MTBE concentrations in each of these wells increased steadily to the hundreds of µg/L over a period of four to six years. Given the concentration trends and timing of impacts in these wells, significant MTBE impacts would have been expected by the present at wells downgradient of the line in Figure 7. However, little to no MTBE impacts have been observed at these sentry wells, suggesting the leading edge of the plume front is stable and not migrating down gradient.

Section 4.0: RISK EVALUATION

To date, eight human health risk assessments (HHRAs) have been conducted throughout the environmental cleanup process at Former UST Site 957/970 as summarized in Table 3. The Water Board and DTSC were involved in each of these HHRAs as the local and state regulatory authorities for the project, respectively. These HHRAs were conducted in accordance with guidelines, guidance, and policies of the U.S. EPA's and DTSC's Human and Ecological Risk Office. The HHRAs focused on evaluating potential risks to future human receptors at Former UST Site 957/970 as a result of residual fuel hydrocarbons in soil and groundwater.

The risk evaluation presented below is used to support the case for site closure for former UST Site 957/970 whereby potential risk from petroleum hydrocarbons and related constituents remaining in soil and groundwater at former UST Site 957/970 is evaluated in accordance with the Water Board's *Low-Threat Underground Storage Tank Case Closure Policy* (Water Board, 2012), which establishes consistent statewide case closure criteria for low-threat petroleum UST sites. The following sections identify COPCs, define risk evaluation screening criteria, present the representative data selected, describe the evaluation methodology, and present the results of the screening evaluation for Former UST Site 957/970.

4.1 Chemicals of Potential Concern

Former UST Site 957/970 was in use as a service station from the mid-1970s through the early 1990s, when the service station was closed and the USTs were removed. Soil and groundwater at the site were contaminated with fuel hydrocarbons resulting from releases from former USTs and associated piping at the site. Gasoline constituents observed in soils and groundwater included TPH-G, BTEX, MTBE, and other fuel-related compounds.

Many environmental investigations were conducted between 1998 and 2015 at Former UST Site 957/970 and numerous environmental samples collected from soil, groundwater, and soil gas and analyzed for gasoline-related petroleum hydrocarbon constituents such as TPH, BTEX, and MTBE in addition to broad analyses for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs; including polycyclic aromatic hydrocarbons [PAHs]), and metals.

Soil underlying and adjacent to the tanks and pipes was excavated following removal of the USTs as described in ERM-WEST (1998). In July 2000, the Water Board passed Board Order No. 00-064 requiring the Navy to develop and execute a CAP for groundwater (Battelle, 2002a), which led to the selection and implementation of a biosparging system to primarily treat gasoline fuel and gasoline additives, such as BTEX and MTBE. The biosparging system operated from September 2002 until March 2005, at which time a one-year shutdown test was performed before restarting the system in March 2006 on a pulsed operation schedule. Data collection and evaluation activities throughout the biosparging operation period indicated the biosparging performance goals had been achieved. Operation of the biosparging system was discontinued in February 2009 with regulatory concurrence).

Multiple HHRAs have been conducted throughout the environmental cleanup process at the Site where COPCs were identified as residual fuel hydrocarbons and associated fuel compounds. Therefore, given the source of the release and the historical presence of petroleum hydrocarbons in soil and groundwater, this risk evaluation only addresses petroleum and target indicator chemicals in soil, groundwater, and soil gas as established in the Water Board Low-Threat Policy (Water Board, 2012).

4.2 Media-Specific Criteria

As stated in the Water Board Low-Threat Policy (2012), releases from USTs can impact human health and the environment through contact with any or all of the following contaminated media: groundwater, surface water, soil, and soil vapor. The most common drivers of health risk are ingestion of groundwater from drinking water wells, inhalation of vapors accumulated in buildings, contact with near surface contaminated soil, and inhalation of vapors in the outdoor environment.

For simplification purposes, the Water Board combined the most common exposure scenarios and developed media-specific criteria for the following:

- Groundwater
- Vapor Intrusion to Indoor Air
- Direct Contact and Outdoor Air Exposure

Media-specific criteria may be qualitative in nature and/or may be a numerical limit. Numerical limits for the following media/chemicals are provided in the Water Board Policy (2012). For groundwater, COPCs are benzene and MTBE. For soil gas, COPCs include benzene, ethylbenzene, and naphthalene. For soil, the COPCs include benzene, ethylbenzene, naphthalene, total TPH (TPH-G and TPH-D combined), and PAH (based on the seven carcinogenic PAHs as benzo(a)pyrene toxicity equivalent [BaPe]).

4.2.1 Groundwater. The medium-specific criteria for groundwater are based on State Water Board Resolution 92-49, Policies and Procedures for Investigation and Cleanup and Abatement of Discharges under Water Code Section 13304. Resolution 92-49 directs that water affected by an unauthorized release attain either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Any alternative level of water quality less stringent than background must be consistent with the maximum benefit to the people of the state, not unreasonably affect current and anticipated beneficial use of affected water, and not result in water quality less than that prescribed in the water quality control plan for the basin within which the site is located. Resolution No. 92-49 does not require that the requisite level of water quality be met at the time of case closure; it specifies compliance with cleanup goals and objectives within a reasonable timeframe.

Although not officially de-designated in accordance with provisions from Water Board Resolution 88-63 (1988 and amended in 2006), impacted groundwater beneath the Site is arguably not a potential drinking water source for reasons previously stated Sections 2.5.1 and 3.3.3.

Since 1998, eight HHRAs have been conducted at Former UST Site 957/970. All of the previous HHRAs focused on evaluating potential risks to future human receptors as a result of residual fuel hydrocarbons in soil and groundwater. The HHRAs were conducted in accordance with U.S. EPA and California EPA guidance, guidelines and policy. DTSC's Human and Ecological Risk Office was involved in the planning and execution of these HHRAs and approved of the exposure scenarios evaluated in these historical documents. Scenarios that were purely hypothetical or plausible but not reasonably likely were not included based on the site specific conditions stated in Sections 2.5.1 and 3.3.3 above. In all eight HHRAs, DTSC agreed that the groundwater beneath Former UST Site 957/970 would not be used for any potable purpose and agreed that receptors only would be indirectly exposed to petroleum hydrocarbons in groundwater as a result of vapor migration into buildings. Thus, the drinking water exposure pathway is incomplete and not evaluated in this risk evaluation. The groundwater-specific criterion for vapor intrusion to indoor air is the more appropriate criterion for chemicals remaining in groundwater. The vapor intrusion to indoor air criteria are further discussed in Section 4.2.2.

4.2.2 Vapor Intrusion to Indoor Air. For the purposes of this risk evaluation, vapor intrusion to indoor air criteria are based on requirements for *Scenario 3- Dissolved Phase Benzene Concentrations in Groundwater (Low concentration groundwater scenarios with or without oxygen data)* provided in the Low-Threat Policy (Water Board, 2012). Scenario 3 criteria include benzene concentrations in groundwater, TPH concentrations in soil, and a continuous separation, or bioattenuation zone of various depth as depicted on Figure 9. In many petroleum release cases, potential human exposures to vapors are mitigated by bioattenuation processes as vapors migrate toward the ground surface. For the purposes of this evaluation, the term "bioattenuation zone" means an area of soil with conditions that support biodegradation of petroleum hydrocarbon vapors.

Although the Low-Threat Policy provides comparison criteria for direct measurement of soil gas concentrations (see *Scenario 4 - Direct Measurement of Soil Gas Concentrations* in the Low-Threat Policy) and soil gas samples have been collected from locations above the groundwater plume at Former UST Site 957/970 (refer to soil gas results in the Human Health Risk Assessment Update for Parcel 1A [Battelle, 2011]), these direct comparisons will not be used to assess risk. Under Scenario 4, the soil gas samples have to be collected from at least 5 feet bgs. Historical soil gas samples collected at Former UST Site 957/970 were obtained from 3 and 4 feet bgs.

4.2.3 Direct Contact and Outdoor Air Exposure. Comparison criteria for direct contact and outdoor air exposure were developed for the Low-Threat Policy as provided in Table 9. In order to meet these criteria, maximum concentrations of petroleum constituents in soil need to be less than or equal to those listed in Table 9 for the specified depth bgs. The concentration limits for 0 to 5 feet bgs protect from ingestion of soil, dermal contact with soil, and inhalation of volatile soil emissions and inhalation of particulate emissions. The 5 to 10 feet bgs concentration limits protect from inhalation of volatile soil emissions. Both the 0 to 5 feet bgs concentration limits and the 5 to 10 feet bgs concentration limits for the appropriate site classification (Residential or Commercial/Industrial) will need to be satisfied. In addition, if exposure to construction workers or utility trench workers are reasonably anticipated, the concentration limits for Utility Worker also need to be satisfied.

4.3 Data Selection

This risk evaluation was performed using historical data where appropriate in conjunction with the most recent data that were collected as part of the ongoing groundwater monitoring program at the Site. The following subsections provide an explanation of the analytical results that comprise the datasets for groundwater and soil. The datasets were selected because they were the most current representation of conditions in soil and groundwater. Depth to groundwater at Former UST Site 957/970 is approximately 9.5 ft bgs, although depths vary somewhat throughout the year and across the Site. For the purpose of this evaluation, soil samples collected from less than 10 feet bgs were included in the evaluation.

4.3.1 Groundwater Data. Since the initial petroleum release, concentrations of benzene have been significantly reduced as a result of active treatment on Navy property as well as attenuation mechanisms. Numerous groundwater samples from the monitoring well network associated with Former UST Site 957/90 have been collected over time and analyzed for benzene (Appendix A). Results of groundwater samples collected during the groundwater monitoring program have been reported in Semi-Annual and Annual Site Status Reports, with the most recent Annual Site Status Report being for the year 2014 (Battelle, 2015).

Figure 6 presents the most current benzene data available (November 2009) depicting the extent of benzene distribution in groundwater As shown on Figure 6, all benzene concentrations in groundwater were below 100 µg/L. As mentioned in Section 3.3.2, since November 2009, benzene (and

TEX) is only analyzed for in one monitoring well (NA-7) (Figure 7) and concentrations remain low. This is because the groundwater monitoring program is optimized annually based on decision criteria discussed in Section 5.0 of the Groundwater Monitoring Plan (Battelle, 2000b). Wells showing a statistically significant decreasing trend in concentrations are either sampled less frequently or eliminated from the monitoring program as decision criteria are met; thus, the 2009 sampling event was that last comprehensive sampling event for benzene.

For groundwater (groundwater-specific criteria for vapor intrusion to indoor air) the most current representation of groundwater conditions are included in the risk evaluation. These data include samples that were collected during the last several annual site-wide groundwater monitoring events between 2009 and 2014. The groundwater data selected for the risk evaluation is provided in Table 7. As stated above, benzene continues to be present in NA-7 at very low levels.

4.3.2 Soil Data. Residual quantities of petroleum constituents exist in soil in two localized areas where gasoline was stored and dispensed. One of the two localized areas is in the vicinity of the former UST 970 complex (i.e., USTs 970-1, 970-2, and 970-3) (Figure 2). The second localized area with petroleum constituents in soil is in the vicinity of former UST 957 (Figure 2). As mentioned in Section 3.1.1, the nature and extent of petroleum constituents in soil at the Site were determined by the hydraulic lift excavation and removal activities within Building 970 conducted from April 17, 2000 to June 22, 2000 (Battelle and RRM, 2000) and soil sampling activities conducted in September 2000 during the RI (Battelle, 2001b) performed in compliance with Task 2 of Water Board Order No 00-64. Petroleum constituent plume maps and analytical results for constituents remaining in soil are provided in these two documents as well as in the Final Revised Risk Assessment [Battelle, 2001b]). A compilation of analytical results for COPCs remaining in soil is provided in Tables 10 through 14. It is expected that concentrations detected almost 15 years ago would be much lower today because the COPCs readily biodegrade. However, these data are the only data available and so are being used to conservatively assess residual risks.

It should be noted that a remedial action for soil in the Hamilton Square Parcel (former UST Site 970 area) has been approved to address the remaining soil contamination to allow unrestricted residential development of the property to proceed in the future (West Yost Associates, 2015). Therefore, based on the fact that contaminated soils will be removed as part of the remedial action, the soils in the UST Site 970 area do not warrant further evaluation.

4.4 Evaluation Methodology

The risk evaluation was conducted in a step-wise manner as follows:

- **Step 1. Compile the Concentrations of all COPCs Detected in Soil and Groundwater:** Available soil and groundwater data representative of the most current conditions are compiled and all related COPCs detected in the samples are identified.
- **Step 2. Compare Concentrations to Media-Specific Screening Criteria:** Detected concentrations of COPCs are compared to the numerical criteria provided in the Low-Threat Policy (Water Board, 2012) provided in Table 9. Any sample for which all detected concentrations are below the screening criteria is considered not to pose a significant risk and is eliminated from further evaluation. All samples for which one or more COPC had a detected concentration that exceeds the screening criteria are further evaluated in Step 3.
- **Step 3. Additional Analyses to Support Risk Management:** Samples with COPC concentrations that exceed the criteria are further evaluated. Additional analyses may

include an evaluation of the spatial distribution of remaining petroleum hydrocarbons, examination of potentially complete exposure pathways, review of relevant exposure scenarios, and evaluation of the timing of site remedial activities relative to the sampling date.

- **Step 4. Summarize Results:** If the results from Steps 2 and 3 indicate that the detected concentrations do not pose a potential risk to human receptors currently, then the site is recommended for closure. If the results indicate that significant impacts to human receptors are possible in the future, then ICs or corrective action is recommended.

4.5 Results of the Risk Evaluation for Groundwater

This section summarizes the results of the groundwater risk evaluation performed for Former UST Site 957/970.

Step 1. Compile the Concentrations of all COPCs Detected in Groundwater: The only COPC identified for groundwater is benzene (Table 7). Vapor intrusion to indoor air is the exposure pathway being evaluated.

Step 2. Compare Concentrations to Media-Specific Screening Criteria: Scenario 3 (Figure 9) presents the media-specific criteria necessary to evaluate dissolved phase benzene in groundwater for the vapor intrusion pathway. Benzene concentrations remaining in groundwater beneath the site are less than 100 µg/L. In fact, the maximum concentration most recently detected is 7.2 µg/L in well NA-7 located in the Former UST Site 957 area (Battelle, 2015). Therefore, media-specific criteria depicted under Scenario 3 is selected as the criteria for this risk evaluation. As depicted on Figure 9, characteristics of the bioattenuation zone without oxygen data require that the bioattenuation zone be a continuous zone that provides a separation of at least 5 feet vertically between the dissolved phase benzene and the foundation of existing or potential buildings and contains total TPH (TPH-G and TPH-D combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone. The 5 feet vertical distance is met as the depth to groundwater is at least 9.5 feet bgs across the Site. As benzene in groundwater is only present in the Former UST Site 957 area, historical soil concentrations of TPH in the Former UST Site 957 area (see Table 14) are used to evaluate the bioattenuation zone. As shown on Table 14, 13 of the 16 TPH soil samples collected within the upper 5 feet of soil are less than 100 mg/kg criterion. Further evaluation of three samples above the 100 mg/kg criterion for TPH (SB-3D at 480 mg/kg; SB-8D at 300 mg/kg; and SB-9D at 200 mg/kg) is warranted as presented in Step 3.

Step 3. Additional Analyses to Support Risk Management: Three of the 16 soil samples collected in the Former UST Site 957 area exceed the TPH criterion of 100 mg/kg. As a result, further evaluation of the sampling date, timing of recent site remediation activities, and spatial distribution was conducted. Figures 10 and 11 show historical concentration contours of TPH-G and TPH-D in soil for each of the sampling locations within the Former UST 957 area. Elevated TPH results were only found within the upper 5 feet of soil and are spread out within the former UST area. Concentrations detected beneath these samples are one to two orders of magnitude lower and well below the 100 mg/kg criterion. Therefore, the vertical extent of elevated TPH is limited. An average TPH concentration for the upper 5 feet of soil within the Former UST Site 957 area is approximately 34 mg/kg, which is well below the 100 mg/kg criterion.

Step 4. Groundwater Summary: Residual concentrations of benzene in groundwater beneath the site are less than 10 µg/L. The extent of benzene is limited to the Former UST Site 957 area. Elevated TPH-impacted soil in the Former UST Site 957 area is limited in horizontal and vertical extent as discussed in Step 3. Biodegradation and other natural attenuation processes are expected to continue to reduce

concentrations of total TPH in soil and benzene in groundwater over time. Based on the results of Steps 2 and 3, remaining elevated concentrations of total TPH in the Former UST Site 957 area is not likely to contribute a vapor intrusion risk to human receptors. Therefore, NFA with respect to petroleum hydrocarbons in groundwater is recommended for the site.

4.6 Results of the Risk Evaluation for Soil

This section summarizes the results of the step-wise risk evaluation for soil performed for Former UST 957/970.

Step 1. Compile the Concentrations of all COPCs Detected in Soil: The COPCs identified for soil associated with the Former UST Site 957/970 and hydraulic lift areas within Building 970 include benzene, ethylbenzene, and naphthalene (Table 9). For the waste oil line near Building 970, COPCs include benzene, ethylbenzene, naphthalene, and PAH (Table 9).

Step 2. Compare Concentrations to Media-Specific Screening Criteria: Concentrations of the COPCs detected in soil between 0 to 5.5 ft bgs (i.e., shallow depth) were compared to both the residential and commercial/industrial media-specific criteria. Table 15 summarizes the COPCs detected and provides a comparison of concentrations detected to the media-specific criteria. All COPC concentrations were less than the more stringent residential criteria.

Concentrations of the COPCs detected in soil that were greater than 5.5 ft bgs (i.e., deep) were compared to both the residential and commercial/industrial media-specific criteria. Table 16 summarizes the COPCs detected and provides a comparison of concentrations detected to the media-specific criteria. All COPC concentrations were less than the more stringent residential criteria.

For the waste oil line soil data (Table 16), PAH data were not available; however, data for total SVOCs were available. Total SVOCs would have included measurements for PAHs. Two sampling locations contained nondetect, but elevated detection limits for the SVOC totals. Overexcavation was performed in these areas to remove the elevated concentrations (Battelle, 2000a).

Based on the comparison to media-specific criteria, residual concentrations of petroleum hydrocarbon constituents in soil will have no significant risk of adversely affecting human health. No further evaluation is necessary.

Section 5.0: LOW-RISK CRITERIA EVALUATION

Former UST Site 957/970 meets all of the general criteria (A through H) outlined in the Water Board's *Low-Threat Underground Storage Tank Case Closure Policy* (Water Board, 2012). Furthermore, Former UST Site 957/970 meets media-specific criteria for groundwater (Class 4; B through D), vapor intrusion (A through C), direct contact and outdoor air exposure (A through C). The following table presents each of the criteria and evidence that the site meets the low-threat criteria:

Criteria	
General Criteria	**Met at Former UST Site 957/970?**
A. The unauthorized release is located within the service area of a public water system.	YES
B. The unauthorized release consists only of petroleum.	YES
C. The unauthorized ("primary") release from the UST system has been stopped.	YES
D. Free product has been removed to the maximum extent practicable.	YES
E. A CSM that assesses the nature, extent, and mobility of the release has been developed.	YES
F. Secondary source has been removed to the extent practicable.	YES
G. Soil or groundwater has been tested for MTBE and results reported in accordance with Health and Safety Code Section 25296.15.	YES
H. Nuisance as defined by Water Code Section 13050 does not exist at the site.	YES
California Water Code Section 13050 (m), defines nuisance as anything which meets all of the following requirements: A. Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.	NO
B. Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.	NO
C. Occurs during, or as a result of, the treatment or disposal of wastes.	NO
Media-Specific Criteria *(1. Groundwater, 2. Vapor Intrusion to Indoor Air, 3. Direct Contact and Outdoor Air Exposure)*	

Criteria	
General Criteria	**Met at Former UST Site 957/970?**
1. **<u>Groundwater</u> (Class 4 and 5)**	
Class 4	
A. The contaminant plume that exceeds water quality objectives is less than 1,000 feet in length.	NO – largest portion of the current MTBE plume is approximately 2,400 ft in length. However, the leading edge area of the plume is stable as depicted by the orange line in Figure 7. In addition, 65% (15 of 23) of the monitoring wells in the leading edge area and 96% (25 of 26) of the monitoring wells in the upgradient area have shown a statistically significant decreasing trend or nondetect concentrations (Battelle, 2015).
B. There is no free product.	YES
C. The nearest existing water supply well or surface water body is greater than 1,000 feet from the defined plume boundary.	Groundwater: YES. Based on a domestic and municipal water well search on Geotracker, no water supply well exists within 1,000 ft of the defined plume boundary. Surface Water: NO. Pacheco Creek runs through the site. It should be noted that Pacheco Creek is an intermittent stream where continuous flow is only observed during the wet season. During the dry season the stream is series of disconnected shallow pools.
D. The dissolved concentration of benzene is less than 1,000 µg/L, and the dissolved concentration of MTBE is less than 1,000 µg/L.	YES – in December 2015, benzene concentrations at NA-7 were nondetect, and the highest MTBE concentration at LEA-MW5 was 320 µg/L.
Class 5	
A. The regulatory agency determines, based on an analysis of site specific conditions that under current and reasonably anticipated near-term future scenarios, the contaminant plume poses a low threat to human health and safety and to the environment and water quality objectives will be achieved within a reasonable time frame.	YES – analysis of groundwater data and fate and transport modeling indicate that MTBE is not migrating at the leading edge front of the plume, and concentrations are decreasing in the southern portion of the plume. Fate and transport groundwater modeling suggests the final cleanup goal for MTBE of 13 µg/L can be achieved via MNA in approximately 15 years.
2. **<u>Vapor Intrusion to Indoor Air</u>**	
A. Site-specific conditions at the release site satisfy all of the characteristics and criteria of scenarios 1 through 3 as applicable, or all of the characteristics and criteria of scenario 4 as applicable; or	YES
B. A site-specific risk assessment for the vapor intrusion pathway is conducted and demonstrates that human health is protected to the satisfaction of the regulatory agency; or	YES
C. As a result of controlling exposure through the use of mitigation measures or through the use of institutional or engineering controls, the regulatory agency determines that	YES

Criteria	
General Criteria	**Met at Former UST Site 957/970?**
petroleum vapors migrating from soil or groundwater will have no significant risk of adversely affecting human health.	
3. **Direct Contact and Outdoor Air Exposure**	
A. Maximum concentrations of petroleum constituents in soil are less than or equal to those listed in Table 1 for the specified depth bgs. The concentration limits for 0 to 5 feet bgs protect from ingestion of soil, dermal contact with soil, and inhalation of volatile soil emissions and inhalation of particulate emissions. The 5 to 10 feet bgs concentration limits protect from inhalation of volatile soil emissions. Both the 0 to 5 feet bgs concentration limits and the 5 to 10 feet bgs concentration limits for the appropriate site classification (Residential or Commercial/Industrial) shall be satisfied. In addition, if exposure to construction workers or utility trench workers are reasonably anticipated, the concentration limits for Utility Worker shall also be satisfied; or	YES
B. Maximum concentrations of petroleum constituents in soil are less than levels that a site specific risk assessment demonstrates will have no significant risk of adversely affecting human health; or	YES (Battelle, 2011)
C. As a result of controlling exposure through the use of mitigation measures or through the use of institutional or engineering controls, the regulatory agency determines that the concentrations of petroleum constituents in soil will have no significant risk of adversely affecting human health.	YES – there are ICs in place to protect human health.

Although the MTBE plume length and proximity to a surface water body remain the only Low-Threat Closure Policy criteria not met as outlined in the *Low-Threat Underground Storage Tank Case Closure Policy* (Water Board, 2012*),* it is the Navy's position that this report shows that there are multiple lines of evidence indicating Former UST Site 957/970 presents a low threat to human health, the environment, and the drinking water resources of the State of California.

Section 6.0: CONCLUSIONS AND RECOMENDATIONS

The Navy has removed the source of any future petroleum-related contamination to the soil and groundwater at Former UST Site 957/970. Following source removal, from 1998 to 2011, multiple successful remedial actions have been implemented at the Site. As a result, MTBE, BTEX, TPH, and other petroleum-related constituents from soil and groundwater have been significantly reduced compared to baseline conditions prior to remediation.

MTBE is currently the only petroleum constituent undergoing regular monitoring and reporting at the Site. The cleanup goal for MTBE of 13 µg/L, which is consistent with the MCL for a drinking water source (Water Board, 2000; Battelle, 2002a) is exceeded in 15 of the 44 monitoring wells monitored during the 2015 annual groundwater sampling events (Table 8). However, the Site is currently not a drinking water source and will most likely never serve as one for several reasons:

- Well purge data and field observations made since regular groundwater monitoring started in 1998 suggest that the sustainable yield requirements of 200 gallons/day (Water Board Resolution 88-63 [1988 and amended in 2006]) and 720 gallons/day (Marin County) cannot be met.
- Drinking water wells would be screened in the bedrock unit at the Site, which further suggests the applicable yield requirements could not be met because the sanitary seal standards stated in California Well Bulletin 74-81 through 74-90 Section 9, require the annular surface seal for an individual domestic water well and community water supply well to extend from ground surface to a minimum depth of 20 and 50 ft bgs, respectively.
- The entire area overlying the MTBE plume is designated and zoned by the City of Novato to be used for public recreation and open space, and development approval requires the utilization of the existing Marin Municipal Water District water supply for drinking water and fire suppression.
- In the extremely unlikely event that a well permit application was to be approved for a water supply well within 600 ft of the MTBE plume, organic chemical testing would need to be performed as per Marin County Water Code: CCR -Title 22, Chapter 15, Articles 3, 4, 5.5, 16 Marin County Code: Sec. 7.28.10 in areas considered vulnerable to past or current contamination (i.e., fuel tanks like those at UST Site 957/9970 and landfills like Landfill 26).
- Furthermore, based on a phone conversation with the supervisor of the Lands Department at Marin Department of Environmental Health Services (DEHS), if the conclusion of this Site Closure Report is that no water supply wells should be installed in the aquifer at the Site (on former Navy property and the property in the leading edge area now owned by the City of Novato), the County would abide by the recommendation and not allow water supply wells to be installed in the affected aquifer in the future (Marin County DEHS, 2015, Appendix C).

No domestic, irrigation, or agricultural wells are currently impacted by the dissolved-phase gasoline constituents released from the Site. As stated above a public water supply is readily available via Marin Municipal Water District and, therefore, nuisance as defined by Water Code Section 13050 does not exist at the site. Therefore, the Tier 1 established by the Water Board for odor nuisance in non-drinking water are more appropriate given the specific water quality and hydrogeologic conditions observed at the Site. Based on the latest groundwater analytical data available, Tier 1 ESLs for vapor

intrusion of MTBE BTEX and TPH-G (more conservative aquatic habitat goals) have been met as shown in Tables 6 through 8.

A multiple lines of evidence approach is presented in this Site Closure Report and summarized below to support a recommendation for site closure:

- Statistically significant decreasing MTBE concentration trends are observed throughout the majority of the MTBE plume footprint over the 15 years since remedial actions began, suggesting natural bioattenuation mechanisms are functioning to degrade petroleum-related products in soil and groundwater (i.e., MNA) and these mechanisms will continue to degrade MTBE. The MTBE analytical results in groundwater from the 2015 annual sampling event suggests that this trend is continuing Overall, 47% of the 44 monitoring wells exhibited a decrease in MTBE concentration in 2015. Among the 44 monitoring wells, 14 wells exhibited a 45% reduction in concentration from November 2014 data supporting the natural bioattenuation mechanism at the site.
- Only seven monitoring wells (14%) located in the leading edge area demonstrated a statistically significant increasing trend in MTBE concentrations from November 2014 data at the Site. The MTBE concentrations from December 2015 are generally consistent or lower than concentrations from November 2014 indicating a similar trend. An empirically calibrated numerical fate and transport groundwater model was developed and indicates the MTBE plume is not migrating at the leading edge front of the plume, and MCLs are attainable through MNA processes in approximately 15 years.
- Results from the risk-based screening evaluation conducted for soil, soil gas, and groundwater show Former UST Site 957/970 poses a low threat to human health and safety and to the environment.
- A low-threat evaluation of Former UST Site 957/970 utilizing the data presented in this report and following the *Low-Threat Underground Storage Tank Case Closure Policy* developed by the Water Board (Water Board, 2012) resulted in only two criteria not being met (i.e., the MTBE plume length is greater than 1000 ft and its proximity to a surface water body).
- TPH-G was sampled during the December 2015 sampling event in eight groundwater monitoring wells to address a TPH-G data gap identified by the Water Board through its evaluation of the Site Closure Report. TPH-G was detected in only two of the eight monitoring wells (970-MW4 [55 µg/L] and NA-7 [4,400 µg/L]) sampled (Table 6). TPH-G concentrations in 970-MW4 have decreased by 98% since 2006. The maximum TPH-G concentration observed in December 2015 was in monitoring well NA-7 with a concentration of 4,400 µg/L. TPH-G concentrations in NA-7 have decreased from 30,000 µg/L in 1999 to 4,400 µg/L in December 2015. The 2015 TPH-G concentrations in NA-7 of 4,400 µg/L suggest residual TPH-G is present at this location. However, it is important to note that downgradient well 957-MW4, screened (8 to 18 ft bgs) in the same interval as NA-7 (10 to 15 ft bgs), was nondetect, suggesting that the residual TPH-G is not migrating and natural bioattenuation mechanisms are occurring to degrade petroleum-related products and resulting in a low threat to human health and safety and to the environment. Overall, the plume area has also significantly decreased (Figure 6). TPH-G was nondetect in the remaining seven monitoring wells confirming that natural bioattenuation mechanisms are occurring to degrade petroleum-related products e resulting in a low threat to human health and safety and to the environment.

Based on these multiple lines of evidence presented in this report, the Navy requests site closure with NFA for petroleum constituents at Former UST Site 957/970.

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FIGURES

Figure 1. Site Location Map

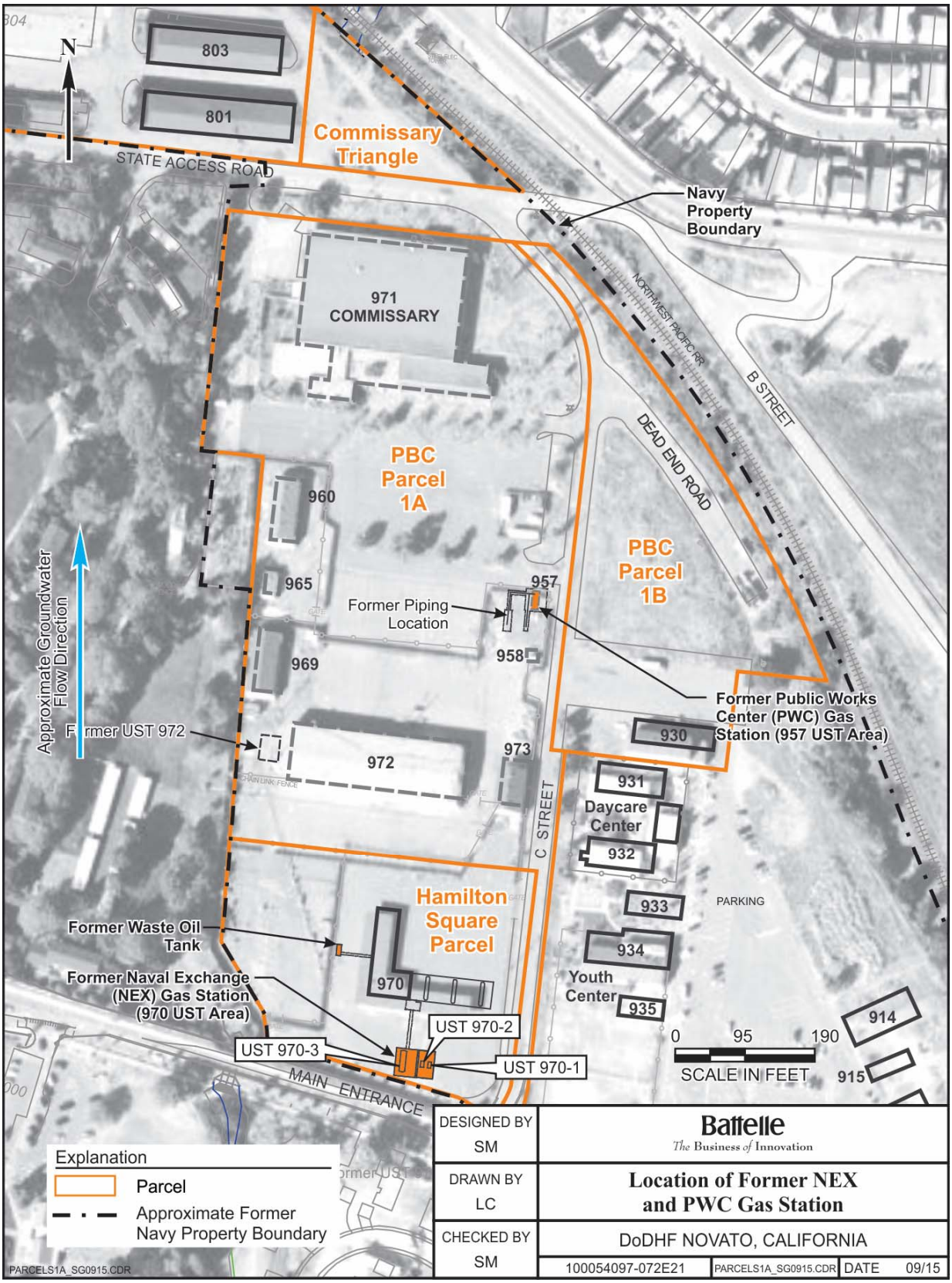


Figure 2. Location of Former NEX and PWC Gas Station

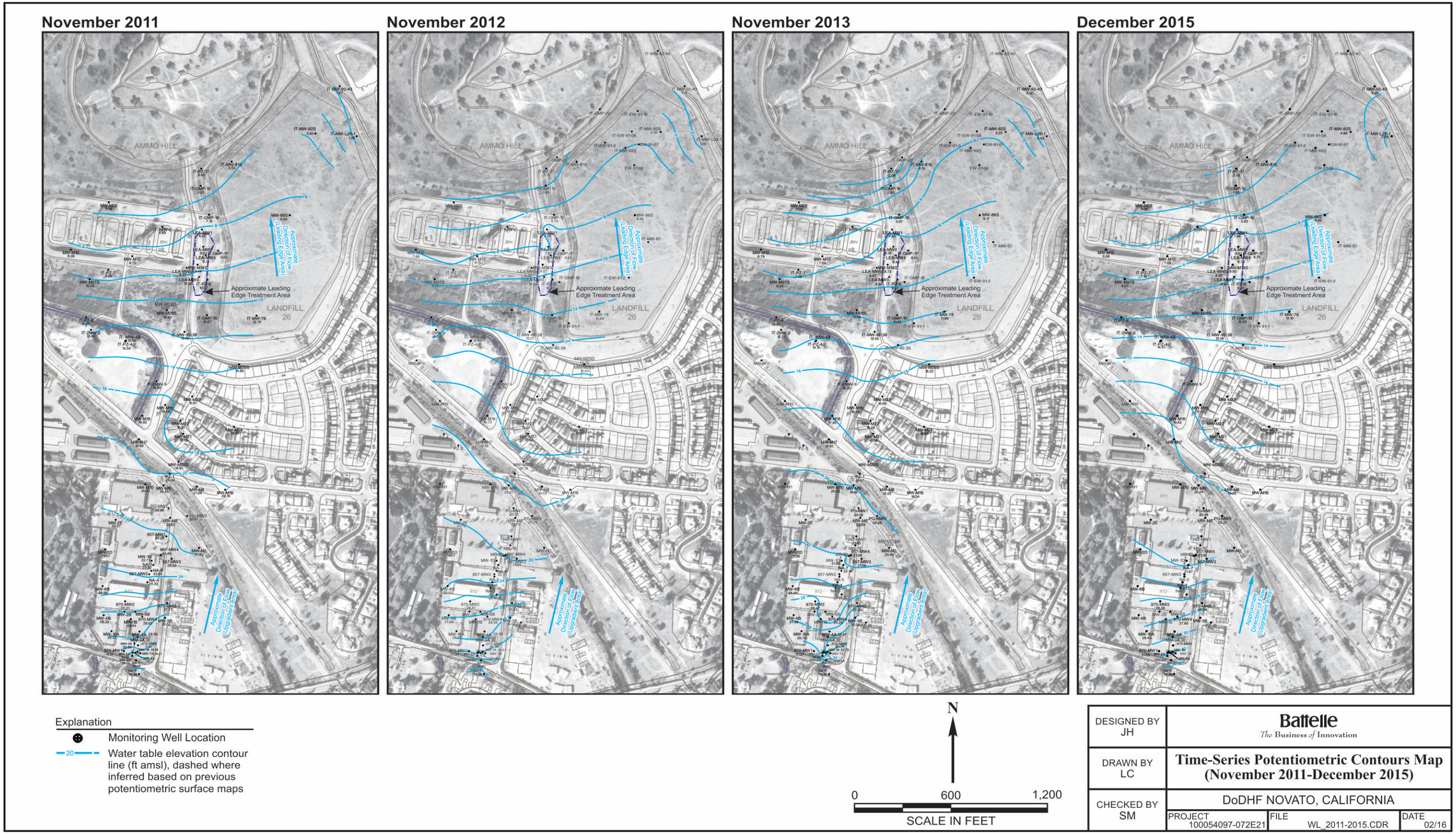
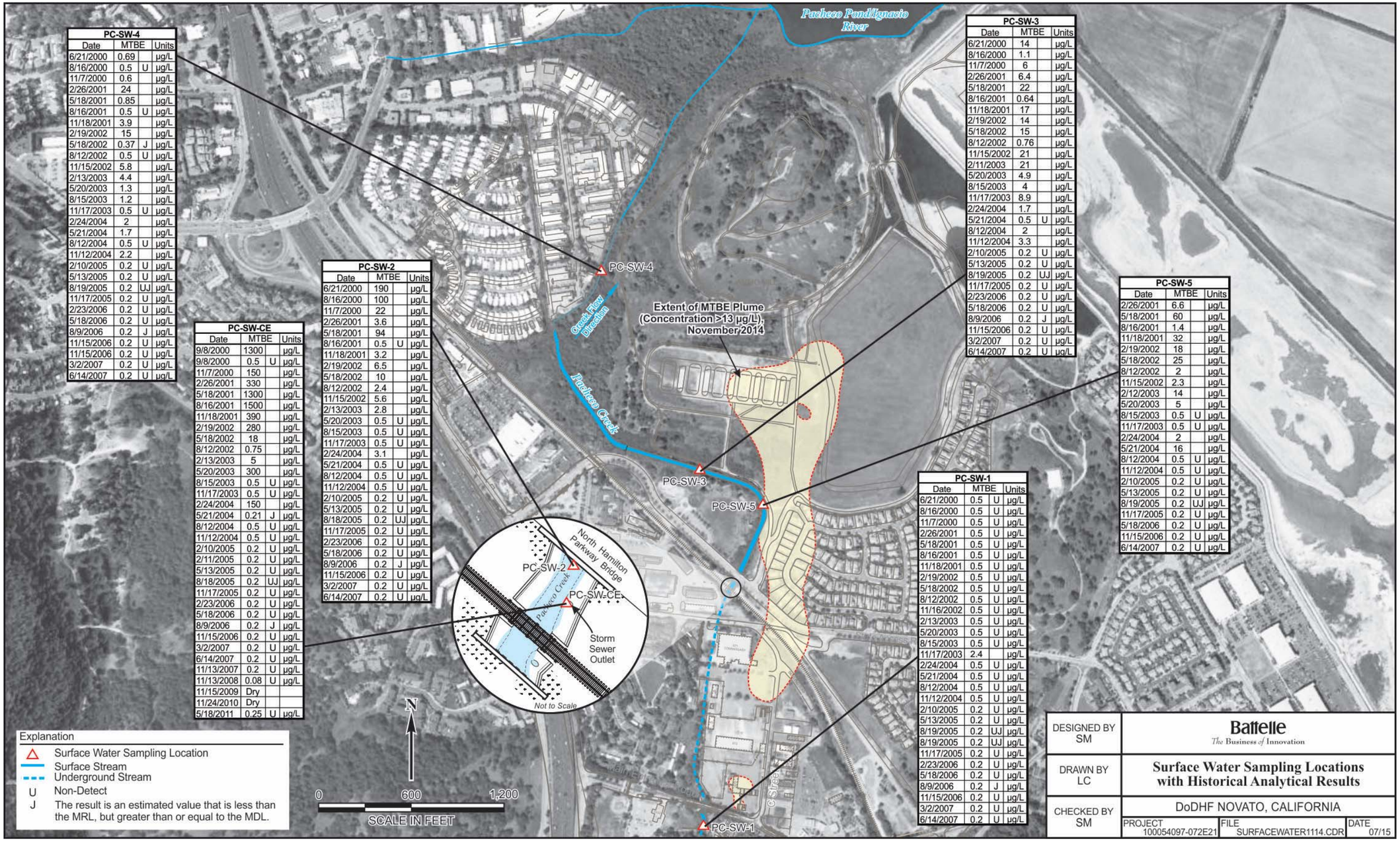


Figure 3. Potentiometric Maps (November 2011-December 2015)



PC-SW-4

Date	MTBE		Units
6/21/2000	0.69		µg/L
8/16/2000	0.5	U	µg/L
11/7/2000	0.6		µg/L
2/26/2001	24		µg/L
5/18/2001	0.85		µg/L
8/16/2001	0.5	U	µg/L
11/18/2001	3.9		µg/L
2/19/2002	15		µg/L
5/18/2002	0.37	J	µg/L
8/12/2002	0.5	U	µg/L
11/15/2002	5.8		µg/L
2/13/2003	4.4		µg/L
5/20/2003	1.3		µg/L
8/15/2003	1.2		µg/L
11/17/2003	0.5	U	µg/L
2/24/2004	2		µg/L
5/21/2004	1.7		µg/L
8/12/2004	0.5	U	µg/L
11/12/2004	2.2		µg/L
2/10/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/19/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
2/23/2006	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
8/9/2006	0.2	J	µg/L
11/15/2006	0.2	U	µg/L
11/15/2006	0.2	U	µg/L
3/2/2007	0.2	U	µg/L
6/14/2007	0.2	U	µg/L

PC-SW-CE

Date	MTBE		Units
9/8/2000	1300		µg/L
9/8/2000	0.5	U	µg/L
11/7/2000	150		µg/L
2/26/2001	330		µg/L
5/18/2001	1300		µg/L
8/16/2001	1500		µg/L
11/18/2001	390		µg/L
2/19/2002	280		µg/L
5/18/2002	18		µg/L
8/12/2002	0.75		µg/L
2/13/2003	5		µg/L
5/20/2003	300		µg/L
8/15/2003	0.5	U	µg/L
11/17/2003	0.5	U	µg/L
2/24/2004	150		µg/L
5/21/2004	0.21	J	µg/L
8/12/2004	0.5	U	µg/L
11/12/2004	0.5	U	µg/L
2/10/2005	0.2	U	µg/L
2/11/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/18/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
2/23/2006	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
8/9/2006	0.2	J	µg/L
11/15/2006	0.2	U	µg/L
3/2/2007	0.2	U	µg/L
6/14/2007	0.2	U	µg/L
11/13/2007	0.2	U	µg/L
11/13/2008	0.08	U	µg/L
11/15/2009	Dry		
11/24/2010	Dry		
5/18/2011	0.25	U	µg/L

PC-SW-2

Date	MTBE		Units
6/21/2000	190		µg/L
8/16/2000	100		µg/L
11/7/2000	22		µg/L
2/26/2001	3.6		µg/L
5/18/2001	94		µg/L
8/16/2001	0.5	U	µg/L
11/18/2001	3.2		µg/L
2/19/2002	6.5		µg/L
5/18/2002	10		µg/L
8/12/2002	2.4		µg/L
11/15/2002	5.6		µg/L
2/13/2003	2.8		µg/L
5/20/2003	0.5	U	µg/L
8/15/2003	0.5	U	µg/L
11/17/2003	0.5	U	µg/L
2/24/2004	3.1		µg/L
5/21/2004	0.5	U	µg/L
8/12/2004	0.5	U	µg/L
11/12/2004	0.5	U	µg/L
2/10/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/18/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
2/23/2006	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
8/9/2006	0.2	J	µg/L
11/15/2006	0.2	U	µg/L
3/2/2007	0.2	U	µg/L
6/14/2007	0.2	U	µg/L

PC-SW-3

Date	MTBE		Units
6/21/2000	14		µg/L
8/16/2000	1.1		µg/L
11/7/2000	6		µg/L
2/26/2001	6.4		µg/L
5/18/2001	22		µg/L
8/16/2001	0.64		µg/L
11/18/2001	17		µg/L
2/19/2002	14		µg/L
5/18/2002	15		µg/L
8/12/2002	0.76		µg/L
11/15/2002	21		µg/L
2/11/2003	21		µg/L
5/20/2003	4.9		µg/L
8/15/2003	4		µg/L
11/17/2003	8.9		µg/L
2/24/2004	1.7		µg/L
5/21/2004	0.5	U	µg/L
8/12/2004	2		µg/L
11/12/2004	3.3		µg/L
2/10/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/19/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
2/23/2006	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
8/9/2006	0.2	J	µg/L
11/15/2006	0.2	U	µg/L
3/2/2007	0.2	U	µg/L
6/14/2007	0.2	U	µg/L

PC-SW-5

Date	MTBE		Units
2/26/2001	6.6		µg/L
5/18/2001	60		µg/L
8/16/2001	1.4		µg/L
11/18/2001	32		µg/L
2/19/2002	18		µg/L
5/18/2002	25		µg/L
8/12/2002	2		µg/L
11/15/2002	2.3		µg/L
2/12/2003	14		µg/L
5/20/2003	5		µg/L
8/15/2003	0.5	U	µg/L
11/17/2003	0.5	U	µg/L
2/24/2004	2		µg/L
5/21/2004	16		µg/L
8/12/2004	0.5	U	µg/L
11/12/2004	0.5	U	µg/L
2/10/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/19/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
11/15/2006	0.2	U	µg/L
6/14/2007	0.2	U	µg/L

PC-SW-1

Date	MTBE		Units
6/21/2000	0.5	U	µg/L
8/16/2000	0.5	U	µg/L
11/7/2000	0.5	U	µg/L
2/26/2001	0.5	U	µg/L
5/18/2001	0.5	U	µg/L
8/16/2001	0.5	U	µg/L
11/18/2001	0.5	U	µg/L
2/19/2002	0.5	U	µg/L
5/18/2002	0.5	U	µg/L
8/12/2002	0.5	U	µg/L
11/16/2002	0.5	U	µg/L
2/13/2003	0.5	U	µg/L
5/20/2003	0.5	U	µg/L
8/15/2003	0.5	U	µg/L
11/17/2003	2.4		µg/L
2/24/2004	0.5	U	µg/L
5/21/2004	0.5	U	µg/L
8/12/2004	0.5	U	µg/L
11/12/2004	0.5	U	µg/L
2/10/2005	0.2	U	µg/L
5/13/2005	0.2	U	µg/L
8/19/2005	0.2	UJ	µg/L
8/19/2005	0.2	UJ	µg/L
11/17/2005	0.2	U	µg/L
2/23/2006	0.2	U	µg/L
5/18/2006	0.2	U	µg/L
8/9/2006	0.2	J	µg/L
11/15/2006	0.2	U	µg/L
3/2/2007	0.2	U	µg/L
6/14/2007	0.2	U	µg/L

Figure 4. Surface Water Sampling Locations from 2000-2011

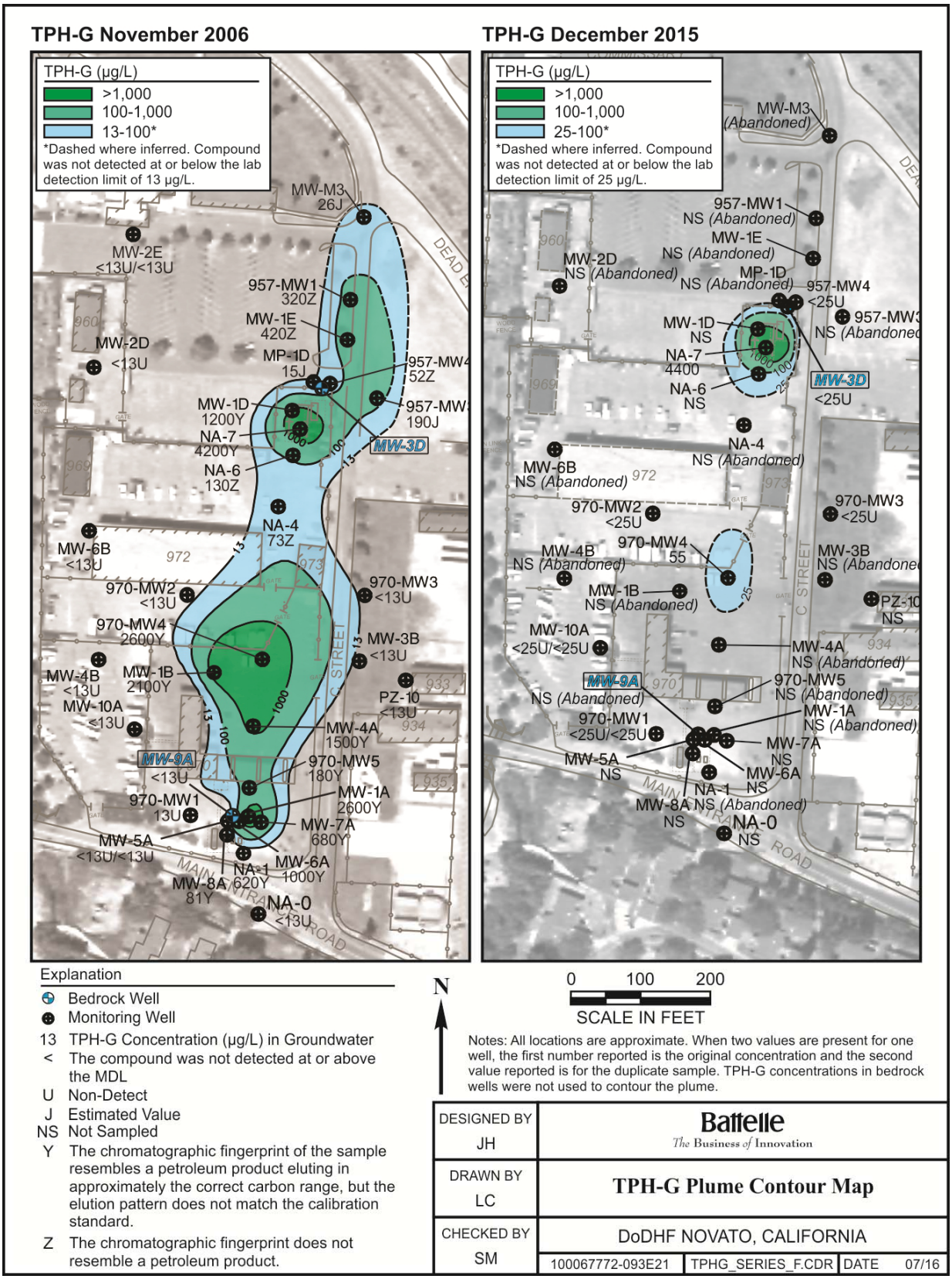


Figure 5. TPH-G Plume Contour Map (November 2006 and December 2015)

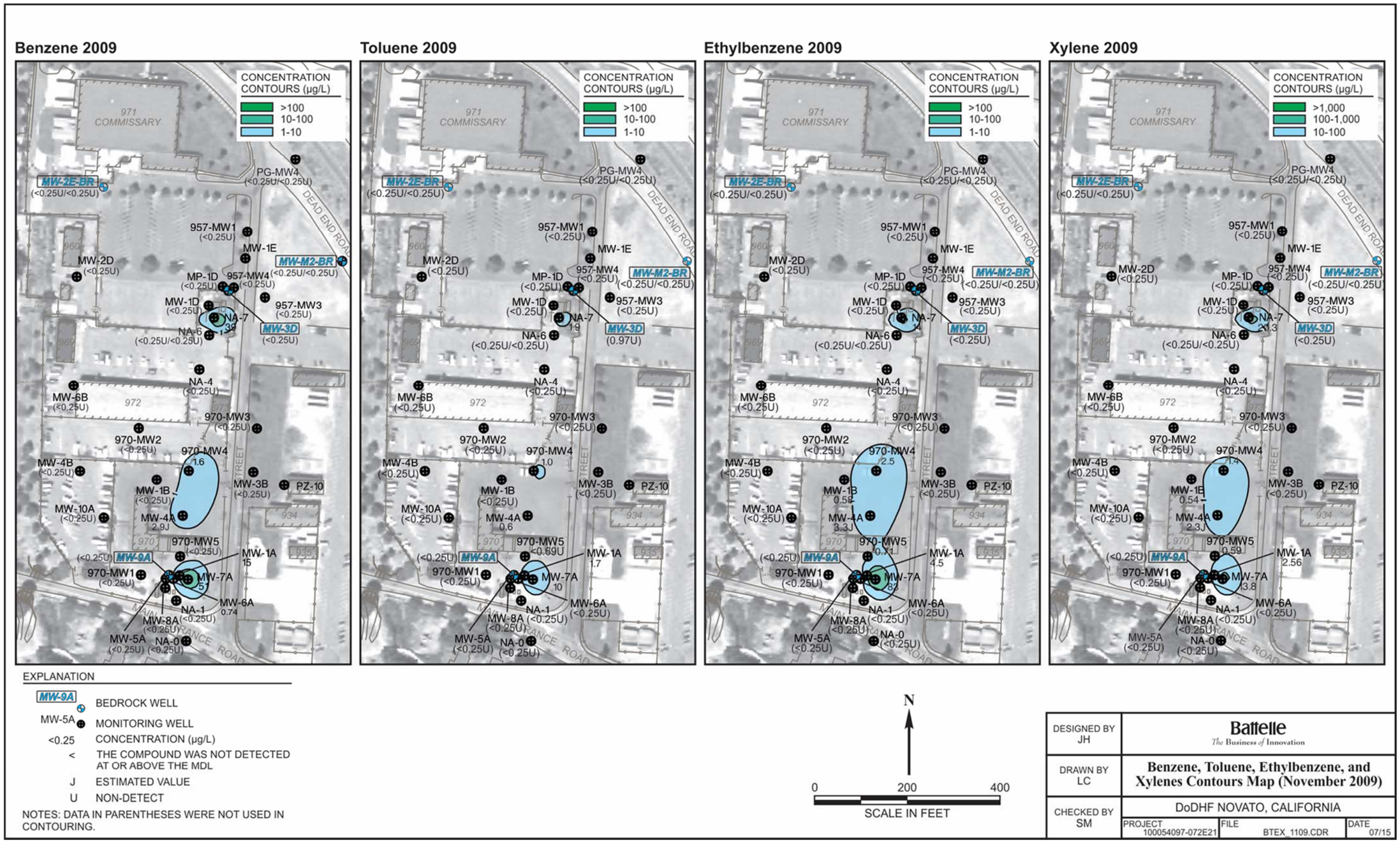


Figure 6. BTEX Plume Contour Maps (November 2009)

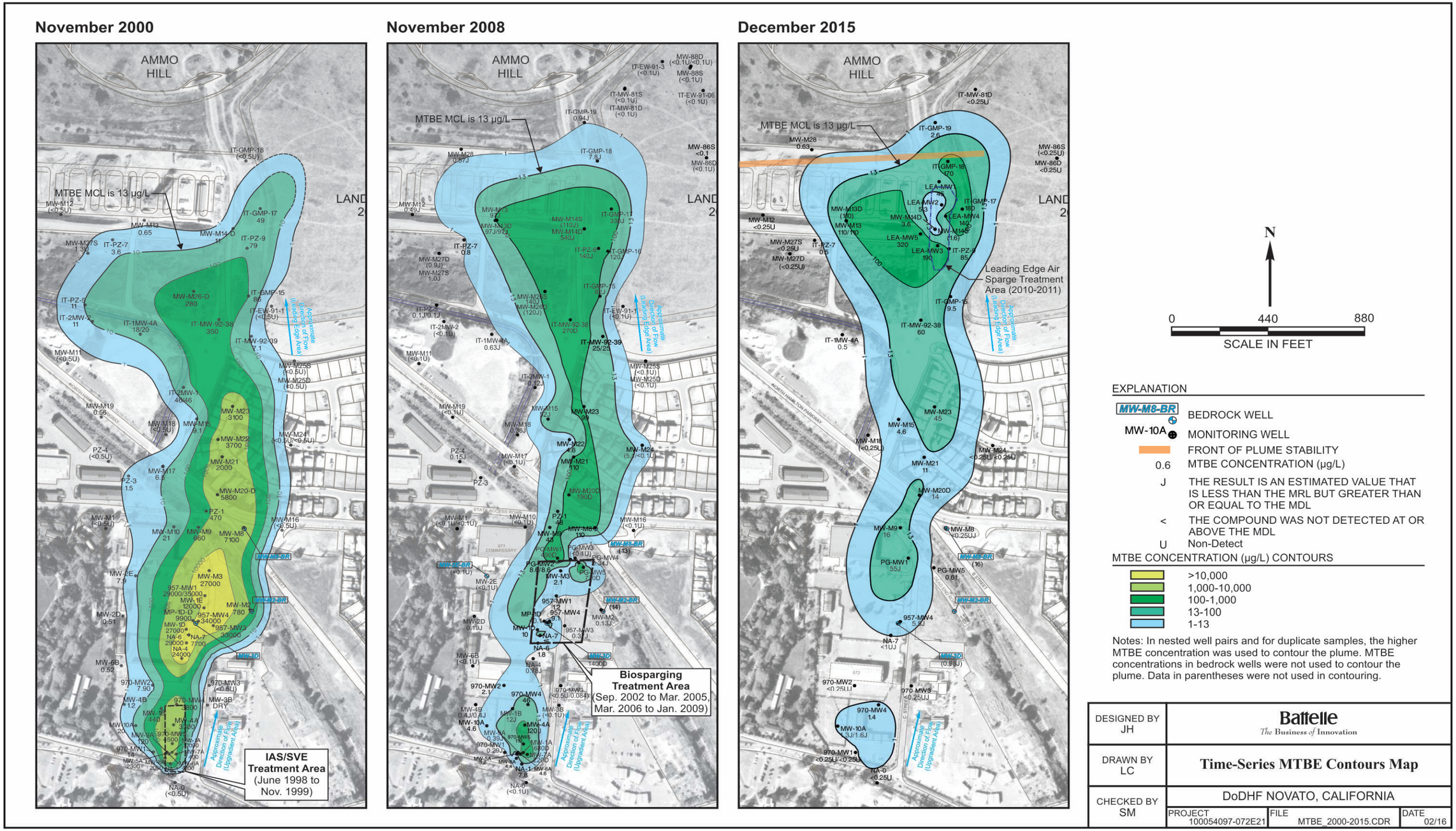


Figure 7. Time Series MTBE Plume Contour Maps (November 2000, 2008, and December 2015)

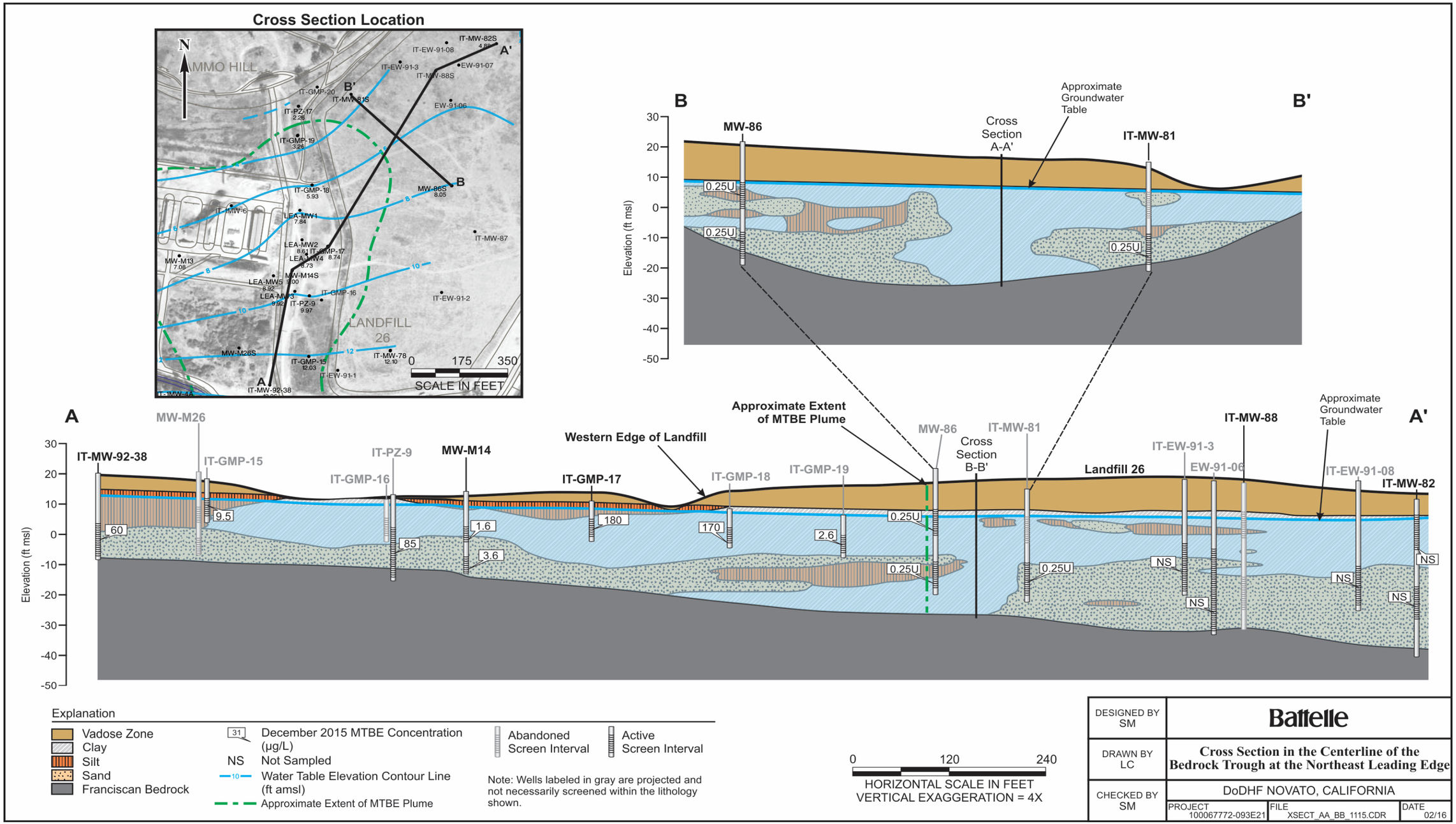
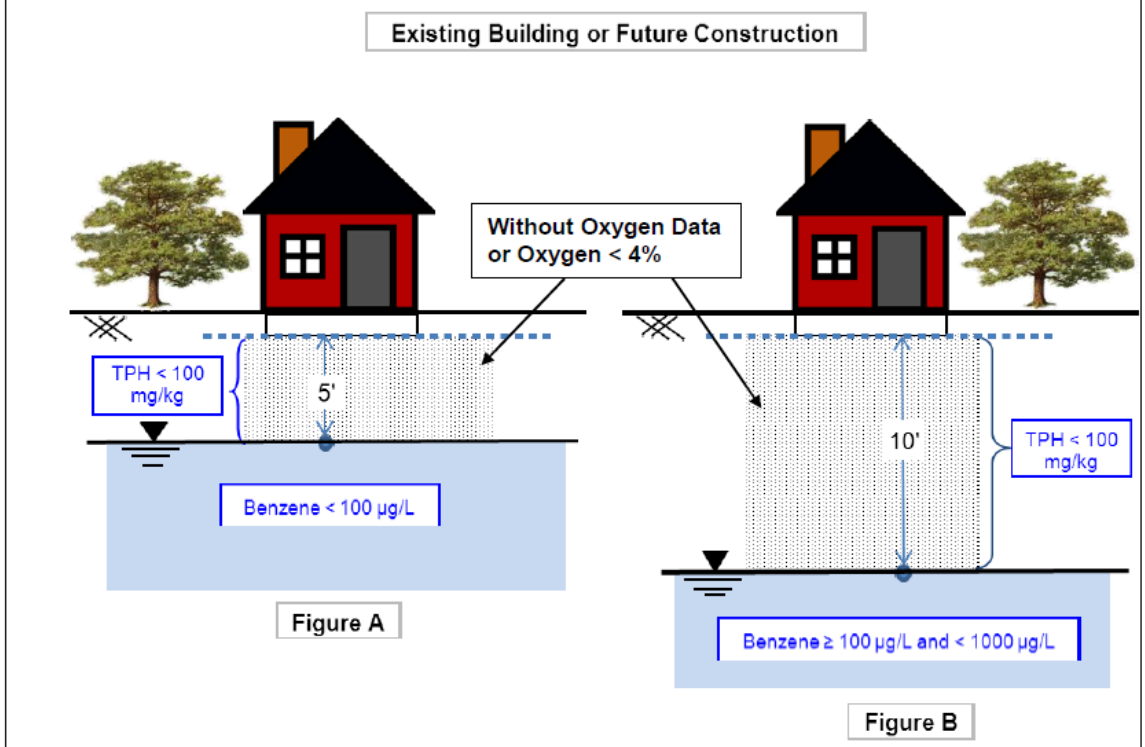


Figure 8. Cross Section of Leading Edge Area

Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater (Low concentration groundwater scenarios with or without oxygen data)

Defining the Bioattenuation Zone Without Oxygen Data or Oxygen < 4%



Required Characteristics of Bioattenuation Zone for Sites Without Oxygen Data or Where Oxygen is < 4%

Figure A: 1) Where benzene concentrations are less than 100 µg/L, the bioattenuation zone:

a) Shall be a continuous zone that provides a separation of at least 5 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and
b) Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

Figure B: 1) Where benzene concentrations are equal to or greater than 100 µg/L but less than 1000 µg/L, the bioattenuation zone:

a) Shall be a continuous zone that provides a separation of at least 10 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and b) Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

Figure 9. Criteria for Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater (Water Board, 2012)

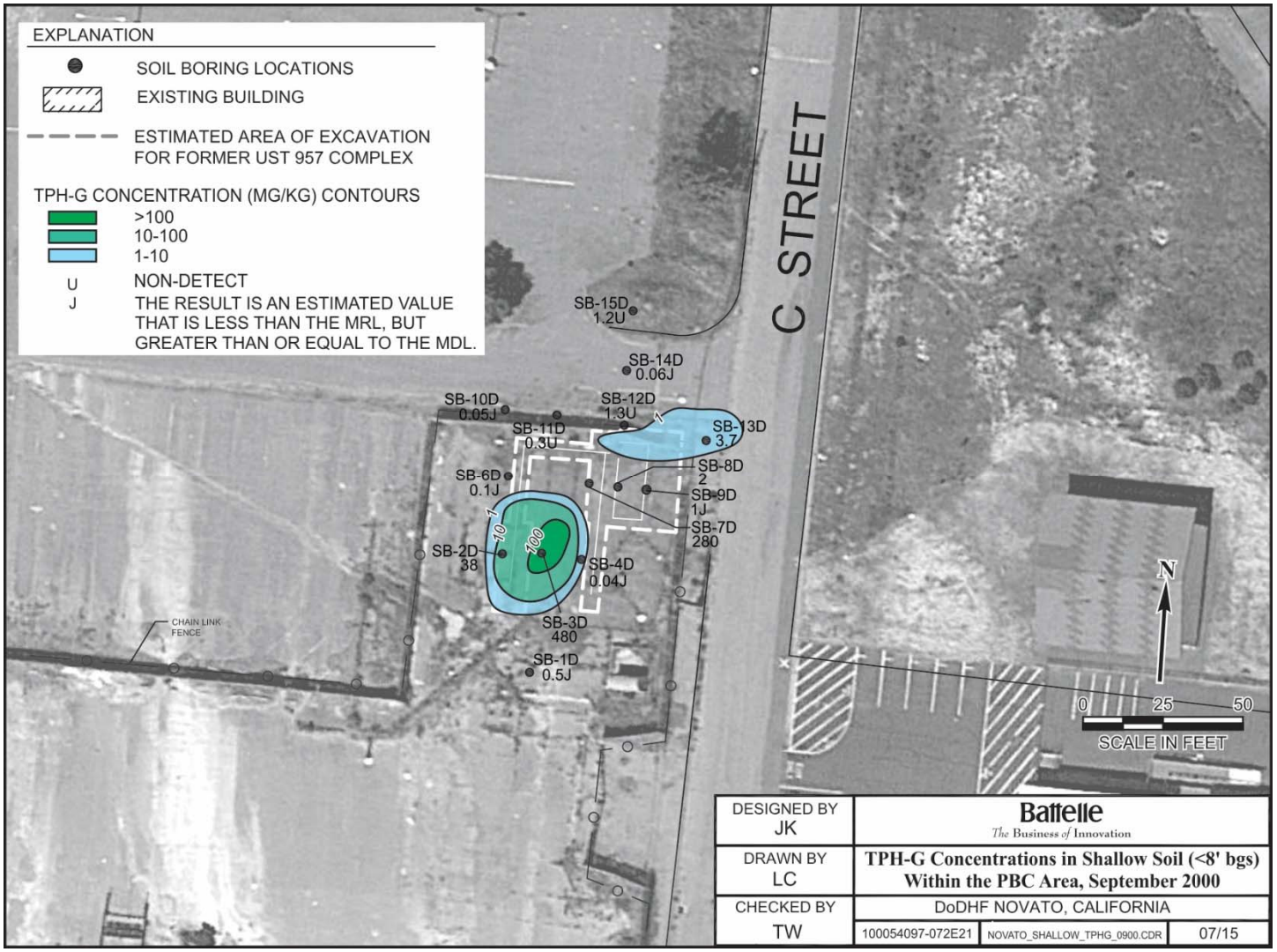


Figure 10. TPH-G Concentrations in Soil in the Former UST 957 Area (September 2000)

Figure 11. TPH-D Concentrations in Soil in the Former UST 957 Area (September 2000)

TABLES

Table 1. Completed Tasks Relevant to Water Board Oder 00-064

Task	Achieved	Supporting Document	Water Board Concurrence
Task 1: Work Plan for Remedial Investigation –submit a workplan acceptable to the Executive Officer to define the vertical and horizontal extent of soil and groundwater contamination at the Site.	August 30, 2000	Final Work Plan for Remedial Investigation of Former UST Site 957/970 at Department of Defense Housing Facility Novato, California	March, 2002
Task 2: Completion of Remedial Investigation –submit a technical report acceptable to the Executive Officer documenting completion of the tasks identified in Task 1 workplan.	January 31, 2001	Final Remedial Investigation Report for Former UST Site 957/970 at Department of Defense Housing Facility, Novato, California.	March, 2002
Task 3: Interim Remedial Action Work Plan for Soil –submit a workplan acceptable to the Executive Officer evaluating interim remedial action alternatives for hydrocarbon-impacted soil of significant concentration, identified in Task No. 1 and in the vicinity of the former Site USTs, ancillary piping, and hydraulic lifts, as appropriate.	July, 2000	Draft Summary Report for Hydraulic Lift and Oil/Water Separator Removal from Building 970, Department of Defense Housing Facility (DoDHF) Novato, California.	April, 2003
Task 4: Completion of Interim Remedial Action for Soil – complete the work and submit a technical report acceptable to the Executive Officer.	July, 2000	Draft Summary Report for Hydraulic Lift and Oil/Water Separator Removal from Building 970, Department of Defense Housing Facility (DoDHF) Novato, California.	April, 2003
Task 5: Monitoring Well Protection Plan –submit a workplan acceptable to the Executive Officer that presents a monitoring well protection and management strategy/plan given the nature and magnitude of proposed site redevelopment/construction activities.	September 13, 2000	Monitoring Well Protection Plan for Former UST Site 957/970 at Department of Defense Housing Facility, Novato, California, Revision 1.0 Final	March, 2002
Task 6: Proposed Final Corrective Action Plan for Groundwater – submit a workplan acceptable to the Executive Officer that includes: 1. Stabilize and contain the higher concentration MTBE groundwater plume on the currently Navy-owned portion of the Site. 2. Remediate the highest concentrations of soil pollution detected.	August, 2001	Final Corrective Action Plan for Groundwater for Former Underground Storage Tank Site 957/970, Department of Defense Housing Facility, Novato, CA	December, 2001

Table 1. Completed Tasks Relevant to Water Board Oder 00-064 (Continued)

Task	Achieved	Supporting Document	Water Board Concurrence
3. Reduce and remediate the concentrations of MTBE in Site groundwater. 4. Reduce and remediate the concentrations of benzene in Site groundwater which exceed applicable risk based screening levels (RBSLs).			
Task 7: Interim Site Controls on Soil and Groundwater (completed) – after consulting with interested parties, prepare and submit a report, acceptable to the Executive Officer, of interim controls to be placed on the excavation of polluted Site soils and extraction and discharge of polluted Site groundwater in order to protect human health and the environment prior to the completion of a final remedial action at the Site pursuant to Task 6.	November 11, 2001	Interim Site Control Plan for the Department of Defense Housing Facility, Novato, California.	March, 2002
Task 8: Groundwater Monitoring Plan – submit a Groundwater Monitoring Plan, acceptable to the Executive Officer, that describes the procedures for conducting quarterly groundwater elevation measurements and quarterly sampling of existing and proposed wells located on Site 957/970 and the adjoining Army property (HAAF) to the north.	January 28, 2013 - "evergreen", ongoing,	Final Groundwater Monitoring Plan for Former UST Site 957/970 at Department of Defense Housing Facility, Novato, California.	March, 2002
Task 9: Site Status Reports –submit Quarterly Site Status Reports, acceptable to the Executive Officer that present the results of each quarterly groundwater/surface water monitoring event. The reports shall include all data gathered and observations made during each sampling event, a summary of findings, potentiometric maps, and tabulated groundwater level measurements and groundwater analytical reports for all pollutants analyzed.	July 24 2014 - "evergreen", on going	Annual Site Status Report for the Year 2012, UST Site 957/970, Former Department of Defense Housing Facility Novato, California.	Pending

Table 2. Summary of Monitoring Well Yield at Former UST Site 957/970

Well ID	Yield (mL/min)[1]	Yield (gal/day)	Total Depth (ft bgs)	Depth to Top Screen (ft bgs)	Depth to Bottom Screen (ft bgs)	Description	Drawdown (ft)	Purge Time (minutes)
Leading Edge Area Wells								
IT-GMP-15[2]	50	19	12	5	10	1-in. PVC	0.1	15
IT-GMP-17	100	38	12	5	10.5	1-in. PVC	0.01	18
IT-GMP-18	50	19	12	6	10.5	1-in. PVC	0.16	15
IT-GMP-19	100	38	12	5	10	1-in. PVC	0.11	15
IT-MW-81D	100	38	31	18	31	IT Well	0.14	24
IT-MW-92-38	100	38	26	15	25	4-in. stainless	0	18
IT-PZ-7	100	38	20.3	9.2	19.2	2-in. PVC	0.13	18
IT-PZ-9	100	38	24	7.9	22.9	2-in. PVC	0	15
LEA-MW1	100	38	22	17	22	2-in. PVC	0.01	18
LEA-MW2	100	38	23	18	23	2-in. PVC	0.03	18
LEA-MW3	100	38	23.5	18.5	23.5	2-in. PVC	0.02	18
LEA-MW4	100	38	22	17	22	2-in. PVC	0.15	26
LEA-MW5	100	38	23	18	23	2-in. PVC	0	18
MW-86D	100	38	38	29	38	4-in.PVC	0.02	18
MW-86S	100	38	39	13	22	4-in.PVC	0.07	15
MW-M12[2]	50	19	15	5	15	2-in. PVC	0.34	NA
MW-M13	50	19	15	5	15	2-in. PVC	0.19	18
MW-M13D	100	38	29.5	25	29.5	2-in. PVC	0.04	15
MW-M14D	100	38	22	17	22	1-in. PVC	0.04	18
MW-M14S	100	38	22	8	13	1-in. PVC	0.03	15
MW-M27D	100	38	20	15	20	1-in. PVC	0.09	42
MW-M27S	100	38	20	5	10	1-in. PVC	0.13	18
MW-M28	100	38	18	7.5	17.5	2-in. PVC	0	18

Table 2. Summary of Monitoring Well Yield at Former UST Site 957/970 (Continued)

Well ID	Yield (mL/min)[1]	Yield (gal/day)	Total Depth (ft bgs)	Depth to Top Screen (ft bgs)	Depth to Bottom Screen (ft bgs)	Description	Drawdown (ft)	Purge Time (minutes)
Upgradient Monitoring Wells								
957-MW4	100	38	20.5	8	18	4-in. PVC	0.15	18
970-MW1	100	38	20.5	8	18	4-in. PVC	0.05	15
970-MW2	200	76	20.5	8	19	4-in. PVC	0.02	18
970-MW3	100	38	17	6	16	4-in. PVC	0.07	15
970-MW4	200	76	20.5	8	18	4-in. PVC	0.02	18
970-MW5	200	76	20.5	8	18	4-in. PVC	0.13	18
IT-1MW-4A	100	38	21	5	20	4-in. PVC	0.1	24
MW-1A	100	38	17	4	17	2-in. PVC	0.11	15
MW-3D	100	38	31	26	31	2-in. PVC	0.13	15
MW-4A	100	38	16	5	15	2-in. PVC	0.17	15
MW-10A	100	38	16	6	16	1-in. PVC	0.08	15
MW-M15[2]	100	38	16	4	16	1-in. PVC	0.33	NA
MW-M18	100	38	15	5	15	1-in. PVC	0.16	18
MW-M20D	100	38	15.5	12.5	15.5	1-in. PVC	0.04	24
MW-M21	100	38	14.5	9.5	14.5	1-in. PVC	0.06	18
MW-M23	100	38	14.5	9	14	1-in. PVC	0.01	15
MW-M24	100	38	14	9	14	1-in. PVC	0.07	21
MW-M2-BR	100	38	39	28	38	2-in. PVC	0.1	13
MW-M8	100	38	15	5	15	2-in. PVC	0.1	15
MW-M8-BR	100	38	60	49	59	2-in. PVC	0.1	24
MW-M9	200	76	16	5	15	2-in. PVC	0.2	18
NA-0[2]	100	38	12	5	12	1-in. PVC	0.34	1
NA-4[2]	100	38	14.5	8.5	13.5	1-in. PVC	13.13	30

Table 2. Summary of Monitoring Well Yield at Former UST Site 957/970 (Continued)

Well ID	Yield (mL/min)[1]	Yield (gal/day)	Total Depth (ft bgs)	Depth to Top Screen (ft bgs)	Depth to Bottom Screen (ft bgs)	Description	Drawdown (ft)	Purge Time (minutes)
NA-7[2]	100	38	15	10	15	1-in. PVC	13.13	6
PG-MW1	100	38	20	10	20	2-IN MW	0.17	15
PG-MW5	200	76	17	6	17	2-IN MW	0.15	18

[1] from 2014 groundwater sampling purge logs
[2] low yield causing excessive drawdown (greater than 0.33ft) bgs=below ground surface
ft=feet
gal=gallon
min=minute
mL=milliliter
NA- not applicable

Table 3. Summary of Investigations and Remediation at Former UST Site 957/970

Investigation/Remediation	Activity	Date	Analysis	Description
Removal of UST 957	UST Removal	March 1992	TPH/BTEX	After tank removal, underlying and adjacent soil was excavated, resulting in an excavation of 28 ft by 30 ft by 12 ft. Groundwater was encountered at 11 ft bgs. Underground piping from the UST to the pump island (109 ft) and vent lines from the tank (10 ft) were removed. The piping trenches were over excavated to depths of 2 to 4 ft bgs. Two confirmatory soil samples were collected from the north and south sidewalls of the UST excavation.
Direct Push Investigation/Monitoring Well Installation	Soil and Groundwater Sampling/Install Monitoring Wells	December 1994	TPH-G/TPH-D/BTEX/MTBE/ Total Lead	Screening level soil and groundwater sampling was conducted in the area surrounding former UST 957 using a Geoprobe™. The investigation included the collection of 64 soil samples from 39 discrete locations in and around the areas of the former USTs. Soil sampling locations were collected from a depth of 5 ft bgs and a depth of 8 to 10 ft bgs. Free product observed in vicinity of UST 957 and monitoring well 970-MW5. Samples from the initial investigations were analyzed for TPH and BTEX only.
Removal of UST 970-3	UST Removal	January 1995	TPH-G /BTEX	Gasoline was observed in water and soils during the excavation activities, and a hole was observed in the tank. Following removal of UST 970-3 and associated piping, two soil samples and one water sample were collected from the excavation and analyzed for TPH-G and BTEX.
Removal of UST 970-Waste Oil	UST Removal	January 1995	TPH-G /TPH-D/TPH-MO/TPH-JF/BTEX/	The tank appeared to be in good condition upon removal and confirmation soil sampling indicated that hydrocarbon impact was below applicable guidelines. For additional information concerning the tank removal activities and results refer to the Final UST Investigation Report for Former Underground Storage Tank Site 957/970 (ERM-West, Inc., 1998).

Table 3. Summary of Investigations and Remediation at Former UST Site 957/970 (Continued)

Investigation/Remediation	Activity	Date	Analysis	Description
Direct Push Investigation	Soil and Groundwater Sampling	November 1995	TPH-G /TPH-D/BTEX	Soil and groundwater sampling were conducted in the area of former UST 970-3 using a Geoprobe™.
Direct Push Investigation/Monitoring Well Installation	Soil and Groundwater Sampling	January/October 1996	TPH-G /TPH-D/BTEX	Soil and groundwater sampling were conducted in the area of former UST 970-3 using a Geoprobe™. Six additional permanent monitoring wells (five in the vicinity of former 970 USTs and one in the vicinity of former UST 957) were installed.
Site Characterization and Analysis Penetrometer System (SCAPS)	Soil and Groundwater Sampling	May 1996	TPH/TPH-G/BTEX/MTBE	The investigation focused on the NEX gas station area around Building 970. The investigation extended the area sampled to the southern (UST 970) portion of the Site, and included 23 pushes ranging from 4.6 to 23 ft bgs and 13 groundwater samples were collected from approximately 9 ft bgs.
Removal of UST 970-1 and UST 970-2	UST Removal	July 1996	TPH-G/BTEX/ MTBE	Five soil samples were collected from the north, south, and east sidewalls of the excavation upon removal of the USTs. All soil samples were analyzed for TPH-G and BTEX. One groundwater sample was collected from the tank pit and analyzed for TPH-G. Analysis of soil samples collected beneath the pump island piping found TPH-G and BTEX in soil.
Well Installation	Groundwater Monitoring Well Installation	October 1996	TPH-G/BTEX	Installed six additional permanent monitoring wells (five in the vicinity of former 970 USTs and one in the vicinity of former UST 957).
Direct Push Investigation	Groundwater Sampling	July 1997	MTBE	MTBE became a concern at the site. The investigation was conducted using a Geoprobe™ for screening level site characterization of MTBE concentrations in groundwater.
Groundwater Monitoring (Quarterly)	Groundwater Sampling	1998	TPH-P/BTEX/MTBE	The scope of the groundwater monitoring program conducted in a comprehensive set of wells each quarter includes the measurement of water levels, sufficient purging of each well, and the collection of groundwater samples. Groundwater samples collected at the Site were analyzed for TPH-G, BTEX and MTBE.
Tier 1 Risk-Based Corrective Action (RBCA) Assessment	Risk Assessment	February 1998	Soil: TPH-G, BTEX, MTBE Groundwater: TPH-G, BTEX, MTBE	This assessment confirmed that some gasoline constituents, including benzene and MTBE, existed at greater than Tier 1 "lookup table" values that are protective of human health under conservative assumptions. These values did not take into consideration site-specific conditions.
IAS/SVE	Remedial System Install	April 1998	BTEX/MTBE	Air sparging with soil vapor extraction (SVE) was used to reduce mass that could have been serving as a source of hydrocarbons to groundwater. The system included 10 air sparging wells and 6 SVE wells arranged to treat 4 "hot spots." An estimated 23,000 lbs. of gasoline were calculated to have been removed through the soil vapor extraction system.
Well Installation	Monitoring Well Network Installation	May 1998	NA	An extensive groundwater monitoring well network was installed at the site. The network included 18 groundwater monitoring wells for routine sampling (designated MW), 8 groundwater monitoring wells for evaluating natural attenuation rates (designated NA), 4 multilevel soil gas and groundwater monitoring points for evaluating system operation (designated MP).
Direct Push Investigation	Groundwater Sampling	May 1998	BTEX/MTBE	A limited investigation was performed using a CPT to delineate the boundaries of the MTBE groundwater plume. A total of 15 borings were advanced and 12 groundwater samples were collected from the CPT push locations. This investigation was also based on the previous delineation, but was expanded to over 200 ft beyond the boundaries identified by previous contractors. This investigation also failed to identify the boundaries of the existing MTBE in groundwater at the Site.
Soil Gas Sample Collection	Soil Gas Sampling	June 1998	BTEX/MTBE	Soil gas from beneath Building 973 was collected and analyzed to initially characterize the concentration profile of VOCs like BTEX and MTBE in the soil void spaces from the water table to the building foundation.
Direct Push Investigation	Groundwater Sampling	August 1998	BTEX/MTBE	Another investigation using a CPT was performed that delineated the MTBE plume. A total of 26 CPT borings were advanced during the investigation. The MTBE plume was found to extend 1,400 ft downgradient (north) beyond the boundaries previously identified, and was observed to have a width of approximately 600 ft. The MTBE plume was found to extend 1,400 ft downgradient (north) beyond the boundaries previously identified, and was observed to have a width of approximately 600 ft.
IAS/SVE Expansion	IAS/SVE Expansion	October 1998	BTEX/MTBE	Groundwater monitoring results from permanent wells not available at the time of pilot system design and installation indicated that greater concentrations of gasoline constituents existed outside the areas treated by the interim (pilot) action system. The system was therefore expanded to almost twice its originally designed capacity to ensure that effective hot spot remediation was achieved. During expansion activities, an additional 8 sparge wells and 7 SVE wells were installed at the Site.
Groundwater Fate and Transport	Groundwater Modeling	November 1998	MTBE	Because of the absence of historical groundwater monitoring data for the Site, an effort was begun to predict the future behavior of MTBE in groundwater at the Site. Aquifer parameters were entered into a numerical model to estimate the likely behavior of the MTBE plume. All site characterization information was assimilated and incorporated into a site conceptual model. This conceptual model was used as a "living" representation of typical site conditions, exposure pathways, and future land uses, and was updated and revised as new information became available

Table 3. Summary of Investigations and Remediation at Former UST Site 957/970 (Continued)

Investigation/Remediation	Activity	Date	Analysis	Description
Monitoring Well Installation	Groundwater Sampling	December 1998	NA	Additional permanent monitoring wells were installed around the perimeter and within the MTBE groundwater plume. These new wells, as well as selected wells installed by the United States Army Corps of Engineers (USACE) were monitored monthly for four (4) months to ensure that the MTBE plume had been adequately delineated, and quarterly thereafter.
Groundwater Monitoring (Quarterly)	Groundwater Sampling	1998	TPH-G/BTEX/MTBE	Groundwater samples were collected from 36 monitoring wells using low-flow purging methods.
Tier 2 RBCA Assessment	Risk Assessment	March 1999	Soil: TPH-G, BTEX, MTBE Groundwater: TPH-G, BTEX, MTBE	This assessment incorporated responses to comments from the Water Board on the Tier 1 RBCA Assessment, as well as some limited site-specific parameters, such as soil porosity, bulk density, and depth to the water table. The Tier 2 RBCA Assessment also found that existing benzene and MTBE concentrations exceeded those protective of human health. However, the most restrictive exposure pathway (volatilization of VOCs from groundwater to indoor air) was believed to incorporate incorrect and incomplete assumptions. A Tier 3 RBCA Assessment was planned that would include extensive site-specific data related to that exposure pathway.
MNA Evaluation	Historic Groundwater Monitoring and Purged Water Quality Information Used in Evaluation	April 1999	NA	Groundwater monitoring and purged water quality information collected over time was used to perform a preliminary evaluation of the potential for the Site to be remediated by natural attenuation mechanisms. This preliminary evaluation indicated that TPH and BTEX were stable in groundwater. MTBE was not included in this evaluation due to insufficient time series data.
Tier 3 RBCA Assessment	Risk Assessment	July 1999	Soil: TPH-G, BTEX, MTBE Groundwater: TPH-G, BTEX, MTBE	This report included a detailed evaluation of the volatilization from groundwater to indoor air pathway and incorporated results from direct air sampling and soil-gas sampling performed at the Site. This detailed evaluation revealed that existing concentrations of BTEX and MTBE were very near or below protective concentrations. Comments from the Water Board on the Tier 3 RBCA Assessment included two substantive requests for further assessment: (1) confirmation soil-gas sampling under worst case conditions at the end of the dry season when dry soils would be most conducive to vapor transport, and (2) more detailed assessment concerning the potential exposure of the ingestion of homegrown fruits and vegetables.
Groundwater Monitoring	Groundwater Sampling	1999	TPH-G/BTEX/MTBE	Groundwater samples were collected from 52 monitoring wells using low-flow purging methods.
Well Abandonment	Abandon Monitoring Wells	August 1999	NA	Four monitoring wells abandoned.
Revised Tier 3 RBCA Assessment	Risk Assessment	October 1999	Soil: TPH-G, BTEX, MTBE Groundwater: TPH-G, BTEX, MTBE	A revised and Final Tier 3 RBCA Assessment was prepared by the Navy that included results of confirmation soil-gas sampling and the expanded assessment of the ingestion of homegrown fruits and vegetables potential exposure pathway as requested by the Water Board.
Draft Ecological Risk Assessment	Risk Assessment	December 1999	Soil: TPH-G, BTEX, MTBE Groundwater: TPH-G, BTEX, MTBE	Draft Ecological Risk Scoping Assessment was performed by the Navy and submitted to the Water Board. The assessment included areas of the Site and former HAAF property (i.e., Pacheco Creek).
Groundwater Monitoring (Quarterly)	Groundwater Sampling and Surface Water Sampling	2000	TPH-G/BTEX/MTBE	Groundwater samples were collected from 70 monitoring wells on a quarterly basis using low-flow purging methods. Eight surface water samples were collected from Pacheco Creek.
Removal of Hydraulic Lift and Oil/Water Separator in Building 970	Hydraulic Lift Removal	April 2000	TPH/Metals	The activities followed procedures outlined in the Final Work Plan for Hydraulic Lift and Oil/Water Separator Removal, which was submitted to and approved by the Water Board in March 2000 (Battelle, 2000e). During removal activities, petroleum hydrocarbon-impacted soil was encountered near both units, around Drums 1 and 2, and beneath and around the foundations in the northern and northwestern portions of Building 970. The finding of unexpected subsurface lines and features (i.e., an additional oil/water separator) extended and expanded field excavation activities, and several locations required over excavation and confirmation sampling. Excavation and backfilling activities were completed in May, and soil disposal was completed in June...
Surface Water Sampling	Surface Water Sampling at Pacheco Creek	June 2000	BTEX/MTBE	Surface water monitoring at four (4) locations within Pacheco Creek began. Following receipt of the analytical results, four (4) additional locations associated with culvert outfalls were sampled to determine whether the culverts were likely sources of MTBE in Pacheco Creek.

Table 3. Summary of Investigations and Remediation at Former UST Site 957/970 (Continued)

Investigation/Remediation	Activity	Date	Analysis	Description
Remedial Investigation Activities	Remedial Investigation	September 2000	TPH/TPH-G/TPH-D/TPH-MO	A GeoprobeTM was used to collect soil samples from 20 locations in the vicinity of the former UST 970 complex (within the Sale Area) and 16 locations in the vicinity of the former UST 957 (within the PBC Area) to confirm that a residual source adding gasoline mass to groundwater does not exist in shallow and smear zone soils at these locations. Soil samples also were collected at four locations near the former UST 970 complex. In the Sale Area, a total of 46 soil samples were collected using and 32 soil samples were collected in the PBC Area. The physical and chemical properties of a three-dimensional volume of soil in this area were characterized using CPT methods. The lithology south of State Access Road was investigated by performing CPT pushes at 42 locations along four transects that were oriented perpendicular to the groundwater flow direction. A total of 20 groundwater samples were obtained using a Hydropunch™.
Groundwater Sampling	Quarterly Groundwater Monitoring	2000	TPH-G BTEX/MTBE	A quarterly Site Status Report presenting the results of groundwater and surface water monitoring activities performed in August was prepared by the Navy and submitted to the Water Board in compliance with Order No. 00-064 Task 9. The Navy will continue to submit quarterly status reports in compliance with Order No. 00-064 Task 9
Final Revised Risk Assessment Report for Former UST Site 957/970	Risk Assessment	March 2001	Soil: 1,2,4-TMB, 1,3,5-TMB, BTEX, Cumene, MTBE, Naphthalene, n-Propylbenzene, sec-Butylbenzene Groundwater: BTEX, MTBE Soil Gas: 1,2,4-TMB, 1,3,5-TMB, BTEX, Cumene, MTBE, Naphthalene, n-Propylbenzene, sec-Butylbenzene, Cymene	Conducted in response to comments provided by DTSC on the Tier 3 RBCA assessment. Results indicated that MTBE and other gasoline constituents in groundwater did not pose a threat to human health or ecological receptors.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2001	TPH-G/BTEX/MTBE	Groundwater samples were collected from 77 monitoring wells using low-flow purging methods. 6 surface water samples were collected from Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2002	TPH-G /BTEX/MTBE	Groundwater samples were collected from 77 monitoring wells using low-flow purging methods. 6 surface water samples were collected from Pacheco Creek.
Biosparge Installation	Biosparge System Installation	September 2002	BTEX/MTBE/TBF/TBA	Biosparge system initiated at Former UST Site 970/965. This remediation system was temporarily shut down for one year (from March 2005 to March 2006) with approval from the San Francisco Bay Regional Water Quality Control Board (Water Board) because asymptotic mass removal was achieved by the system. No significant rebound of MTBE concentrations was observed during this interim shutdown phase. The system was restarted in March 2006 and operated on a pulsed schedule until January 2009.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2003	TPH-P/BTEX/MTBE/TBA/TBF/ETBE/TAME/DIPE	Groundwater samples were collected from 88 monitoring wells using low-flow purging techniques. Surface water samples collected at 6 locations along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2004	TPH-P/BTEX/MTBE/TBA/TBF/ETBE/TAME/DIPE	Groundwater samples were collected from 88 monitoring wells using low-flow purging techniques. Surface water samples collected at 6 locations along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2005	TPH-P/BTEX/MTBE/TBA/TBF/ETBE/TAME/DIPE	Groundwater samples were collected from 94 monitoring wells using low-flow purging techniques. Surface water samples collected at 6 locations along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2006	TPH-P/BTEX/MTBE/TBA/TBF/ETBE/TAME/DIPE	Groundwater samples were collected from 92 monitoring wells using low-flow purging techniques. Surface water samples collected at 5 locations along Pacheco Creek
Final Human Health Risk Assessment	Risk Assessment	2006	Groundwater: BTEX, MTBE Soil Gas: 1,3-Butadiene, MTBE, BTEX, iso-Propylbenzene, n-Propylbenzene, 1,3,5-TMB, 1,2,4-TMB, sec-Butylbenzene	Presents the results of the risk assessment update conducted to determine health risks to potential future human receptors at PBC Parcels 1A and 1B of the Former UST Site 957/970 caused by the presence of residual fuel hydrocarbons in soil and groundwater remaining after remediation activities at the site.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2007	BTEX/MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 94 monitoring wells using low-flow purging techniques. Surface water sample collected at 1 location along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2008	BTEX (one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 95 monitoring wells using low-flow purging techniques. Surface water sample collected at 1 location along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2009	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 107 monitoring wells using low-flow purging techniques. Surface water sample collected at 1 location along Pacheco Creek.
Groundwater Monitoring (Quarterly)	Groundwater and Surface Water Sampling	2010	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 84 monitoring wells using low-flow purging techniques. Surface water sample collected at 1 location along Pacheco Creek.

Table 3. Summary of Investigations and Remediation at Former UST Site 957/970 (Continued)

Investigation/Remediation	Activity	Date	Analysis	Description
Direct Push Investigation	Groundwater Grab Sampling and Soil Core Investigation/Well Abandonment	May 2010	MTBE	Groundwater grab samples collected and soil core logging conducted at 15 locations in the leading edge area to inform final design of air sparge system. 122 former air sparge, SVE, piezometers, and monitoring wells located on former Navy property were abandoned.
Well Abandonment	Abandon Monitoring Wells	May 2010	NA	Biosparge system well removal (67 air sparge and SVE wells, 23 soil gas monitoring points abandoned), and 26 monitoring wells removed from the monitoring well network.
Air Sparge System Installation	Air Sparge System Installation/Performance well Installation (leading edge area Area)	October 2010	NA	An air sparge system (50 sparge wells across 4 zones) was installed and initiated at the Site to mitigate elevated concentrations of MTBE in the leading edge area. Five additional monitoring wells were installed in and around the treatment area to monitor air sparge system performance. After one year of operation and with regulatory approval the air sparge system was shutdown.
Groundwater Monitoring (semiannually)	Groundwater and Surface Water Sampling	2011	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 84 monitoring wells using low-flow purging techniques. Surface water sample collected at 1 location along Pacheco Creek.
Final Human Health Risk Assessment Update For Parcel 1a, Department Of Defense Housing Facility Novato, California	Risk Assessment	2011	Groundwater: BTEX, MTBE Soil Gas: 1,3-Butadiene, MTBE, BTEX, iso-Propylbenzene, n-Propylbenzene, 1,3,5-TMB, 1,2,4-TMB, sec-Butylbenzene	This document presents a human health risk assessment (HHRA) conducted to assess site conditions following all remediation activities completed to date within Parcel 1A at the Department of Defense Housing Facility (DoDHF) in Novato, California
Groundwater Monitoring (semiannually)	Groundwater Sampling	2012	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 48 monitoring wells using low-flow purging methods.
Groundwater Monitoring (semiannually)	Groundwater Sampling	2013	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 49 monitoring wells using low-flow purging methods.
Air Sparge System Removal and Well Abandonment	Air Sparge System Removal and Monitoring Well Abandonment	November 2013	NA	Air sparge system removed from the leading edge area, 50 air sparge wells and 24 monitoring wells removed from monitoring well network.
Groundwater Monitoring (annually)	Groundwater Sampling	November 2014	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 49 monitoring wells using low-flow purging methods. Updated groundwater fate and transport modeling and CSM
Soil Excavation (former UST 970 vicinity)	Remedial Action	July 2015	TPH-G/D/MO/VOCs (BTEX) and MTBE/SVOCs/ PAHs/Total Organic Lead/CAM Metals/PCBs	The remedial action will prepare the Site for a future risk assessment that will be conducted to determine conformity with residential human health standards. When residential standards are met at all depths below ground surface (bgs), the land use covenant between the California Department of Toxic Substances Control (DTSC), the San Francisco Bay Regional Water Quality Board, Department of the Navy (DON) and the property owners, Hamilton Square LLC; as well as the DON deed restriction on the property, may be removed to allow for residential development.
Groundwater Monitoring (annually)	Groundwater Sampling	December 2015	BTEX(one well) /MTBE/TBA/TBF/Nitrate/Sulfate/iron and dissolved iron	Groundwater samples were collected from 44 monitoring wells using low-flow purging methods. Result presented in Site Closure Report (Battelle, in progress)

Table 4. Historical Analytical Parameters for Groundwater and Surface Water Sampling at Former UST Site 957/970

Analyte	Matrix	Year	Sampling Frequency
BTEX, MTBE, TPH (purgeable)	GW	2000-2001	Quarterly
BTEX, MTBE	SW		
BTEX, MTBE, TBA, TBF, ETBE, TAME, DIPE, TPH (purgeable)	GW	2002-2006	Quarterly
BTEX, MTBE	SW	2002-2009	Quarterly (2000-2002)
BTEX1, MTBE, TBA, TBF, Iron, Nitrate, Sulfate	GW	2006-2014	Quartely (2006-2010) Semiannually (2010-2013), Annaully (2014)
MTBE	SW	2009-2011	Semiannually (2002-2011)

GW – groundwater
SW - surface water (Pacheco Creek)
[1] After November 2009, only monitoring well NA-7 sampled for BTEX.

Table 5. Well Summary Information for Monitoring Wells in Groundwater Monitoring Program

Well ID	Completion Date	Easting NAD 27	Northing NAD 27	Status	Total Depth	Depth to Top Screen	Depth to Bottom Screen	Description	Elevation Units	Type	Location
MW-86S	NA	1417776	575731	Active	39	13	22	4-in.PVC	ftbgs	MW	Leading Edge
IT-GMP-19	NA	1417220	575923	Active	12	5	10	1-in. PVC	ft amsl	GMP	Leading Edge
MW-86D	NA	1417776	575731	Active	38	29	38	4-in.PVC	ftbgs	MW	Leading Edge
PG-MW1	5/14/2002	1417020	573816	Active	20	10	20	2-IN MW	ftbgs	MW	Former NEX 957 Area
PG-MW5	5/15/2002	1417137	573766	Active	17	6	17	2-IN MW	ft amsl	MW	Former NEX 957 Area
MW-M8	12/7/1998	1417198	573956	Active	15	5	15	2-in. PVC	ft amsl	MW	Former NEX 957 Area
MW-M9	12/7/1998	1416989	573965	Active	16	5	15	2-in. PVC	ft amsl	MW	Former NEX 957 Area
NA-0	5/19/1998	1416837	572732	Active	12	5	12	1-in. PVC	ft amsl	MW	Former UST 970
NA-4	5/2/1998	1416889	573332	Active	14.5	8.5	13.5	1-in. PVC	ft amsl	MW	Former NEX 957 Area
NA-7	5/3/1998	1416926	573445	Active	15	10	15	1-in. PVC	ft amsl	MW	Former NEX 957 Area
957-MW4	10/31/1996	1416972	573510	Active	20.5	8	18	4-in. PVC	ft amsl	MW	Former NEX 957 Area
970-MW1	10/31/1996	1416743	572882	Active	20.5	8	18	4-in. PVC	ft amsl	MW	Former UST 970
970-MW2	10/30/1996	1416750	573207	Active	20.5	8	19	4-in. PVC	ft amsl	MW	Former UST 970
970-MW3	10/31/1996	1417011	573196	Active	17	6	16	4-in. PVC	ft amsl	MW	Daycare Center
970-MW4	10/30/1996	1416857	573108	Active	20.5	8	18	4-in. PVC	ft amsl	MW	Former UST 970
970-MW5	10/30/1996	1416831	572919	Active	20.5	8	18	4-in. PVC	ft amsl	MW	Former UST 970
IT-1MW-4A	4/10/1997	1416756	574911	Active	21	5	20	4-in. PVC	ft amsl	MW	Leading Edge
IT-GMP-15	7/25/1995	1417261	575078	Active	12	5	10	1-in. PVC	ft amsl	MW	Leading Edge
IT-GMP-18	5/4/1994	1417273	575734	Active	12	6	10.5	1-in. PVC	ft amsl	MP	Leading Edge
IT-MW-92-38	8/25/1992	1417121	574969	Active	26	15	25	4-in. stainless	ft amsl	MW	Leading Edge
IT-PZ-7	4/18/1997	1416646	575374	Active	20.3	9.2	19.2	2-in. PVC	ft amsl	P	Leading Edge
IT-PZ-9	4/18/1997	1417263	575310	Active	24	7.9	22.9	2-in. PVC	ft amsl	P	Leading Edge
MW-10A	9/25/2000	1416665	573012	Active	16	6	16	1-in. PVC	ft amsl	MW	Former UST 970
MW-1A	4/29/1998	1416828	572878	Active	17	4	17	2-in. PVC	ft amsl	MW	Former UST 970

Table 5. Well Summary Information for Monitoring Wells in Groundwater Monitoring Program (Continued)

MW-3D	8/17/2001	1416960	573504	Active	31	26	31	2-in. PVC	ft amsl	MW	Bedrock Wells
MW-4A	4/29/1998	1416840	573010	Active	16	5	15	2-in. PVC	ft amsl	MW	Former UST 970
IT-MW-81D	NA	1417413	576078	Active	31	18	31	IT Well	ft amsl	MW	Leading Edge
MW-M12	12/8/1998	1416412	575505	Active	15	5	15	2-in. PVC	ft amsl	MW	Western Edge
MW-M13	12/8/1998	1416795	575463	Active	15	5	15	2-in. PVC	ft amsl	MW	Leading Edge
MW-M14D	9/24/2000	1417202	575407	Active	22	17	22	1-in. PVC	ft amsl	MW	Leading Edge
MW-M14S	9/24/2000	1417202	575407	Active	22	8	13	1-in. PVC	ft amsl	MW	Leading Edge
MW-M15	10/8/1999	1417000	574491	Active	16	4	16	1-in. PVC	ft amsl	MW	Hamilton Meadows
MW-M18	9/21/2000	1416857	574420	Active	15	5	15	1-in. PVC	ft amsl	MW	Hamilton Meadows
MW-M20D	9/23/2000	1417083	574120	Active	15.5	12.5	15.5	1-in. PVC	ft amsl	MW	Hamilton Meadows
MW-M21	9/22/2000	1417112	574303	Active	14.5	9.5	14.5	1-in. PVC	ft amsl	MW	Hamilton Meadows
MW-M23	9/22/2000	1417168	574545	Active	14.5	9	14	1-in. PVC	ft amsl	MW	Hamilton Meadows
MW-M24	9/22/2000	1417429	574348	Active	14	9	14	1-in. PVC	ft amsl	MW	Eastern Edge
MW-M27D	9/24/2000	1416529	575313	Active	20	15	20	1-in. PVC	ft amsl	MW	Western Edge
MW-M27S	9/24/2000	1416529	575313	Active	20	5	10	1-in. PVC	ft amsl	MW	Western Edge
MW-M2-BR	11/19/2003	1417212	573557	Active	39	28	38	2-in. PVC	ft amsl	MW	Bedrock Wells
MW-M8-BR	11/17/2003	1417198	573956	Active	60	49	59	2-in. PVC	ft amsl	MW	Bedrock Wells
MW-M13D	12/7/2005	1416800	575464	Active	29.5	25	29.5	2-in. PVC	ft amsl	MW	Leading Edge
MW-M28	12/7/2005	1416649	575814	Active	18	7.5	17.5	2-in. PVC	ft amsl	MW	Leading Edge
IT-GMP-17	5/4/1994	1417329	575499	Active	12	5	10.5	1-in. PVC	ft amsl	MW	Leading Edge
LEA-MW1	11/2/2010	1417229	575637	Active	22	17	22	2-in. PVC	ft amsl	MW	Leading Edge
LEA-MW2	11/2/2010	1417237	575524	Active	23	18	23	2-in. PVC	ft amsl	MW	Leading Edge
LEA-MW3	11/2/2010	1417211	575327	Active	23.5	18.5	23.5	2-in. PVC	ft amsl	MW	Leading Edge
LEA-MW4	11/2/2010	1417253	575469	Active	22	17	22	2-in. PVC	ft amsl	MW	Leading Edge
LEA-MW5	11/2/2010	1417134	575387	Active	23	18	23	2-in. PVC	ft amsl	MW	Leading Edge

GMP –gas monitoring point
MW –monitoring well
P –piezometer
NA –not available
ft amsl –feet above mean sea level
ft bgs –feet below ground surface

Table 6. TPH-G Concentrations in Groundwater (2006 and 2015)

Well ID	Sample Date	TPH-G (µg/L)		Sample Date	TPH-G (µg/L)	
Groundwater ESL		**443**			**443**	
957-MW1[a]	11/7/2006	320	Z	Abandoned		
957-MW3[a]	11/14/2006	190	J	Abandoned		
957-MW4	11/7/2006	52	Z	12/10/2015	25	U
970-MW1	11/6/2006	13	U	12/9/2015	25	U
970-MW1-DUP	NA			12/9/2015	25	U
970-MW2	11/6/2006	13	U	12/10/2015	25	U
970-MW3	11/14/2006	13	U	12/10/2015	25	U
970-MW4[a]	11/6/2006	2600	Y	12/9/2015	55	
970-MW5[a]	11/6/2006	180	Y	Abandoned		
MP-1D	11/8/2006	15	J	Abandoned		
MW-10A	11/6/2006	13	U	12/10/2015	25	U
MW-10A-DUP	NA			12/10/2015	25	U
MW-1A[a]	11/6/2006	2600	Y	Abandoned		
MW-1B[a]	11/6/2006	2100	Y	Abandoned		
MW-1D[a]	11/7/2006	1200	Y	-	-	-
MW-1E	11/7/2006	420	Z	Abandoned		
MW-2D[a]	11/8/2006	13	U	Abandoned		
MW-2E[a]	11/14/2006	13	U	Abandoned		
MW-3B[a]	11/14/2006	13	U	Abandoned		
MW-3D	NA			12/10/2015	25	U
MW-4A[a]	11/6/2006	1500	Y	Abandoned		
MW-4B[a]	11/6/2006	13	U	Abandoned		
MW-5A	11/6/2006	13	U	- -	-	-
MW-5A - DUP	11/6/2006	13	U	-	-	-
MW-6A	11/6/2006	1000	Y	Abandoned		
MW-6B[a]	11/6/2006	13	U	Abandoned		
MW-7A	11/6/2006	680	Y	Abandoned		
MW-8A[a]	11/6/2006	81	Y	Abandoned		
MW-9A[a]	11/14/2006	13	U	Abandoned		
MW-M3[a]	11/7/2006	26	J	Abandoned		
NA-0	11/14/2006	13	U	-	-	-
NA-1	11/6/2006	620	Y	Abandoned		

Table 6. TPH-G Concentrations in Groundwater (2006 and 2015) (Continued)

Well ID	Sample Date	TPH-G (µg/L)		Sample Date	TPH-G (µg/L)	
Groundwater ESL		**443**			**443**	
NA-4 [a]	11/7/2006	73	Z	Abandoned		
NA-6[a]	11/7/2006	130	Z	-	-	-
NA-7	11/7/2006	4200	Y	12/10/2015	4400	-
PZ-10	11/15/2006	13	U	-	-	-
Maximum		**4200**	**Y**	**-**	**4400**	**-**

concentration exceeds current ESLs
- not sampled
[a] no longer in monitoring well network
NA- Not analyzed
J - estimated value
U - nondetect
Y - the chromatographic fingerprint of the sample resembles a petroleum product elution in approximately the correct carbon range, but the elutiopattern does not match the calibration standard.
Z - the chromatographic fingerprint does not resemble a petroleum product.
[1] 2016 Tier 1 ESLs aquatic habitat goal used because no ESL is provided for vapor intrusion of TPH-G

Table 7. BTEX Concentrations in Groundwater (2009, 2014 and 2015)

Well ID	Sample Date	Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylenes (µg/L)	
Groundwater ESL[1]		**30**		**130**		**43**		**100**	
Groundwater to Indoor Air ESL[2]		**30**		**100,000**		**370**		**38,000**	
2015 Groundwater Sampling Event									
NA-7	12/10/2015	1	U	1	U	1	U	1	U
2014 Groundwater Sampling Event									
NA-7	11/13/2014	7.2		0.71		1.4		3.1	
2009 Groundwater Sampling Event									
957-MW1	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
957-MW3	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
957-MW4	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
970-MW1	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
970-MW2	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
970-MW3	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
970-MW4	11/9/2009	1.6		1		2.5		1.4	
970-MW5	11/11/2009	0.25	U	0.69	U	0.71		0.59	
IT-1MW-4A	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-2MW-1	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-2MW-2	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-EW-91-06	11/18/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-EW-91-1	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-EW-91-3	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-15	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-16	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-17	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-17 - DUP	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-18	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-GMP-19	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-MW-81D	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-MW-81S	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-MW-92-38	11/17/2009	0.75	U	0.75	U	0.75	U	0.75	U
IT-MW-92-39	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-PZ-5	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-PZ-7	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
IT-PZ-9	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
MP-1D	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U

Table 7. BTEX Concentrations in Groundwater (2009, 2014 and 2015) (Continued)

Well ID	Sample Date	Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylenes (µg/L)	
Groundwater ESL[1]		**30**		**130**		**43**		**100**	
Groundwater to Indoor Air ESL[2]		**30**		**100,000**		**370**		**38,000**	
MW-10A	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-1A	11/9/2009	15		1.7		4.5		2.56	
MW-1B	11/11/2009	0.25	U	0.25	U	0.58		0.54	
MW-1D	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-2D	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-2E	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-2E - DUP	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-2E-BR	11/19/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-3B	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-3D	11/18/2009	0.25	U	0.97	U	0.25	U	0.25	U
MW-4A	11/11/2009	2.9	J	0.6		3.3	J	2.3	J
MW-4B	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-5A	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-6A	11/9/2009	0.74		0.25	U	0.25	U	0.25	U
MW-6B	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-7Aa	11/9/2009	51		10		83		13.8	
MW-86D	11/18/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-86D - DUP	11/18/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-86S	11/18/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-88D	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-88S	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-8A	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-9A	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M1	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M10	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M11	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M12	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M13	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M13D	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M13D - DUP	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M14D	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M14S	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M15	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M16	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U

Table 7. BTEX Concentrations in Groundwater (2009, 2014 and 2015) (Continued)

Well ID	Sample Date	Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylenes (µg/L)	
Groundwater ESL[1]		**30**		**130**		**43**		**100**	
Groundwater to Indoor Air ESL[2]		**30**		**100,000**		**370**		**38,000**	
MW-M17	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M18	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M19	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M19 - DUP	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M2	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M20D	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M21	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M22	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M23	11/18/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M24	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M25D	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M25D - DUP	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M25S	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M26D	11/16/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M26S	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M27D	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M27S	11/14/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M28	11/17/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M2-BR	11/19/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M2-BR - DUP	11/19/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M3	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M8	11/12/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M8-BR	11/19/2009	0.25	U	0.25	U	0.25	U	0.25	U
MW-M9	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-0	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-1	11/9/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-4	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-6	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-6 - DUP	11/10/2009	0.25	U	0.25	U	0.25	U	0.25	U
NA-7	11/10/2009	39		1.9		14		20.3	
PG-MW1	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
PG-MW2	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
PG-MW3	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
PG-MW4	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U

Table 7. BTEX Concentrations in Groundwater (2009, 2014 and 2015) (Continued)

Well ID	Sample Date	Benzene (µg/L)		Toluene (µg/L)		Ethylbenzene (µg/L)		Total Xylenes (µg/L)	
Groundwater ESL[1]		**30**		**130**		**43**		**100**	
Groundwater to Indoor Air ESL[2]		**30**		**100,000**		**370**		**38,000**	
PG-MW4 - DUP	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
PG-MW5	11/11/2009	0.25	U	0.25	U	0.25	U	0.25	U
PZ-1	11/13/2009	0.25	U	0.25	U	0.25	U	0.25	U
Maximum		**51**		**10**		**83**		**20.3**	

concentration exceeds ESLs

[a] no longer in monitoring well network

U - nondetect

J - estimated value

[1] 2016 ESLs: final aquatic habitat goal,

[2] 2016 ESLs groundwater vapor intrusion human health risk levels- deep groundwater residential: fine to coarse scenario

Table 8. MTBE Concentrations in Groundwater (2014 and 2015)

Well ID	Sample Date	MTBE (µg/L)		Sample Date	MTBE (µg/L)	
Groundwater ESL[1]		180			180	
957-MW4	11/13/2014	7.2		12/10/2015	5.5	J
970-MW1	11/14/2014	0.25	U	12/9/2015	0.25	U
970-MW1 -DUP	NA			12/9/2015	0.25	U
970-MW2	11/14/2014	0.5	U	12/10/2015	0.25	UJ
970-MW3	11/13/2014	0.25	U	12/10/2015	0.25	UJ
970-MW3 - DUP	11/13/2014	0.25	U	NA		
970-MW4	11/14/2014	1.5		12/9/2015	1.4	
970-MW5	11/14/2014	6.5		Abandoned		
IT-1MW-4A	11/12/2014	0.25	U	12/10/2015	0.5	J
IT-GMP-15	11/13/2014	31		12/11/2015	9.5	
IT-GMP-17	11/13/2014	210		12/9/2015	180	
IT-GMP-18	11/13/2014	190		12/9/2015	170	
IT-GMP-18 - DUP	11/13/2014	190		NA		
IT-GMP-19	11/12/2014	2.5		12/9/2015	2.6	
IT-MW-81D	11/11/2014	0.25	U	12/9/2015	0.25	U
IT-MW-92-38	11/12/2014	130		12/11/2015	60	
IT-PZ-7	11/12/2014	0.25	U	12/11/2015	0.5	
IT-PZ-9	11/13/2014	200		12/9/2015	85	
LEA-MW1	11/12/2014	20		12/9/2015	45	
LEA-MW2	11/11/2014	50		12/9/2015	5.3	
LEA-MW2 - DUP	11/11/2014	55		NA		
LEA-MW3	11/11/2014	290		12/9/2015	190	
LEA-MW4	11/11/2014	270		12/9/2015	140	
LEA-MW5	11/13/2014	410		12/9/2015	320	
MW-10A	11/14/2014	2.5		12/10/2015	1.3	J
MW-10A-DUP	NA			12/10/2015	1.6	
MW-1A	11/14/2014	15		Abandoned		
MW-3D	11/13/2014	1.9		12/10/2015	0.98	J
MW-4A	11/14/2014	60		Abandoned		
MW-86D	11/11/2014	0.25	U	12/9/2015	0.25	U
MW-86S	11/11/2014	0.25	U	12/9/2015	0.25	U
MW-M12	11/11/2014	0.25	U	12/11/2015	0.25	U
MW-M13	11/13/2014	120		12/11/2015	110	
MW-M13-DUP	NA			12/11/2015	110	

Table 8. MTBE Concentrations in Groundwater (2014 and 2015) (Continued)

Well ID	Sample Date	MTBE (µg/L)		Sample Date	MTBE (µg/L)	
Groundwater ESL[1]		180			180	
MW-M13D	11/13/2014	110		12/11/2015	110	
MW-M14D	11/11/2014	0.25	U	12/9/2015	3.6	
MW-M14S	11/12/2014	0.59		12/9/2015	1.6	
MW-M15	11/14/2014	26		12/11/2015	4.6	
MW-M18	11/11/2014	0.25	U	12/9/2015	0.25	U
MW-M20D	11/12/2014	26		12/10/2015	14	J
MW-M21	11/12/2014	26		12/11/2015	11	
MW-M23	11/14/2014	84		12/10/2015	45	J
MW-M24	11/11/2014	0.25	U	12/10/2015	0.25	UJ
MW-M24 - DUP	11/11/2014	0.25	U	12/10/2015	0.25	UJ
MW-M27D	11/12/2014	0.25	U	12/11/2015	0.25	U
MW-M27S	11/12/2014	0.53		12/11/1205	0.25	U
MW-M28	11/12/2014	0.95		12/11/2015	0.63	
MW-M28 - DUP	11/12/2014	0.93		NA		
MW-M2-BR	11/11/2014	0.25	U	Buried in adjacent construction		
MW-M8	11/13/2014	26		12/10/2015	0.25	UJ
MW-M8-BR	11/12/2014	0.25	U	12/10/2015	16	J
MW-M9	11/13/2014	24		12/10/2015	16	J
NA-0	11/12/2014	0.25	U	12/10/2015	0.25	UJ
NA-4	11/14/2014	0.25	U	Abandoned		
NA-7	11/13/2014	0.93		12/10/2015	1	UJ
PG-MW1	11/13/2014	54		12/10/2015	55	J
PG-MW5	11/13/2014	22		12/10/2015	0.61	J
Maximum		**410**			**320**	

concentration exceeds remedial goal of 13 µg/L
NA- Not analyzed
U - nondetect

J - estimated value
[1] 2016 ESLs (Water Board) non-drinking water resource nuisance/odor level

Table 9. Concentrations of Petroleum Constituents in Soil That Will Have No Significant Risk of Adversely Affecting Human Health

Chemical	Residential		Commercial/ Industrial		Utility Worker
	Direct Contact (0 to 5 ft bgs) mg/kg	Volatilization to outdoor air (5 to 10 ft bgs) mg/kg	Direct Contact (0 to 5 ft bgs) mg/kg	Volatilization to outdoor air (5 to 10 ft bgs) mg/kg	Direct Contact (0 to 10 ft bgs) mg/kg
Benzene	1.9	2.8	8.2	12	14
Ethylbenzene	21	32	89	134	314
Naphthalene	9.7	9.7	45	45	219
PAH[1]	0.063	NA	0.68	NA	4.5

[1]Based on the seven carcinogenic PAHs as BaPe.
NA = not applicable
mg/kg = milligrams per kilogram

Table 10. Hydraulic Lift Soil Analytical Data – Building 970 Area

Sample ID	Sample Depth (feet bgs)	Date Sampled	TPH-G	TPH-D	Benzene	Ethyl-benzene	SVOCs	VOCs
Hydraulic Lift Removal								
H-N-10	10	4/19/2000	**32**	NA	0.0125U	0.016	NA	NA
H-N-N5	5	4/19/2000	1U	NA	0.005U	0.005U	NA	NA
H-N-S5	5	4/19/2000	1U	NA	0.005U	0.005U	NA	NA
H-N-E5	5	4/19/2000	1U	NA	0.005U	0.005U	NA	NA
H-N-W5	5	4/19/2000	1U	NA	0.006	0.005U	NA	NA
H-Mid-10	10	4/19/2000	1U	NA	0.005U	0.005U	NA	NA
H-S-10	10	4/19/2000	1U	NA	0.005U	0.005U	NA	NA
H-4-10	10	4/25/2000	1U	NA	0.005U	0.005U	NA	NA
Hydraulic Lift Control Line Removal								
CL-N-2	2	4/18/2000	1U	NA	0.005U	**0.011**	NA	NA
CL-S-2	2	4/25/2000	1U	NA	0.005U	0.005U	NA	NA
CL-Mid-2	2	4/25/2000	1U	NA	0.005U	0.005U	NA	NA
Drum-1-3.5	3.5	4/25/2000	1U	1,500[(a)]	0.005U	0.005U	ND (85U)	ND
Drum-1-5	5	5/2/2000	NA	55 [(a)]	NA	NA	NA	NA

Units = mg/kg
NA = not analyzed
J = estimated value
U = not detected above the reporting limit.
TPH-G = gasoline range total petroleum hydrocarbons.
TPH-D = diesel range total petroleum hydrocarbons.
(a) laboratory noted that while the results were within the quantitation range; the chromatographic pattern was not typical of fuel.

= sample removed via over excavation activities
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

Table 11. Oil/Water Separator Soil Analytical Data – Building 970 Area

Sample ID	Sample Depth (feet bgs)	Date Sampled	TPH-G	TPH-D	Benzene	Ethyl-benzene	SVOCs	VOCs
Oil/Water Separator 1 Removal								
OS-N-9	9	4/19/2000	1U	2.8[a]	0.005U	0.005U	ND[e] (1.7U)	ND
OS-S-9	9	4/19/2000	1U	5.3[a]	0.005U	0.005U	ND[e] (1.7U)	ND
OS-E-3	3	4/19/2000	1,300	660[a]	0.25U	0.68	ND[e] (34U)	ND
Oil/Water Separator 1 Over-Excavation								
OS-OX-E3.5	3.5	4/25/2000	1U	50[a]	0.005U	0.005U	ND[e] (34U)	ND[f]
Floor Drain Line Removal (Oil/Water Separator 1 Influent Line)								
DL-1-5.5	5.5	4/18/2000	1.4	1.8[a]	0.005U	**0.015**	ND (1.7U)	ND
DL-2-3.5	3.5	4/18/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
DL-3-3.5	3.5	4/18/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
DL-4-3.5	3.5	4/18/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
DL-5-3	3	4/18/2000	1U	1U	0.005U	0.005U	ND (3.4U)	ND
Oil/Water Separator 2 Removal								
OS2-N-3.5	3.5	4/25/2000	140	3,300[a]	0.1U	0.33	[b],[e]	ND
OS2-W-3.5	3.5	4/25/2000	110	3,700[a]	0.017	0.24	[c],[e]	ND
OS2-S-3.5	3.5	4/25/2000	1U	6.7[a]	0.005U	0.005U	ND[e] (2.0U)	ND
OS2-E-3.5	3.5	4/25/2000	1U	390[a]	0.005U	0.005U	ND[e] (2.0U)	ND
OS2-B-E5.5	5.5	4/25/2000					ND (34U)	
OS2-B-W5.5	5.5	4/25/2000					ND (1.7U)	
Oil Water Separator 2 Over-Excavation								
OS2-E-6	6	4/27/2000	5.1	100[a]	0.0125U	0.017	ND[e] (2.0U)	ND
OS2-W-6	6	4/27/2000	1.9	460[a]	0.005U	0.013	ND[e] (2.0U)	ND
55-Gallon Drum Removal (Oil/Water Separator 2 Influent Line)								
Drum-1-3.5	3.5	4/25/2000	1U	1,500[a]	0.005U	0.005U	ND (85U)	ND[f]
Drum-2-3.5	3.5	5/1/2000	300	10,000[a]	0.077	1.5	ND (68U)	ND
Drum-3-3.5	3.5	5/1/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
Drum-4-3.5	3.5	4/25/2000	1U	4.0[a]	0.005U	0.005U	ND (1.7U)	ND[f]
55-Gallon Drum Over-Excavation (Oil/Water Separator 2 Influent Line)								
Drum-1-5	5	5/2/2000	NA	55[a]	NA	NA	NA	NA
Drum2-OX-5.5	5.5	5/11/2000	43	950[a]	0.0125U	0.064	ND (85U)	ND
Drum-1-OX-S3	3	5/11/2000	1U	1U	0.005U	0.005U	ND (1.7)	ND

Table 11. Oil/Water Separator Soil Analytical Data –Building 970 Area (Continued)

Sample ID	Sample Depth (feet bgs)	Date Sampled	TPH-G	TPH-D	Benzene	Ethyl-benzene	SVOCs	VOCs
Drum-1-OX-NE3	3	5/11/2000	18[a]	2,300[a]	0.0125U	0.0125U	ND (85U)	ND
Drum2-OX-E3	3	5/11/2000	82	920[a]	0.05U	0.79	ND (85U)	ND
Influent Line to Oil/Water Separator 2								
INF-1-2	2	4/25/2000	1U	130[a]	0.005U	0.005U	ND (34U)	ND[f]
INF-2-2	2	4/25/2000	1U	790[a]	0.005U	0.005U	ND (34U)	ND[f]
INF-3-2	2	5/1/2000	1U	2,400[a]	0.005U	0.005U	ND (34U)	ND
INF-4-2	2	5/1/2000	1U	790[a]	0.005U	0.005U	ND (17U)	ND
INF-5-2	2	5/1/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
Effluent Line from Oil/ Water Separator 2								
EFF-1-5	5	4/28/2000	1U	1U	0.005U	0.005U	ND (2.0U)	ND
EFF-2-5	5	4/28/2000	1U	1U	0.005U	0.005U	ND (2.0U)	ND
EFF-2-E3	3	5/1/2000	260	8,000[a]	0.05U	0.24	ND (68U)	ND
EFF-2-W3	3	5/1/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
EFF-3-6	6	5/1/2000	1U	130[a]	0.005U	0.005U	ND (1.7U)	ND
EFF-4-E3	3	5/1/2000	160	400[a]	0.074	0.57	ND (68U)	ND
EFF-4-W3	3	5/1/2000	1U	2.6[a]	0.005U	0.005U	ND (1.7U)	ND
EFF-4-6	6	5/1/2000	1U	9.1[a]	0.005U	0.005U	ND (1.7U)	ND
EFF-5-6	6	5/2/2000	1U	1U	0.005U	0.005U	ND (2.0U)	ND
EFF-6-3E	3	6/21/2000	4.4[a]	3,300[a]	0.0125U	0.0125U	ND (170U)	ND
EFF-6-6	6	6/21/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
EFF-6-3W	3	6/21/2000	1U	4,000[a]	0.005U	0.005U	ND (170U)	ND
Exploratory Trench – Northern								
ET-B-5	5	4/27/2000	1U	1.1[a]	0.02	0.005U	ND (2.0U)	ND
ET-S-3	3	4/27/2000	1U	2.7[a]	0.005U	0.005U	ND (2.0U)	ND
Exploratory Trench - Effluent Trench Extension								
EFF-NE-3	3	5/4/2000	14	1,800[a]	0.025U	0.091	[d]	ND
EFF-N-3	3	6/21/2000	1U	56	0.005U	0.005U	ND (6.8U)	ND
EFF-N-6	6	6/21/2000	1U	1U	0.005U	0.005U	ND (1.7U)	ND
Test Pit Excavations								
TP-1-3	3	5/4/2000	1U	2.7[a]	0.005U	0.005U	ND (3.4U)	ND
TP-1-5	5	5/4/2000	7.3	3.0[a]	0.05	0.027	ND (1.7U)	ND

Table 11. Oil/Water Separator Soil Analytical Data –Building 970 Area (Continued)

Sample ID	Sample Depth (feet bgs)	Date Sampled	TPH-G	TPH-D	Benzene	Ethyl-benzene	SVOCs	VOCs
TP-2-3	3	5/4/2000	1U	7.6[(a)]	0.005U	0.005U	ND (3.4U)	ND
TP-2-5	5	5/4/2000	1U	1U	0.008	0.005U	ND (1.7U)	ND
Sewer Excavation								
SEW-1-5	5	5/2/2000	1U	1.2[(a)]	0.005U	0.005U	ND (2.0U)	ND
SEW-2-5	5	5/2/2000	1U	1U	0.005U	0.005U	ND (2.0U)	ND
SEW-3-5	5	5/2/2000	1U	1U	0.005U	0.005U	ND (2.0U)	ND

Units = mg/kg
NA = not analyzed.
ND = all compounds not detected.
U = concentrations not detected at or above the detection limit shown.
(1.7U) = maximum detection limit for suite of analytes.
TPH-G = gasoline range total petroleum hydrocarbons.
TPH-D = diesel range total petroleum hydrocarbons.
SVOCs = semivolatile organic compounds.
VOCs = volatile organic compounds.
(a) laboratory noted that while the results were within the quantitation range; the chromatographic pattern was not typical of fuel.
(b) naphthalene, 2-methylnaphthalene, phenanthrene and pyrene were detected at 1.6, 2.9, 0.64 and 0.54 mg/kg, respectively.
(c) naphthalene, phenanthrene, fluoranthene and pyrene were detected at 0.93, 0.19, 0.14 and 0.20 mg/kg, respectively.
(d) naphthalene detected at 1.47 mg/kg.
(e) analysis for creosote resulted in ND.
(f) EPA Method 8260B analysis performed for VOCs.
= sample location removed as a result of over-excavation activities.

Table 12. Waste Oil Line Soil Analytical Data – Building 970 Area

Sample ID	Sample Depth (feet bgs)	Date Sampled	TPH-G	TPH-D	Benzene	Ethyl-benzene	SVOCs	VOCs
WO-1-2.5	2.5	04/25/00	5.6	660[(a)]	0.01U	0.027	ND (85U)	ND[(b)]
WO-1-5	5	05/02/00	NA	NA	NA	NA	NA	NA
WO-2-2.5	2.5	04/25/00	1U	25[(a)]	0.005U	0.005U	ND (1.7U)	ND[(b)]
WO-3-2.5	2.5	04/25/00	1U	1,400	0.005U	0.005U	ND(340U)	ND[(b)]
WO-3-5	5	05/02/00	NA	1U	NA	NA	NA	NA

Units = mg/kg
TPH-G = gasoline range total petroleum hydrocarbons.
TPH-D = diesel range total petroleum hydrocarbons.
SVOCs = semivolatile organic compounds.
VOCs = volatile organic compounds.
NA = not analyzed.
ND = all compounds not detected.
U = concentrations not detected at or above the detection limit shown.
(a) (<85) = Maximum detection limit for sweep of analytes. Laboratory noted that while the results were within the quantitation range; the chromatographic pattern was not typical of fuel.
(b) U.S. EPA Method 8260B analysis performed for VOCs.

Table 13. Soil Sampling Results from the Former UST 970 Area, September 2000

Sample ID	Benzene (mg/kg)		Ethylbenzene (mg/kg)		Naphthalene (mg/kg)		TPH-G (mg/kg)	
SB-1A-5.5	0.6		0.08	J	0.58	U	2	
SB-1A-9.5	0.0058	U	0.0058	U	0.0058	U	0.1	J
SB-2A-5.5	0.005	J	0.001	J	0.0051	U	0.1	J
SB-2A-9.5	0.0051	U	0.0051	U	0.0051	U	0.04	J
SB-5A-5.5	1		2		1		0.1	J
SB-5A-9.5	1.2	U	1		1.2	J	120	
SB-6A-6	0.5	J	0.14	J	1.2	U	1	
SB-6A-9.5	0.12	J	0.26	J	0.25	J	270	
SB-7A-5.5	0.0005	J	0.0056	U	0.0056	U	0.2	J
SB-8A-5.5	0.59	U	0.59	U	0.59	U	3.5	
SB-8A-9.5	0.59	U	0.59	U	0.59	U	0.06	J
SB-9A-6	1.3	U	1.3	U	1.3	U	4.3	
SB-9A-9.5	0.55	U	0.55	U	0.073	J	12	J
SB-10A-5.5	0.6	U	0.6	U	0.6	U	2	
SB-10A-9.5	0.6	U	0.6	U	0.06	J	2.7	
SB-11A-5.5	0.004	J	0.0058	U	0.0058	U	1	J
SB11A-9.5	0.0058	U	0.0058	U	0.0058	U	0.05	J
SB-12A-5.5	0.006	U	0.006	U	0.006	U	0.04	J
SB-12A-8	0.0052	U	0.0052	U	0.0052	U	0.06	J
SB-13A-12(a)	12	U	110		40		2,000	
SB-13A-6	0.57	U	0.57	U	0.049	J	0.6	J
SB-13A-9.5	0.56	U	0.56	U	0.56	U	2	
SB-14A-6	0.6	U	0.6	U	0.067	J	3.0	
SB-14A-9	0.001	J	0.002	J	0.0062	U	0.4	J
SB-15A-5.5	0.079	J	0.61	U	0.051	J	0.5	J
SB-15A-9.5	0.0057	U	0.0057	U	0.0057	U	0.06	J
SB-16A-5.5	0.62	U	0.62	U	0.62	U	0.3	J
SB-16A-9.5	0.0058	U	0.0058	U	0.0058	U	0.08	J
SB-17A-6	1		0.34	J	1.2	U	0.8	J
SB-17A-9.5	1.2	U	0.2	J	1.2	U	740	
SB-18A-10.5	0.0009	J	0.0075	U	0.0075	U	0.8	J
SB-18A-5.5	0.59	U	0.054	J	0.18	J	2.4	
SB-19A-6	0.37	J	0.27	J	1.2	U	2	
SB-19A-9.5	0.58	U	0.58	U	0.58	U	0.2	J
SB-20A-6	0.099	J	0.57	U	0.57	U	0.4	J
SB-20A-9.5	0.58	U	0.58	U	0.58	U	0.05	J
SB-21A-5.5	NA		NA		NA		0.6	J
SB-22A-6	0.0061	U	0.0061	U	0.0061	U	0.03	J
SB-22A-9.5	0.0053	U	0.0053	U	0.0053	U	0.04	J
MW-5A-6	0.0052	U	0.0052	U	0.0052	U	0.4	J
MW-5A-9.5	0.007		0.0063	U	0.0006	J	0.2	J
MW-6A-6	0.006	J	0.0008	J	0.0005	J	2	
MW-6A-9.5	2.9	U	20		9		800	
MW-7A-6	29	U	16	J	120		450	J
MW-7A-9.5	3.8	J	42		29		2,100	
MW-8A-6	0.0055	U	0.0055	U	0.0055	U	0.1	J

J = estimated value U = not detected above the listed detection limit NA = not analyzed

Table 14. Soil Sampling Results from the Former UST 957 Area, September 2000

Location ID	Sample Depth (ft bgs)	Benzene (mg/kg)		Ethyl-benzene (mg/kg)		Naphthalene (mg/kg)		TPH-G (mg/kg)		TPH-D (mg/kg)	
SB-1D	5.5	1.2	U	0.78	J	3.7		0.5	J	5.9	U
	9.5	0.006	U	0.006	U	0.006	U	0.03	J	5.9	U
SB-2D	5.5	0.003	J	0.006		0.001	J	38		5.8	U
	10	0.0008	J	0.0053	U	0.0053	U	21	J	5.6	U
SB-3D	5.5	0.25	J	5.7		3.3		480		5.9	U
	9.5	0.049	J	0.14	J	0.58	U	4.9		5.8	U
SB-4D	5.5	0.0006	J	0.0052	U	0.0052	U	0.04	J	5.9	U
	10	1.1	U	1.1	U	0.26	J	29	J	5.5	U
SB-5D	5.5	0.0049	U	0.0049	U	0.0049	U	0.1	J	5.8	U
	10	0.0045	U	0.0045	U	0.0045	U	0.02	J	5.8	U
SB-6D	5.5	0.0058	U	0.0007	J	0.002	J	0.1	J	5.8	U
	9.5	0.001	J	0.0008	J	0.0061	U	2		5.8	U
SB-7D	10	0.59	U	0.59	U	0.05	J	280		38	
	5.5	0.0045	U	0.0045	U	0.0045	U	0.3	J	5.6	U
SB-8D	10	0.074		0.055		0.041		2		100	J
	5.5	0.0068	U	0.0068	U	0.002	J	0.3	J	300	
SB-9D	10	0.0072	U	0.0008	J	0.005	J	1	J	6.3	U
	5.5	0.0062	U	0.0062	U	0.0062	U	0.02	J	200	
SB-10D	5.5	0.0062	U	0.0062	U	0.0062	U	0.05	J	5.8	U
	9.5	0.0055	U	0.0055	U	0.0055	U	1.2	U	5.8	U
SB-11D	5.5	0.0054	U	0.0054	U	0.0054	U	0.3	J	6.2	U
	9.5	0.0051	U	0.0051	U	0.0051	U	0.02	J	5.9	U
SB-12D	5.5	0.0059	U	0.0059	U	0.0059	U	1.3	U	6.3	U
	9.5	0.0058	U	0.0058	U	0.0058	U	1.2	U	6.1	U
SB-13D	5.5	0.61	U	0.53	J	1.3		3.7		6.1	U
	9.5	1.1	U	0.73	J	1.1	U	340		28	U
SB-14D	5.5	0.0058	U	0.0058	U	0.001	J	0.06	J	6.1	U
	9.5	0.0048	U	0.0048	U	0.0048	U	0.02	J	6.1	U
SB-15D	5.5	0.0061	U	0.0061	U	0.0061	U	1.2	U	6	U
	9.5	0.006	U	0.006	U	0.006	U	1.2	U	6.2	U
SB-16D	6	0.007	U	0.007	U	0.007	U	0.05	J	NA	
	9.5	0.0057	U	0.0057	U	0.0057	U	0.3	J	NA	

J = estimated value
U = not detected above the listed detection limit
NA = not analyzed

Table 15. Comparison of COPC Concentrations Detected in Shallow Soil Samples to Media-Specific Criteria

Location ID	Location	Sample Depth (ft bgs)	Benzene		Ethyl-benzene		Naphthalene	
Residential Criteria			**1.9**		**21**		**9.7**	
Commercial/ Industrial Criteria			**8.2**		**89**		**45**	
SB-1D	UST 957 Area	5.5	1.2	U	0.78	J	3.7	
SB-2D	UST 957 Area	5.5	0.003	J	0.006		0.001	J
SB-3D	UST 957 Area	5.5	0.25	J	5.7		3.3	
SB-4D	UST 957 Area	5.5	0.0006	J	0.0052	U	0.0052	U
SB-6D	UST 957 Area	5.5	0.0058	U	0.0007	J	0.002	J
SB-8D	UST 957 Area	5.5	0.0068	U	0.0068	U	0.002	J
SB-13D	UST 957 Area	5.5	0.61	U	0.53	J	1.3	
SB-14D	UST 957 Area	5.5	0.0058	U	0.0058	U	0.001	J
SB-1A-5.5	UST 970 Area	5.5	0.6		0.08	J	0.58	U
SB-2A-5.5	UST 970 Area	5.5	0.005	J	0.001	J	0.0051	U
SB-5A-5.5	UST 970 Area	5.5	1		2		1	
SB-7A-5.5	UST 970 Area	5.5	0.0005	J	0.0056	U	0.0056	U
SB-11A-5.5	UST 970 Area	5.5	0.004	J	0.0058	U	0.0058	U
SB-15A-5.5	UST 970 Area	5.5	0.079	J	0.61	U	0.051	J
SB-18A-5.5	UST 970 Area	5.5	0.59	U	0.054	J	0.18	J
H-N-W5	Building 970	5	0.006		0.005	U	NA	
Drum2-OX-E3	Building 970	3	0.05	U	0.79		NA	
EFF-2-E3	Building 970	3	0.05	U	0.24		NA	
EFF-4-E3	Building 970	3	0.074		0.57		NA	
EFF-NE-3	Building 970	3	0.025	U	0.091		NA	
OS2-N-3.5	Building 970	3.5	0.1	U	0.33		NA	
OS2-W-3.5	Building 970	3.5	0.017		0.24		NA	
ET-B-5	Building 970	5	0.02		0.005	U	NA	
TP-1-5	Building 970	5	0.05		0.027		NA	
TP-2-5	Building 970	5	0.008		0.005	U	NA	
DL-1-5.5	Building 970	5.5	0.005	U	0.015		NA	
Drum2-OX-5.5	Building 970	5.5	0.0125	U	0.064		NA	
OS2-E-6	Building 970	6	0.0125	U	0.017		NA	
OS2-W-6	Building 970	6	0.005	U	0.013		NA	
Maximum			**1**		**5.7**		**3.7**	

Units = mg/kg
U= not detected
J = estimated value
NA = not analyzed

Table 16. Comparison of COPC Concentrations Detected in Deep Soil Samples to Media-Specific Criteria

Location ID	Location	Sample Depth (ft bgs)	Benzene		Ethyl-benzene		Naphthalene	
Residential Criteria			**1.9**		**21**		**9.7**	
Commercial/Industrial Criteria			**8.2**		**89**		**45**	
SB-1D	UST 957 Area	9.5	0.006	U	0.006	U	0.006	U
SB-2D	UST 957 Area	10	0.0008	J	0.0053	U	0.0053	U
SB-3D	UST 957 Area	9.5	0.049	J	0.14	J	0.58	U
SB-4D	UST 957 Area	10	1.1	U	1.1	U	0.26	J
SB-5D	UST 957 Area	10	0.0045	U	0.0045	U	0.0045	U
SB-6D	UST 957 Area	9.5	0.001	J	0.0008	J	0.0061	U
SB-7D	UST 957 Area	10	0.59	U	0.59	U	0.05	J
SB-8D	UST 957 Area	10	0.074		0.055		0.041	
SB-9D	UST 957 Area	10	0.0072	U	0.0008	J	0.005	J
SB-10D	UST 957 Area	9.5	0.0055	U	0.0055	U	0.0055	U
SB-11D	UST 957 Area	9.5	0.0051	U	0.0051	U	0.0051	U
SB-12D	UST 957 Area	9.5	0.0058	U	0.0058	U	0.0058	U
SB-13D	UST 957 Area	9.5	1.1	U	0.73	J	1.1	U
SB-14D	UST 957 Area	9.5	0.0048	U	0.0048	U	0.0048	U
SB-15D	UST 957 Area	9.5	0.006	U	0.006	U	0.006	U
SB-16D	UST 957 Area	6	0.007	U	0.007	U	0.007	U
SB-16D	UST 957 Area	9.5	0.0057	U	0.0057	U	0.0057	U
H-N-10	Building 970	10	0.0125	U	0.016		NA	
OS2-E-6	Building 970	6	0.0125	U	0.017		NA	
OS2-W-6	Building 970	6	0.005	U	0.013		NA	
Maximum			**0.074**		**0.14**		**0.26**	

Units = mg/kg
U= not detected
J = estimated value
NA = not analyzed