EXPANDED SITE INSPECTION ADDENDUM REPORT

Environmental Investigation at the Formerly Used Defense Site (FUDS)
at the former Benicia Army Arsenal, Benicia, California
FUDS Number: J09CA075600

DRAFT FINAL

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BENICIA ARMY ARSENAL, BENICIA, CALIFORNIA

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LIST OF ACRONYMS AND ABBREVIATIONS

AFV	Armored Fighting Vehicle
Arsenal	former Benicia Army Arsenal
bgs	below ground surface
BC	Brown and Caldwell
BSL	Benicia Screening Level
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHM	Conceptual Hydrogeologic Model
CSM	Conceptual Site Model
cis-1,2-DCE	cis-1,2-dichlororethene
COI	chemicals of interest
CPT	cone penetration testing
CSM	conceptual site model
DDT	dichlhorodipheryl trichloroethane
DoD	Department of Defense
DTSC	Department of Toxic Substances Control
EC	electrical conductivity
ER	electrical resistivity
ESLs	Environmental Screening Levels
Expanded SI	Expanded Site Inspection
FA/BC	Forsgren Associates/Brown and Caldwell
FUDS	Formerly Used Defense Sites
FSIP	Field Site Investigation Plan
GSA	General Services Administration
IDW	Investigation Derived Waste
MCL	maximum contaminant levels
MDL	method detection limit
mg/kg	milligrams per kilograms
mg/L	micrograms per liter
MtBE	methyl tertiary-butyl ether
NDAI	No DoD Action Indicated
NORCAL	Norcal Geophysical Consultants, Incorporated
ORP	oxidation reduction potential
PA	Preliminary Assessment
PAH	polynuclear aromatic hydrocarbon
PCE	tetrachloroethene
ppbv	parts per billion by volume
PQL	practical quantitation limit
PVC	poly vinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	quality control
RCRA	Resource Conservation Recovery Act
RWQCB	Regional Water Quality Control Board, San Francisco Bay Region
SI	Site Inspection

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

SVOC	semi-volatile organic compound
TCE	trichloroethene
TC	terrain conductivity
TPH	total petroleum hydrocarbon
TPHD	total petroleum hydrocarbon as diesel fuel
TPHG	total petroleum hydrocarbon as gasoline
TPHMO	total petroleum hydrocarbon as motor oil
µg/L	microgram per liter
USACE	United States Army Corps of Engineers
UST	Underground Storage Tank
VC	vinyl chloride
VMG	vertical magnetic gradient
VOC	volatile organic compound

EXECUTIVE SUMMARY

This addendum to the Expanded Site Inspection (SI) Report presents data from an additional environmental site investigation conducted at the former Benicia Army Arsenal (Arsenal), a formerly used defense site (FUDS), located in Benicia, California. This work was performed on behalf of and with oversight by the United States Army Corps of Engineers (USACE), Sacramento District.

The Expanded SI (Brown and Caldwell [BC], 2005a) recommended further investigation at nine sites because contaminants were not fully delineated in the time (21 field days) funded for the Expanded SI. Of these nine sites, three sites (former Building 58(A), CL2, and the former septic tank at Building 194), could not be investigated because the landowner would not grant USACE access to the property and two sites (underground storage tanks at Building 27 and 161) were investigated in a separate field event (BC, 2006). The remaining four sites were investigated for the following:

- to determine the lateral extent of lead and polynuclear aromatic hydrocarbons (PAHs) in soil at the former drum storage area at Building 51,
- to determine the source of diesel fuel in groundwater reported south and southwest of Building 168,
- to determine if the diesel fuel reported in shallow groundwater at Expanded SI boring AFVSB002 is from the alleged Post Dumpsite or attributed from the Armored Fighting Vehicle (AFV),
- to determine the location of buried ferrous and non-metallic debris using geophysics at the alleged Post Dumpsite, and
- to determine lateral extent of fuels and solvents in soil and groundwater at the alleged Post Dumpsite.

According to the sampling flow decision diagram in the Expanded SI Field Site Investigation Plan (BC, 2004) (Diagram 5-1), samples should have been collected at two additional sites, Buildings 90 and 101. Soil vapor at Building 90 and lead in shallow soil at Building 101 were investigated. According to this Diagram, if a groundwater sample contained key indicators above the non-detection limit, and the location is adjacent to a building, a soil gas sample should be collected. However, a soil gas sample was not collected during the initial investigation; therefore, a soil gas sample was collected and reported in this addendum. At Building 101, groundwater samples collected during the Expanded SI contained metals in groundwater and there is a possibility that soil may be impacted with lead that was not detected in the groundwater samples.

This addendum investigation focuses on closing data gaps identified in the Expanded SI Report by delineating existing impacts to soil gas, soil or groundwater. The resulting recommendations were limited to only a few analytical tests (e.g. lead, PAHs, volatile organic compound [VOCs]) that needed to be delineated. This addendum excludes sites where a right of entry was requested but not granted.

The approach to the investigative work is similar to the Expanded SI but with some differences. Since this addendum fieldwork only required a few analytical tests and the boundaries were nearly complete, the dynamic sampling strategy's use of a mobile laboratory in the Expanded SI was not deemed necessary. Therefore, all of the samples were sent to a fixed laboratory for analysis. Otherwise, the decision logic, assessment criteria, and methods of sampling remained the same.

A total of five soil samples, one soil gas sample, and twelve grab groundwater samples were collected during this investigation. The samples collected were analyzed for compounds that may have been commonly used at these locations and discarded by the Department of Defense (DoD) and chemicals that demonstrate post-army use, such as methyl tertiary-butyl ether (MtBE). All laboratory data underwent data verification.

The results were evaluated to determine the presence or absence of key contamination indicators (cis-1,2-dichloroethene [Cis-1,2-DCE], trichloroethene [TCE], vinyl chloride, benzene, gasoline and diesel fuel). If these key indicators were present above the laboratory method detection limits and the indicator was not delineated from previous samples collected, additional samples were advanced to vertically and laterally delineate the contamination (dependent upon funding).

The following are conclusions for each site investigated in this Expanded SI Addendum:

- No significant DoD impact was reported at former drum storage area (Building 51) (Section 6.1).
- No significant impact was reported in soil gas from the underlying solvent-containing groundwater at the former locomotive building (Building 90) (Section 6.2).
- No significant DoD impact was reported at Building 101 (Section 6.3).
- No source or significant impact was reported at Building 168 (Section 6.4).
- TCE, cis-1,2-DCE and vinyl chloride were reported by another consultant to be present in groundwater at the alleged Post Dumpsite (Section 6.5). TCE was not detected in groundwater during this investigation, but the other signs of degradation, cis-1,2-DCE and vinyl chloride were present in a localized area. Biodegradation is occurring and is likely to continue. Diesel fuel and motor oil range hydrocarbons were reported in all of the shallow groundwater samples but a forensic analysis of the data indicated that a fraction of the result is due to natural sources.
- The diesel fuel and motor oil range hydrocarbon present in groundwater, approximately 300 feet downgradient of the AFV (Section 6.6) is not from the AFV but attributed to the area of the alleged Post Dumpsite.

SECTION 1
INTRODUCTION AND BACKGROUND

This addendum to the Expanded Site Inspection (SI) was conducted at the former Benicia Army Arsenal (Arsenal) under General Services Administration Contract No. GS-10F-0101L, Veterans Administration Purchase Order 674-V40113 to comply with requirements of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Resource Conservation Recovery Act (RCRA), as appropriate. This investigation was conducted in accordance with the *Expanded SI Field Site Investigation Plan* (FSIP) (BC, 2004) and the *Quality Assurance Project Plan* (QAPP) (Forsgren Associates/Brown and Caldwell [FA/BC], 2001). Figure 1-1 shows the location of the former Arsenal.

A description of the relationship between the Expanded SI and the Formerly Used Defense Sites (FUDS) program, the methodology of choosing these sites, the location, and the historical and subsequent post-Army use of the Arsenal is provided in the *Expanded SI Report* (BC, 2005a).

This Expanded SI addendum report is organized into eight sections. Section 1.0 presents background information, including the historical uses and a summary of previous investigations. Section 2.0 describes the investigative approach. Section 3.0 presents a summary of field methods and sampling rationale. It also summarizes disposal of Investigation Derived Waste (IDW). Section 4.0 describes the regional, localized, and site-specific geology and hydrogeology. Section 5.0 describes the quality and usability of the data collected during this site inspection. A summary and analysis of results are presented in Section 6.0. Section 7.0 presents the conclusions and recommendations and references are included as Section 8.0.

This report contains eight appendices. Each appendix is described briefly below.

- **Appendix A – Background Details of the Expanded SI Sites**. This appendix includes Preliminary Assessment (PA) summary forms for each Expanded SI site investigated for this addendum report. These forms have been updated with information gathered from the Expanded SI and other relevant investigations since the PA.

- **Appendix B – NORCAL 21 July 2005 Geophysical Report**. A summary report of the geophysical survey conducted at the alleged Post Dumpsite.

- **Appendix C – Cone Penetration Testing Logs.** Testing logs for CPT borings at the alleged Post Dumpsite are provided (Expanded SI Addendum only).

- **Appendix D – Water Quality Measurements**. Data is included in this appendix include water depth to water, groundwater elevations, pH, temperature, electrical conductivity (EC), oxidation reduction potential (ORP), and total dissolved solids. All data gathered for the Arsenal for this addendum investigation is included in this appendix.

- **Appendix E – Legend for Analytical Results**. Definitions of data acronyms, quality control flags, and reason codes.

- **Appendix F – Analytical Results for Soil**. The analytical results for soil are tabulated for all samples collected for this addendum investigation.

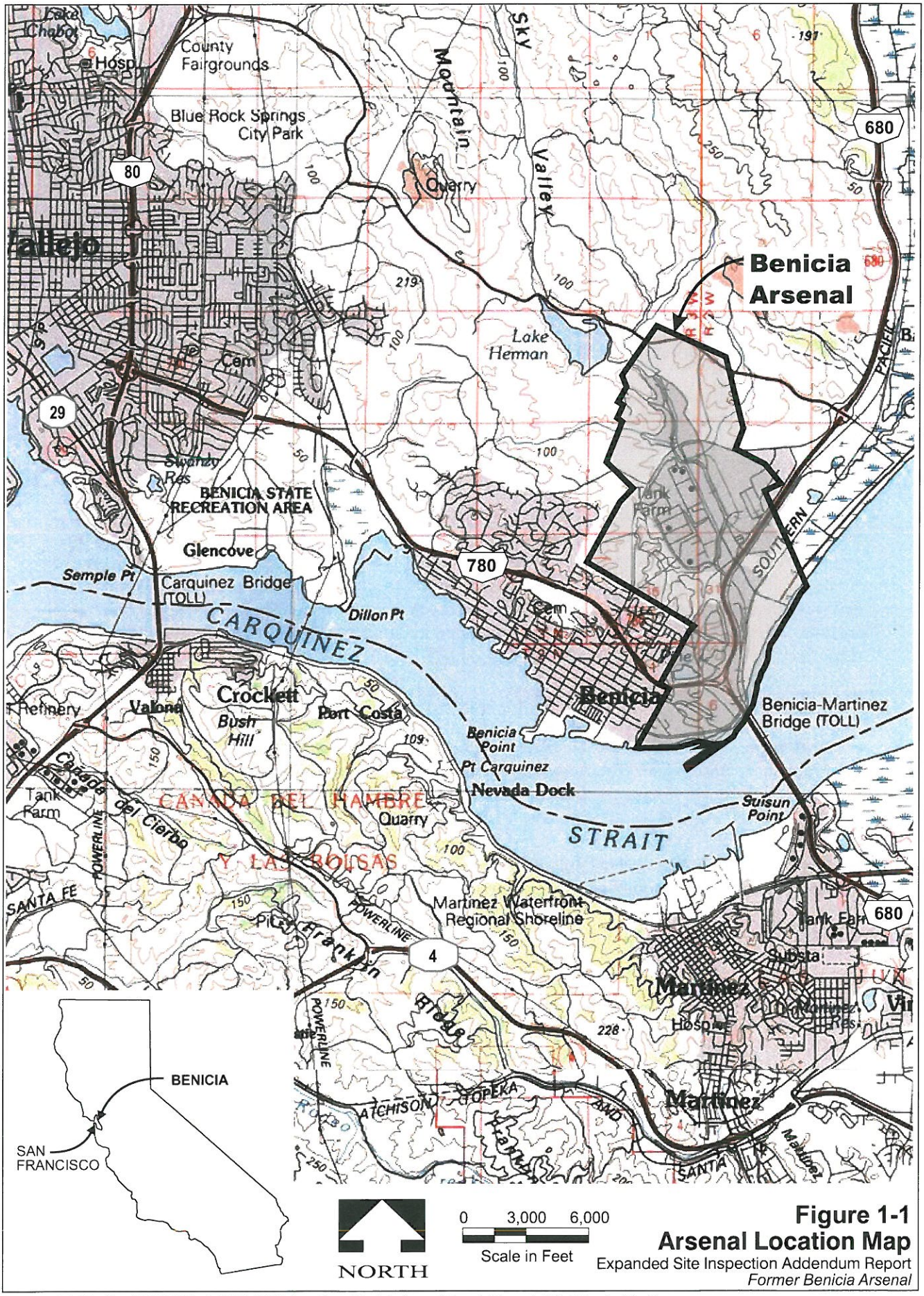


Figure 1-1
Arsenal Location Map
Expanded Site Inspection Addendum Report
Former Benicia Arsenal

- **Appendix G– Analytical Results for Soil Gas**. The analytical results for soil gas are tabulated for all samples collected for this addendum investigation.

- **Appendix H - Analytical Results for Groundwater**. The analytical results for groundwater are tabulated for all samples collected for this addendum investigation.

1.1 Problem Definition and Scope

Because of all the data already collected and summarized in the Expanded SI, this addendum fieldwork only required a few analytical tests necessary to delineate some analytes. All of the work was not completed in the Expanded SI because project funding was allocated for a specific time period, 21 field days.

Since only a few samples were planned for this addendum, the use of a mobile laboratory, like in the Expanded SI, was not deemed necessary or cost effective.

Nine sites were recommended in the Expanded SI for investigation. Additional investigation was performed to close SI data gaps at two sites (Buildings 90 and 101). Therefore, there are a total of 11 sites requiring further investigation.

Of these 11 sites, three (former Building 58(A), CL2, and the former septic tank at Building 194), could not be investigated because the landowner would not grant USACE access to the property and two sites (Building 27 underground storage tank [UST] and Building 161 UST) were investigated as part of the *Fuel Storage Tank Removal Action Addendum* (BC, 2006). All 11 sites are listed below with recommended activities and comments (Table 1-1). Their locations are shown on Figure 1-2 and subsequent figures in this report.

As used in the *Expanded SI Report* (BC, 2005a), the word "delineation" in terms of contamination means to non-detect in the vertical and horizontal direction. Similarly, concentration data was compared to the same regulatory criteria included in the *Expanded SI Report* (BC, 2005a).

1.2 Project Objectives

The overall objective of this investigation is to delineate existing impacts to soil or groundwater at the locations identified in Table 1-1. Soil gas was also collected at one site, Building 90, to determine soil gas concentrations in the vadose zone from volatile organic compound (VOC)-impacted groundwater.

Chemical indicators of releases resulting from post-Army use were also analyzed for and were reported in this report (i.e. sampling for fuel oxygenates such as methyl tertiary-butyl ether [MtBE]. MtBE, a fuel oxygenate was added to gasoline in the 1970s after Arsenal closure).

Further details and background information of these investigated sites are provided in Appendix A.

Table 1-1. Summary of Expanded SI Sites Recommended for Further Investigation

Site	DoD Use	DoD Activity	Recommendations	Summary of Other Investigations
27	Captain's Quarters	UST*	Remove 250-gallon fuel oil UST and delineate any contamination.	The UST was removed from the site on January 5, 2006. Soil excavation was performed around the tank. Details about the UST removal and the results from these borings are provided in the *Fuel Storage Tank Removal Action Addendum* (BC, 2006).
51	Stable/ Maintenance	Maintenance	Additional investigation to determine the lateral extent of lead and PAHs in soil from Expanded SI boring B051HP001.	Lead, in a duplicate sample, and several PAHs exceeded their respective RWQCB ESLs in the 1.5-foot layer of soil covering the sandstone bedrock (BC, 2005a)
58(A)	Small Arms Repair and Retinning/ Boiler Room	Repair, former boiler UST (not found)	Additional investigation to determine the lateral extent of lead in soil south of Expanded SI boring B058ASB001.	Lead is defined north, west, and east of boring B058ASB001 but not to the south. The landowner has refused USACE access to the property.
90	Locomotive Building	Repair/ Maintenance	Additional investigation to determine the concentration of soil vapor in the vadose zone from impacted groundwater at Expanded SI boring B090HP001.	One grab sample, B090HP001, was collected and analyzed for solvents and fuels during the Expanded SI (BC, 2005a). TCE and its degradation products were reported in the groundwater sample. Low concentrations of diesel fuel (97 micrograms per liter [µg/L]) were also reported.
101	Battery Charge Building	Steam cleaning battery cases	Additional investigation to determine the impact of lead in the vadose zone beneath the Building 101 concrete foundation at the drain inlet due to former battery cleaning operations.	Low to trace concentrations of metals and diesel fuel were reported in two downgradient groundwater samples (B101HP001 and B101HP002) collected during the Expanded SI (BC, 2005a).
161	Motor Cleaning Building/Steam Cleaning/Paint Spray/Fuel Storage	UST*	Remove 3,000-gallon UST and delineate any contamination.	The UST was removed from the site on January 5, 2006. Limited soil excavation was performed. The west end of the excavation appeared to be impacted with fuels. Four soil borings (B161GB001 through B161GB004) were drilled and sampled to delineate the lateral extent of the impacted soil. Details about the UST removal and the results from these borings are provided in the *Fuel Storage Tank Removal Action Addendum* (BC, 2006).
168	Bar Stock Building/Storage/Vehicle Shop for Motor Pool	Maintenance	Additional investigation to determine the source of diesel fuel in groundwater reported in Expanded SI boring B168HP001 and SWAMPBHP002.	The Expanded SI decision criteria requires that if there is no known source than additional sampling would be required to determine if there is a source upgradient of that point. Diesel fuel concentrations of 100 µg/L and 270 µg/L were reported in shallow groundwater at B168HP001 and SWAMPBHP001, respectively (BC, 2005a). But the nearest point upgradient of B168HP001 and SWAMPBHP001 is approximately 250 to 280 feet north. Other diesel fuel plumes in the area have been delineated with smaller lateral distances.

Table 1-1. Summary of Expanded SI Sites Recommended for Further Investigation (continued)

Site	DoD Use	DoD Activity	Recommendations	Summary of Other Investigations
194	Former Septic Tank for CL1	Sewer	USACE to attempt another right-of-entry with new landowner for the investigation of a suspected discharge from CL1 into the former septic tank.	The landowner would not grant USACE access to the property.
CL2	Former boiler house	UST	A geophysical investigation to determine the presence of a UST and a site investigation to determine the presence/absence of a suspected release from the UST and AST.	A request to remove the UST by the Army in 1955 was found but it is unknown if the UST was removed. An AST reportedly replaced the UST. The AST is no longer present (BC, 2005a). The landowner has refused USACE access to the property.
Popping pot (Armored Fighting Vehicle)	Incineration	Disposal	To determine if the diesel fuel reported in shallow groundwater at Expanded SI boring AFVSB002 is from the alleged Post Dumpsite	The source of diesel fuel reported in Expanded SI boring AFVASB002 in shallow groundwater is not clear. Diesel fuel concentrations of 910 µg/L were reported in AFVSB002 (BC, 2005a).
Alleged Post Dumpsite	Dump	Disposal	To determine the location of buried ferrous and non-metallic debris using geophysics. Based on the results of this geophysical survey and previous results from the Expanded SI, additional sampling will be performed to determine lateral and vertical extent of fuels and solvents in groundwater.	

*UST investigated in a separate field event.

194
CL2
Sulfur Springs Creek Drainage Canal
LOWLANDS
Former
Burn Pits
Outline of alleged
"Post Dump" based
on 1954 Army map
Popping Pot (Armored
Fighting Vehicle)
Carquinez Strait
INTERSTATE 780
EAST MILITARY
GRANT STREET
ADAMS STREET
BAYSHORE ROAD
INTERSTATE 680
PARK ROAD
90
27
51
161
58(A)
168
101
Industrial Area
N
0 350 700
Feet
Index Map
Legend
Arsenal Boundary
Railroads
Roads
Elevation Contours (100 ft.)
Elevation Contours (25 ft.)
RI Sites
Marsh
Buildings
Lowlands
Highlands
BROWN AND CALDWELL
PROJECT: 128336
DATE: 3/6/2006
TITLE: Expanded SI Addendum Sites
SITE: Benicia Arsenal, Benicia, California
Figure 1-2
S:\Benicia_expandedsi Addendum\Figure 1-2 Expanded SI Addendum Sites.mxd

1.3 Previous Investigations

Previous sampling results from the six sites investigated in this addendum are provided below. This text has been summarized from the Expanded SI (BC, 2005a). For detailed information about each, please refer to the *Expanded SI Report* (BC, 2005a).

1.3.1 Former Drum Storage/Maintenance Area (Building 51)

Building 51 was used as a drum storage/maintenance area by the DoD and was sampled to determine if former DoD activities have impacted soil from a possible surface release of fuels and solvents. The building is constructed on sandstone and located on the hills overlooking the industrial area (Figure 1-2). Other chemicals of interest (COIs) investigated were polynuclear aromatic hydrocarbons (PAHs), semi-volatile organic compounds (SVOCs) and metals. One boring (B051HP001) was hand augered and two soil samples were collected at 0.5 feet to 1.0 feet and 1.5 feet to 2.0 feet bgs during the Expanded SI. Because the building is located in the highlands area of the Arsenal, no groundwater was encountered, as expected.

No metals concentrations or petroleum hydrocarbon concentrations exceeded their respective Regional Water Quality Control Board, San Francisco Bay Region (RWQCB) Environmental Screening Levels (ESLs) in the primary sample. However, in the duplicate sample at 0.5 feet below ground surface (bgs) to 1.0 feet bgs, lead was detected at a concentration of 798 milligrams per kilogram (mg/kg) and exceeded the RWQCB ESL for a commercial/industrial worker of 750 mg/kg. At 1.5 feet bgs, lead concentrations are 153 mg/kg. Lead concentrations do decrease in concentration with depth.

PAHs and semi-volatile compounds were detected in the soil above laboratory method detection limits (MDLs). Dimethyl phthalate, a SVOC, was the only analyte detected above its respective RWQCB ESL (RWQCB, 2005). However, the presence of phthalates, a common plasticizer, has not been associated with former DoD activities.

Since lead and PAHs reported in soil may be indicative of a nearby source area, additional investigation was warranted to determine if there is a source for the lead and PAHs in soil in the area of the former drum storage area at Building 51.

1.3.2 Former Locomotive Building (Building 90)

Constructed in 1941 to house the Arsenal's two diesel locomotives and associated maintenance facilities, Building 90 had a concrete locomotive pit. The actual location of the sump or drain lines from the pit are unknown and the location of the pit could not be confirmed during site visits. Between 1972 and 1975 (after the Army left the Arsenal), the building was used to manufacture aluminum wheels for automobiles and for installing fiberglass truck beds on pick-up trucks. The aluminum wheel process included pouring the aluminum into a form then grinding and cleaning the wheel. Trichloroethene (TCE) was used in the cleaning process. Currently, the building is used as an industrial painting operation and is located on the western side of the industrial area (Figure 1-2).

One Hydropunch™ boring (B090HP001) was advanced during the Expanded SI to determine the presence or absence of a possible release of fuels and solvents from former DoD activities in the building. The building footprint overlies a thin lens of saturated alluvium overlying sandstone

bedrock. In addition, there is an estimated 3-foot lens of saturated clayey silt overlying weathered sandstone at approximately 9 feet bgs. Depth to groundwater in April 2004 was 5.7 feet bgs. Diesel fuel was detected in the hydropunch sample at a concentration of 97 µg/L. Cis-1,2-dichlororethene (cis-1,2-DCE) and TCE was detected at 13 µg/L and 96 µg/L, respectively. The occurrence of the TCE is part of a larger plume and is discussed in detail in the *Expanded SI Report* (BC, 2005a). The groundwater contamination could be associated with the post-arsenal wheel manufacturing. According to the Process Flow and Decision Diagram in the *Expanded SI Report*, a soil gas sample should have been collected but was inadvertently missed. Therefore, one boring (B090GB001) was advanced for this supplemental investigation next to Expanded SI boring B090HP001 to collect a soil gas within the vadose zone.

1.3.3 Former Battery Charge Building (Building 101)

Built in 1942, building operations included steam cleaning of battery cases. The building is located on the eastern side of the industrial area at the northwest corner of Bayshore Road and Adams Street (Figure 1-2). A septic tank, located on the east side of the building, served the building and was constructed of wood. The septic tank discharged into a pipe that crossed beneath Bayshore Road and the railroad tracks to a point at the Carquinez Strait. The building foundation was constructed with a floor drain, a hydraulic lift, two battery blocks, and a raceway approximately 26 feet long and 2 feet deep. The hydraulic lift could not be located. Two Expanded SI borings (B101HP001 and B101HP002) were drilled on the south or downgradient side of the building foundation. The purpose of these samples was to determine the presence or absence of metals and fuels in groundwater from DoD steam cleaning of battery cases. These groundwater samples were analyzed for metals, diesel fuel and motor oil.

Low to trace concentrations of metals and fuels were reported in groundwater. Cobalt was the only metal that exceeded its RWQCB ESL of 0.003 milligrams per liter (mg/L). The concentration of cobalt in B101HP002 was 0.0129 mg/L.

Research was performed to determine if cobalt was used in the manufacture of vehicular batteries at the time the Army occupied the Arsenal. There are eight metals commonly used in batteries including lead, mercury, nickel, cadmium, lithium, silver, zinc, and manganese (Colorado Department of Public Health and the Environment, 2002). Lead-acid batteries, developed in the late 1800s, were the first commercially practical batteries. Cobalt has been only recently (since the 1990s) used in the development of longer lasting rechargeable lithium ion, nickel-cadmium, and nickel-metal hydride batteries. The source of cobalt in groundwater at concentrations that exceed RWQCB ESLs is unknown, but is not associated with the type of batteries that were used by the Army. According to the Process Flow and Decision Diagram in the *Expanded SI Report* (BC, 2005a), a soil sample should have been collected to determine the impact of lead in the vadose zone from the former battery cleaning operations at Building 101 since metals were detected in groundwater. Therefore, one soil boring (B101GB001) was advanced next to the drain inlet within the concrete building foundation to collect a soil sample near the drain bottom. The sample was analyzed for lead.

1.3.4 Former Bar Stock Building/Storage/Vehicle Shops for Motor Pool (Building 168)

Building 168 is grouped with Building 167 in the Expanded SI because of their close proximity and similar uses. Both of these building were built in 1945 during the World War II expansion at the former Arsenal and are located in the industrial area (Figure 1-2). The buildings are located on the former marshland and are supported by pilings that have been driven to the top of the underlying sandstone at approximately 38 feet bgs.

Historical records identify both buildings as vehicle shops but records did not indicate whether maintenance work was performed. Four borings (B167HP001, B167HP002, B168HP001, and B168HP002) were advanced during the Expanded SI downgradient of both buildings to determine the presence or absence of fuels and solvents in groundwater from possible DoD vehicle maintenance activities.

The only contaminates detected above MDLs were diesel fuel (100 micrograms per liter [µg/L] in B168HP001), naphthalene (0.61 µg/L in B167HP002), and bis(2-ethylhexyl)phthalate (190 µg/L in B168HP001), reported in samples collected from shallow groundwater (5 feet bgs to 10 feet bgs). Diesel fuel and naphthalene concentrations are less than their respective ESLs of 640 µg/L and 24 µg/L, respectively. The bis(2-ethylhexyl)phthalate concentration exceeds its ESL of 32 µg/L. As stated previously for the former drum storage area at Building 51, phthalates have not been associated with former DoD activities.

Even though the diesel fuel concentration in groundwater did not exceed its respective ESL, the decision criteria required that if a key indicator, like diesel fuel, was reported in a sample with no known source, that additional sampling would be required to determine if there is a source in the area. Additionally, Expanded SI boring SWAMPBHP002, approximately 125 feet west of B168HP001, reported 270 µg/L of diesel fuel. Therefore, additional groundwater sampling was recommended to determine if there is a source of diesel fuel in this area.

1.3.5 Popping Pot (also known as the Armored Fighting Vehicle)

This site is known by several names, the Incinerator, the Popping Pot, the Armored Fighting Vehicle and the General Grant Tank Site. Most recently the Popping Pot or the Armored Fighting Vehicle (AFV) are the names most commonly used. It is located west of the alleged Post Dumpsite in low-lying hills (Figure 1-2). The AFV is a tank turret from a World War II era General Grant type tank used as a furnace or "popping pot" to destroy unserviceable ordnance. A small fuel line supplied diesel fuel to keep the furnace burning. Popping pot operations were stopped periodically to allow the removal of burned fuses and debris. The burned fuses and debris were disposed of adjacent to the AFV. In 2001, Explosive Ordnance Disposal Technology, Inc. performed a clearance effort over a two-week period around the area of the AFV. They removed and inspected 8,445 burned fuses. No energetic explosives were found.

Located on Caltrans property, fill has been placed over the AFV comprising of sandstone boulders 2-feet in diameter and larger, and up to 15-feet thick. The large boulders in the 15-feet of fill material placed on top of the AFV prohibits drilling with a small rig, and the steep incline of the adjacent slopes and access road prohibits access of a larger drill rig. Because of the fill and access restrictions by Caltrans at the site of the AFV, the nearest possible sampling location was identified

approximately 300 feet downgradient of the AFV on Bayshore Road. Because of the distance, groundwater samples were the best method to determine if any of the burnt material has impacted groundwater. During the Expanded SI, two groundwater samples were collected from shallow and a deeper water bearing zone and analyzed for fuels, metals and explosive residues.

Caltrans collected two soil samples (Caltrans 1 and Caltrans 2) from the area of AFV before the area was filled in.

The conclusions from the Expanded SI and the Caltrans investigation are as follows:

- The stratigraphy encountered in boring AFVSB002 indicates that this boring is within the same alluvial valley as the AFV. In addition, the deep groundwater sample collected beneath the Bay Mud in the older alluvium at AFVSB002 is representative of groundwater downgradient of the AFV.
- Several metals (antimony, cadmium, copper, lead, nickel, selenium and zinc) were found in shallow soil at concentrations exceeding their respective ambient metals concentrations at Caltrans 2 but do not exceed their respective BSLs for an industrial/commercial worker. Explosives were not reported above analytical reporting limits.
- Total petroleum hydrocarbon (TPH) concentrations for diesel fuel and motor oil in groundwater exceed their respective ESLs. Oils from the roadway and the nearby railroad tracks percolating into shallow groundwater may be a contributor to shallow groundwater concentrations. Arsenic, barium, and zinc were reported in groundwater at concentrations that do not exceed their respective maximum contaminant levels (MCLs) or ESLs at the AFV locations. Explosives were not reported above MDLs.
- Chemical results in the deeper water sample are used to determine if there is sufficient evidence to determine if there is an impact from the AFV. Even though explosives and metals were not found at significant concentrations in the deeper groundwater sample, these contaminants would not likely be expected approximately 300-feet downgradient of the AFV. However, diesel fuel and motor oil was present in the deeper groundwater sample. There was insufficient evidence to eliminate the possibility of a release from the AFV site. The source of the diesel fuel and motor oil could be from the alleged Post Dumpsite.

1.3.6 Alleged Post Dumpsite

The alleged Post Dumpsite was reportedly in operation from 1940 through 1964 and located in the eastern side of the former Arsenal (Figure 1-2). The location of the alleged Post Dumpsite is based on a 1954 Army map that shows an area named, the "Post Dump". It is suspected that the disposal and burning of scrap lumber associated with the industrial area carpenter shops, and pilings and other waste material from repairs made to the Arsenal wharf were placed at this dumpsite. Thousands of gallons of gasoline were reportedly burned in pits at the north end of the site near Sulphur Springs Creek drainage canal (Figure 1-2). Based on aerial photographs, this area at the north end of the site does not appear to have been used as a disposal area but two black circular areas are present that may indicate the locations of the burn pits. An interview with Mr. Leroy Bailey, a former Arsenal employee, also indicated that this area received industrial waste, including acids, metal-cleaning corrosives, dichloro dipheryl trichloroethane (DDT), high-octane gasoline, and other waste generated at the Arsenal (FA/BC, 2004). The majority of the information from this

interview could not be substantiated; however, aerial photos and other interviews did substantiate Mr. Bailey's statement about the disposal of metal cleaning corrosives and the burning of scrap lumber in the pits.

In addition to the Expanded SI fieldwork, a soil and groundwater investigation was performed by the URS Corporation for Kinder Morgan Energy Partners in April 2004 (URS, 2004).

The URS investigation included sampling along the proposed Concord to Sacramento pipeline route, in particular, along the eastern boundary of the alleged Post Dumpsite and near the former burn pits. Seven locations (SB-1 through SB-7) were drilled along the pipeline right-of-way in this area. Samples were analyzed for SVOCs, total petroleum hydrocarbons as gasoline (TPHG), total petroleum hydrocarbons as diesel fuel (TPHD), total petroleum hydrocarbons as motor oil (TPHMO), Title 22 metals, polychlorinated biphenyls, organochlorine pesticides, moisture content, and pH.

URS results in shallow soil (less than 0.5 feet bgs) contain solvents and fuel related compounds, such as benzene, xylene and 1,3-5 trimethylbenzene. Fuels, in particular diesel fuel, were detected in each of the URS borings but qualified in the report, in whole or in part, contributed from the naturally occurring non-petroleum organics in soil. The highest concentrations were detected in SB-1 and SB-2 (diesel fuel at 180 mg/kg and motor oil at 600 mg/kg). The highest concentrations were compared to RWQCB ESLs for shallow soil (less than 9.8 feet [3 meters]) and for commercial land use. All of the detected analytes did not exceed their respective ESLs, except TCE. TCE was detected in soil exceeding its ESL but the soil concentrations at 5 feet bgs to 5.5 feet bgs should be considered approximate. Since groundwater is approximately 2 feet bgs to 7 feet bgs, soil samples collected 5 feet bgs to 5.5 feet bgs were most likely saturated or within the capillary fringe. Therefore, all the contaminants in soil are assumed to be from impacted groundwater.

Diesel fuel, motor oil and vinyl chloride were reported above their respective groundwater ESLs at URS borings SB-1, SB-2 and SB-4. Maximum concentrations of diesel fuel (5,700 µg/L), motor oil (3,800 µg/L), and vinyl chloride (65 µg/L) were reported in SB-1 or SB-2, both located in the southern end of the alleged Post Dumpsite.

Organochlorine pesticides and semi-volatile organics were also detected in soil samples at low concentrations from the URS borings. The pesticides, heptachlor and 4-4'-DDT, exceed their respective ESL but not their respective BSL in soil at URS boring SB-1.

During the Expanded SI, six hydropunches (PD001HP001 through PD001HP006) were advanced at the alleged Post Dumpsite to determine if there was a suspected release of metal cleaning corrosives.

The URS and Expanded SI boring logs indicate that the fill is a mixture of gravelly sand to silty sand, approximately 2.5 feet to 5 feet thick. The marshland or Bay Mud is thinnest at the southern end (PD001HP001) approximately 20 feet thick to approximately 70 feet thick at PD001HP006. Below the marshland are sequences of silt and sand silts from 100 feet bgs to greater than 108 feet bgs, where the top of the sandstone was encountered. The total depth of this sequence could not be determined at PD001HP005 because the depth to the top of sandstone bedrock was greater than amount of cone penetration testing (CPT) rod available (108 feet).

Comparison of the metals concentrations from the URS and the Expanded SI sampling indicate that antimony, arsenic, barium, beryllium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, vanadium, and zinc were detected in both URS and the Expanded SI investigations at similar concentrations. Arsenic, barium, cobalt, copper, lead, nickel, vanadium and zinc were reported in groundwater that exceed their respective RWQCB ESLs. At CPT location PD001HP006, six metals (arsenic, barium, lead, nickel, vanadium and zinc) exceeded RWQCB ESLs. Barium was detected in concentrations that exceeded its RWQCB ESL of 1.0 µg/L in eight of the 13 borings advanced during the Expanded SI and the URS investigation.

There is evidence to suggest that solvents, fuels, metals, and two pesticides (heptachlor and 4-4'-DDT) may have been disposed of at the alleged Post Dumpsite. Further investigation was warranted to determine if wastes had been buried at the alleged Post Dumpsite. A geophysical investigation was recommended to locate ferrous and non-metallic debris. Based on the results of the survey, samples were planned to determine the lateral and vertical extent of these contaminants in soil and groundwater.

SECTION 2
INVESTIGATIVE APPROACH

Conceptual site models (CSM) are used as a planning tool to design and guide investigations usually incorporating site-specific, geologic, and hydrogeologic information to identify contaminants of interest, sources of pollution, and pathways of migration. A CSM is a representation of an environmental system. It is meant to be dynamic such that new information may change the CSM. For example, the Expanded SI and previous investigations determined that the Industrial Area Lowlands groundwater is shallow and brackish and the simplified geologic sequence is artificial fill over Bay Mud over alluvium. For this addendum investigation, the Post Dumpsite had not been investigated and it was assumed that similar aspects would be encountered at the Post Dumpsite because of similar topography, elevation, and close proximity to the Carquinez Strait as the Industrial Area Lowlands. The CPT logs and the geophysical survey from this addendum investigation at the Post Dumpsite confirmed the geology and measurements taken during groundwater collection of the brackish water quality and shallow depth to groundwater. Refer to the *Expanded SI Report* (BC, 2005a) for a detailed discussion of the CSM for the Arsenal.

SECTION 3
FIELD METHODS AND SAMPLING RATIONALE

This section describes the field methods used, the rationale for selecting the number and location of samples, analytical parameters, and investigation derived waste (IDW) management procedures for the addendum Expanded SI.

3.1 Field Methods

Field techniques are described in detail in the FSIP (BC, 2004). A total of five soil samples, one soil gas sample, and 12 grab groundwater samples were collected during this investigation (excluding quality assurance/quality control (QA/QC) samples).

3.1.1 Geophysical Survey

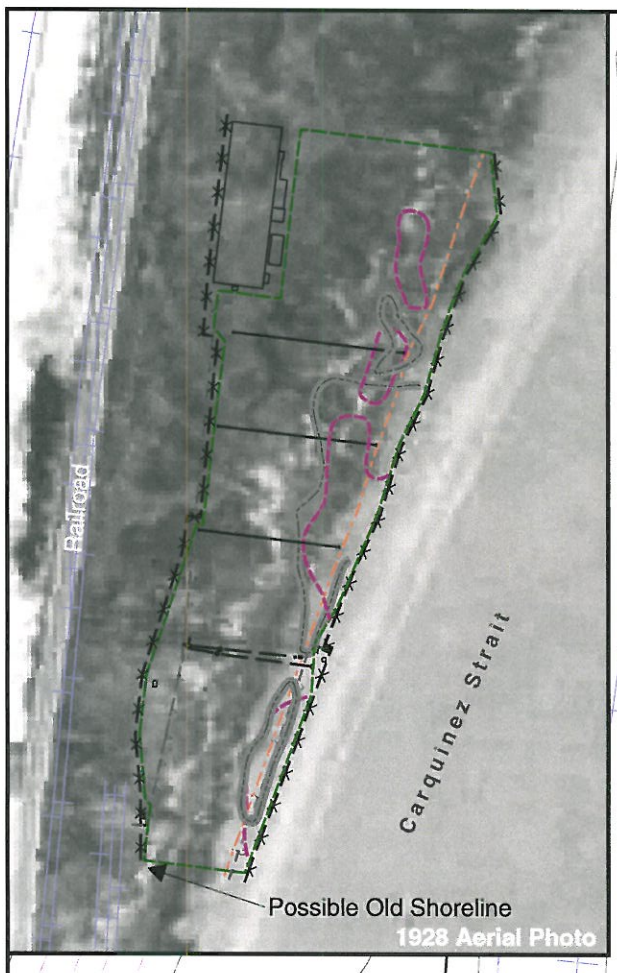
A geophysical survey was conducted at the alleged Post Dumpsite to assess the presence and extent of buried fill (ferrous and non-ferrous) in the suspected area. The geophysical area encompassed approximately 8.3 acres; as outlined on Figure 3-1. Several different geophysical methods were used: a vertical magnetic gradient (VMG), terrain conductivity (TC), metal detection and electrical resistivity (ER) methods methods. These methods were chosen since the buried debris could be variable and include both ferrous and non-ferrous metal, as well as non-metallic debris. NORCAL Geophysical Consultants, Incorporated (NORCAL) of Cotati, California performed the geophysical investigation on 6 June 2005 through 15 June 2005. Appendix B contains the NORCAL letter report, dated 21 July 2005 that details the methodology, data acquisition, results, and conclusions of this survey. A summary of the methods used and findings are provided below.

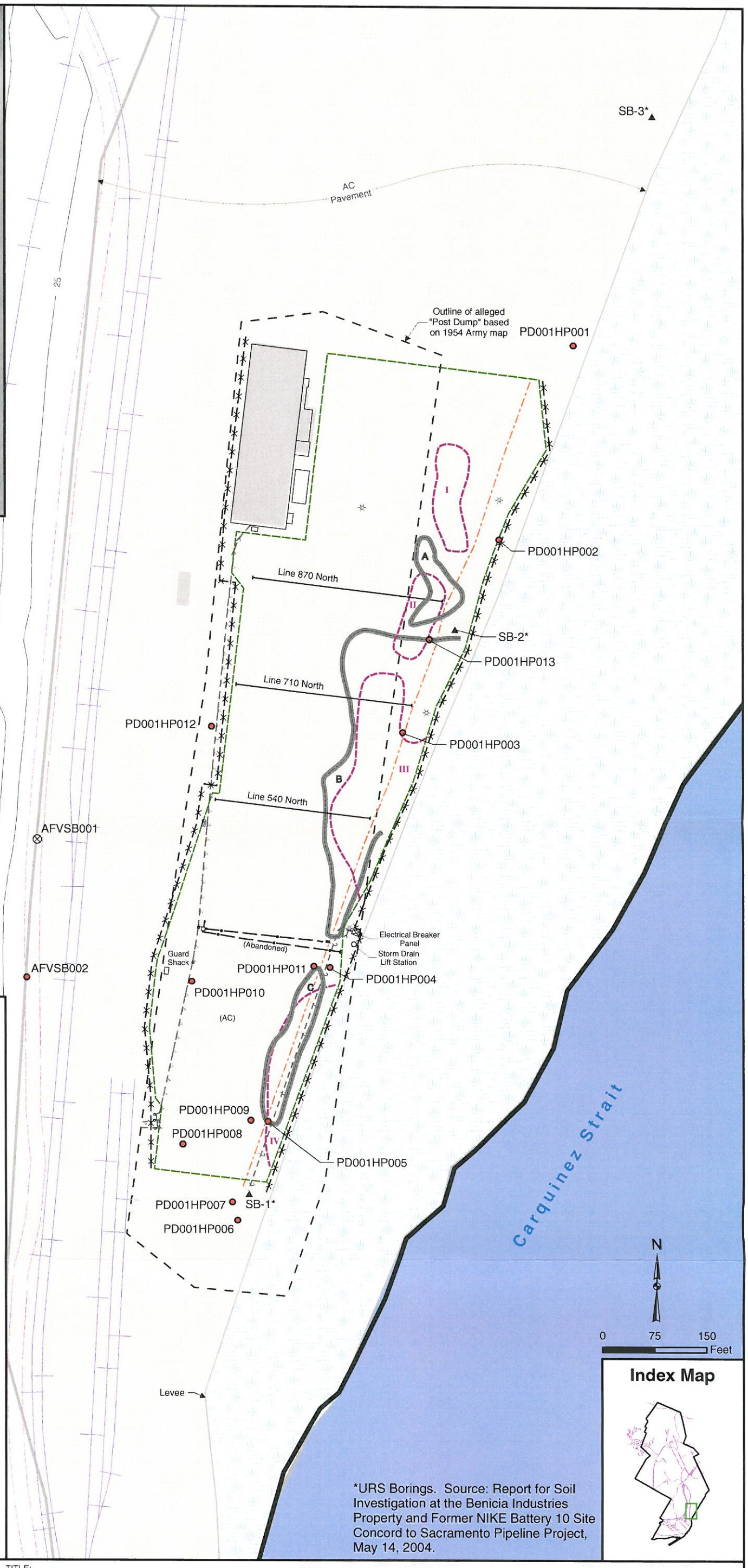
3.1.1.1 Methodology

VMG surveys were used to assess the presence of buried ferrous objects. TC is used to characterize the lateral changes in soil conductivity that may represent lithologic contacts, areas of disturbed soil, and zones of metallic debris (both magnetic and non-magnetic). The metal detector was used to further characterize suspected buried metallic objects initially detected by the VMG and TC methods. The ER method was used to characterize both lateral and vertical changes in soil conductivity at selected profile locations. The variations in ER may represent lithological contacts between the overburden/fill and native soil, areas of disturbed soil, and zones of subsurface debris.

A survey grid was setup based on 10-foot centers. Data for the VMG was collected on 4-foot intervals and 10-foot intervals for the TC data. Data from the VMG and TC were evaluated in the field.

VMG survey setup at the Post Dumpsite





Legend

- Piezometers
- Expanded SI Borings
- URS Borings
- Dry - no groundwater
- Railroads
- Roads
- Elevation Contours (100 ft.)
- Elevation Contours (25 ft.)
- Site Boundary
- Marsh
- Buildings
- Lowlands
- Approximate Limits of Geophysical Survey
- Electrical Resistivity Profile Location
- Interpreted Zones of Buried Ferrous Debris
- Interpreted Zones of Possible Buried Debris
- Electric Line
- Suspected Electric Line
- Kinder-Morgan Pipeline
- Storm Drain
- Fence
- Utility Pole (With Guy Wire)
- Utility Vault/Pull Box
- (AC) Asphalt

*URS Borings. Source: Report for Soil Investigation at the Benicia Industries Property and Former NIKE Battery 10 Site Concord to Sacramento Pipeline Project, May 14, 2004.

Index Map

BROWN AND CALDWELL

PROJECT: 128336

DATE: 3/6/2006

TITLE: **Geophysical Results at the Alleged "Post Dump"**

SITE: **Benicia Arsenal, Benicia, California**

Figure 3-1

S:\Benicia_expandedsi Addendum\Figure 3-1 Geophysical Result Post Dumpsite with Aerial.mxd

Areas of anomalous variations were further investigated using the metal detector and the ER. Three ER profile locations were chosen to depict "slices" of the subsurface where there are large anomalous areas exist.

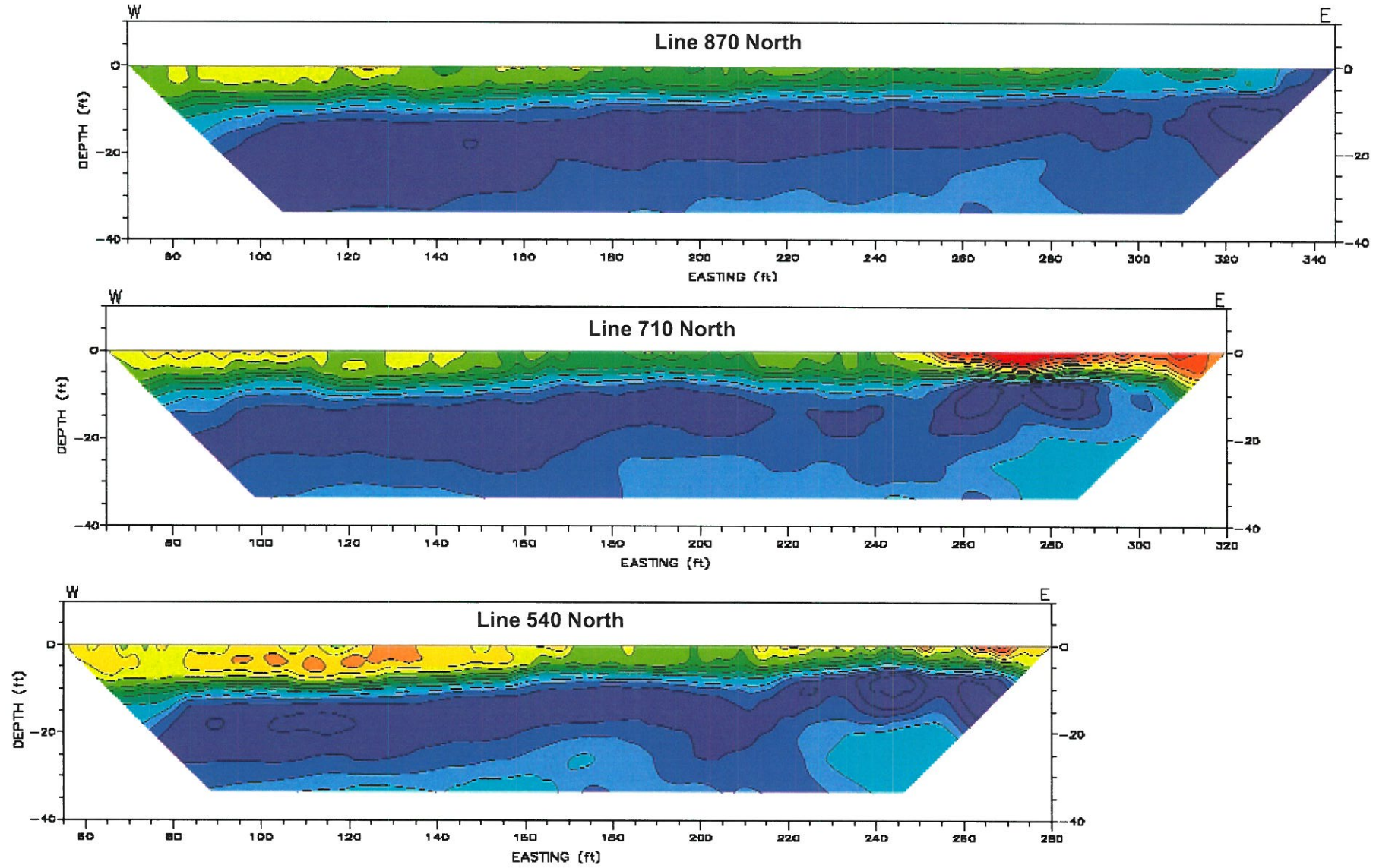
The interpreted results from the VMG, TC and metal detector data are provided on Figure 3-1. There are a total of six zones identified; three gray-outlined areas, labeled "A" through "C", and three red-dashed outlined areas, labeled "I" through "IV". These zones are orientated parallel to the levee and not more than 100 feet wide. These areas are interpreted to be zones of possible buried ferrous debris (A through C) and zones of buried debris (I through IV). Existing subsurface structures found by the survey included storm drain lines, a buried electrical line, and the Kinder-Morgan pipeline (Figure 3-1). The Kinder-Morgan pipeline is located parallel to the levee and within these anomalous zones.

The ER data indicates that the survey area is comprised of relatively resistive (greater than 4 ohm-meters) material overlying more conductive material (Figure 3-2). The more resistive material is interpreted to consist of silts and sands and probably represents fill material. The fill thickness appears to increase in thickness in a fairly uniform pattern from 5 feet in the east to 10 feet in the west. Below the fill, the conductive material is interpreted to be comprised of clay and/or marsh deposits with high moisture content.

The geophysical interpretations of fill material overlying clay correlates with the drilling performed for the Expanded SI and the URS investigation. Borings were advanced along the east side of the alleged Post Dumpsite during both of these investigations. Borings logs indicate that the fill is a mixture of gravelly sand to silty sand, approximately 2.5-feet to 5-feet thick, overlying marshland or Bay Mud to depths of 70 feet and deeper. The deepest depth that the ER could interpret was approximately
37-feet.

A hypothesis was formed based on the orientation and appearance of the anomalous material. The linear mass appeared to be material that could have been pushed over into the water and that the western boundary of the material may represent an old shoreline. Research was performed by reviewing older aerial photos before the area was reclaimed by the Army to confirm or disprove this hypothesis.

In 1928, the area of the alleged Post Dumpsite was undisturbed land. This photo and the anomalous areas identified during the geophysical survey were overlaid on top of the 1928 photo, as shown on Figure 3-1. The anomalous areas are positioned west of the 1928 shoreline and east of an irregular white line. This white line could represent high tide. The dark material on the photo is vegetation. It is presumed that the anomalous areas are likely construction debris that was pushed into this area as a means to support the existing paved surface and/or a foundation for the existing levee. The location of the levee coincides with the eastern extent of the survey area and is also located at the boundary between the marsh and the paved area.



Source: Norcal Geophysical Consultants, 2005

Figure 3-2
Geophysical Electrical Resistivity Profiles - Post Dumpsite
Expanded Site Inspection Addendum Report
Former Benicia Arsenal

3.1.2 Soil Samples

A total of five soil samples were collected during this investigation (excluding QA/QC samples). Hand-augered soil borings and direct-push soil borings were advanced during field activities and are described below. A soil sample was also collected using a CPT rig at the alleged Post Dumpsite.

Hand Auger Soil Borings. Three soil borings (B051HA001 through B051HA003) were hand augered at Building 51. The purpose of the hand-augered soil borings was to collect soil samples for chemical analyses in areas of limited vehicle access, where a drill rig could not be used. The borings were augered to the desired sampling depth and then withdrawn. To collect the soil sample, a manual slide impact sampler with a sample sleeve was pounded into the soil to a depth of 6-inches (the length of the sample sleeve). If additional soil samples were needed, the boring was advanced to the next interval and the drive sampling process was repeated.

Direct Push Soil Borings. Soil samples were collected using direct push techniques at Building 101. Direct push allows for a continuous sample to be collected, usually in 4-foot lengths. The soil is encased in a plastic sleeve as it is pushed into the ground. The advantages to using direct push are minimal soil cuttings, continuous cores and sampling is quick. The primary disadvantage is the depth to which the sleeve can be pushed (usually no more than 25-feet to 50-feet bgs). For this project, the maximum required depth pushed was 5-feet bgs.

3.1.3 Soil Gas Sampling

One soil gas sample (B090GB001) was collected during this investigation (excluding QA/QC samples) at Building 90. The purpose of the soil gas sample was to evaluate areas near current buildings where VOCs have potential to impact indoor air quality. Soil gas samples collected during this project were collected from a direct push boring. A soil gas probe was inserted into the ground and opened approximately 6 inches to allow soil vapor to enter the probe and the tubing attached to the probe. The sample was drawn from the tubing using a syringe. Five tubing volumes were removed before the sample was collected. Before the probe tip was extracted, a field measurement for total VOCs using a photo ionization detector was performed by attaching the meter directly to the tubing.

3.1.4 Groundwater Sampling

A total of 12 grab groundwater samples were collected during this investigation (excluding QA/QC samples) at Building 168 and the alleged Post Dumpsite. At the alleged Post Dumpsite, borings were advanced using a CPT rig to the top of the sandstone at PD001HP008, PD001HP009, PD001HP010, PD011HP012, and PD001HP013 to determine the lithology before collecting the groundwater sample. The CPT logs are provided in Appendix C of this report. Lithology at the other CPT borings (PD001HP007 and PD001HP011) had already been gathered at those locations because they were advanced next to Expanded SI CPT borings. A description of the CPT is provided in the *Expanded SI Report* (BC, 2005a).

For each groundwater sample, a boring was advanced. Drill rod was pushed to the desired depth and a polyvinyl chloride (PVC) casing with 5-feet of slotted interval was inserted into the rod to the bottom of the boring. The rods were retracted no more than 5-feet to allow groundwater to enter

the casing for sampling. At depths greater than first groundwater (approximately 5 to 10 feet bgs), the rod was not removed until the groundwater sample was collected to prevent any potential cross contamination between water bearing zones above the zone being sampled. For samples at first encountered groundwater, if groundwater was slow to enter the casing, the rod was removed and the CPT rig moved to the next location while waiting for enough water to enter the PVC casing for sampling.

At Building 168, a direct push rig was used to advance the boring to a pre-determined depth of 10 feet bgs. The same procedure for sampling was used as discussed above for the CPT rig. At several of the Building 168 locations, an extra boring was required at each location to ensure that enough groundwater could be collected for sampling.

After the sample was collected, the borings were abandoned properly with neat cement grout.

3.2 Sample Locations and Analytical Parameters

The boring ID, matrix sampled and depth, and analyses performed for this addendum fieldwork is shown in Table 3-1.

Table 3-1. Sample IDs, Matrix, and Analysis

Inspection Site	Boring / Piezometer ID	Matrix (SG/S/GW)	Sampling Depths (feet bgs)	Analyses (EPA Method #)
51	B051HA001	S	1.75-2.2	Lead (6010B), PAHs (8310)
	B051HA002	S	1.5-2.0	Lead (6010B), PAHs (8310)
	B051HA003	S	1.75-2.2	Lead (6010B), PAHs (8310)
90	B090GB001	SG	3	VOCs (TO-14)
101	B101GB001	S	1.5-2.0	Lead (6010B)
168	B168HP003	GW	5-10*	TPHD (8015B)
	B168HP004	GW	5-10	
	B168HP005	GW	5-10	
	B168HP006	GW	5-10*	
	B168HP007	GW	5-10*	
Alleged Post Dumpsite	PD001HP007	S	1.5-2	TPHG (8015B), TPHD/TPHMO (8015B), VOCs (8260B)
		GW	0-5	TPHG (8015B), TPHD/TPHMO (8015B), VOCs (8260B)
		GW	103-108	
	PD001HP008	GW	5-10	
	PD001HP009	GW	0-5	
		GW	105-110	
Alleged Post Dumpsite/ AFV	PD001HP010	GW	5-10	TPHG (8015B), TPHD/TPHMO (8015B), VOCs (8260B)
		GW	44-49	

Table 3-1. Sample IDs, Matrix, and Analysis (continued)

Inspection Site	Boring / Piezometer ID	Matrix (SG/S/GW)	Sampling Depths (feet bgs)	Analyses (EPA Method #)
Alleged Post Dumpsite	PD001HP011	GW	0-5	TPHG (8015B), TPHD/TPHMO (8015B), VOCs (8260B)
		GW	105-110	
	PD001HP012	GW	0-5	
		GW	50-55	
	PD001HP013	GW	0-5	
		GW	103-108	

Notes:
* An additional boring was pushed at these locations due to very low yield
bgs = below ground surface
GW = groundwater
NA = not applicable
PAHs = polyaromatic hydrocarbons
S = soil
SG = soil gas
TPHD = total petroleum hydrocarbons as diesel fuel
TPHG = total petroleum hydrocarbons as gasoline
TPHMO = total petroleum hydrocarbons as motor oil
VOCs = volatile organic compounds

3.3 Investigation Derived Waste

IDW generated as part of the field effort included soil from direct push drilling and decontamination rinsate water from hand augering. The soil cuttings left over from direct push sampling and the volume of the water generated from decontamination was less than the size of a 5 gallon pail. The cuttings were added to soil generated from the removal and over-excavation of the USTs at Buildings 27 and 161. The soil was stored in several soil bins at Building 103. The decontamination water was added to drums generated from purging rainwater from the Building 27 UST. The soil bins and drums from the UST investigation were stored at Building 103. The Building 103 site is secure with perimeter fencing and lockable gates. The soil and water generated from this investigation and the UST investigation was sampled and classified as non-hazardous waste.

All decontamination was performed as specified in the QAPP (FA/BC, 2001).

The soil and decontamination water is being classified as part of the *Fuel Storage Tank Removal Action Addendum* (BC, 2006) for Buildings 27 and 161 since the amount of IDW generated for the removal action was significantly larger than the IDW generated from this Expanded SI addendum fieldwork.

Disposable wastes derived from sampling, such as gloves and bailers were disposed by BFI, which provides local garbage disposal service for the area.

SECTION 4
GEOLOGY AND HYDROGEOLOGY

The geology and hydrogeology of the former Benicia Arsenal are discussed in the Conceptual Hydrogeologic Model (CHM) report (BC, 2005b), and summarized in the *Expanded SI Report* (BC, 2005a). The geologic and hydrogeologic information gathered during this fieldwork did not change the information already provided in the previous reports. Therefore, the reader is referred to these references if interested in those details.

Field water quality measurements (e.g. pH, EC, temperature) were collected from several locations. They are presented in Appendix D and were compared and evaluated against the CHM (BC, 2005b). The data collected during the Expanded SI addendum is in agreement with the CHM.

SECTION 5
DATA USABILITY

This section summarizes the data quality assessment of analytical results reported for soil, soil gas and groundwater samples collected during this investigation. Validation and/or verification of the laboratory analytical data was performed per the criteria specified in the Benicia QAPP (FA/BC, 2001).

Soil, water, and soil gas samples were collected by Brown and Caldwell (BC) in two mobilizations (July 2005 and January 2006). Soil and groundwater water samples were delivered by overnight courier to EMAX Laboratories, Inc. (EMAX) in Torrance, California. The soil gas samples were couriered to Air Toxics LTD in Folsom, California. Data was received in both hard copy and electronic formats.

Individual analytical results were qualified during the data verification procedures. The percentage of results that are qualified as estimated or rejected due to quality control (QC) deficiencies is an indication of the overall data quality for a given analytical method. Table 5-1 provides a summary of the number of results that were qualified by method.

Table 5-1. Analytical Completeness by Method for the Expanded SI Addendum

				Number of results				Completeness	
Method	Parameter	Samples Analyzed (N+FD)	Analytes per sample	Total	Rejected	Estimated due to QC deficiencies	Estimated due to >MDL but <PQL	Percent usable	Percent quantitative*
SW6010B	Metals by ICP/AES	4	1	4	0	0	0	100%	100%
SW8015B	TPHG, TPHD, and TPHMO	19	2/3	52	0	0	19	100%	100%
SW8260B	Volatiles	14	71	994	0	1	34	100%	99.9%
SW8310	PAHs	3	16	48	0	0	12	100%	100%
TO14	Volatiles in soil gas	2	66	132	0	12**	0	100%	90.9%

* Note: Estimations due solely to results <PQL do not affect the calculated completeness
Calculations do not include any required field or laboratory QC samples, except field duplicates.
** Four results were qualified to low laboratory control sample recoveries and the remaining eight are TICS, which were qualified due to missing supporting QC.
FD = field duplicate sample
N = normal environmental sample
PQL = practical quantitation limit

In general, the results are of acceptable quality and are usable for their intended purpose. None of the results were rejected. All holding time requirements were met. No global problems were identified. All methods met the analytical completeness goals with a high percentage of unqualified results (greater than 90 percent).

SECTION 6
RESULTS AND ANALYSIS

In this section, the analytical results of samples specified in Section 3.0 are discussed. A total of five soil samples, one soil gas sample, and 12 grab groundwater samples were collected during this investigation. These sample counts do not include QA/QC samples.

A comparison of data from previous investigations is included in this section, where applicable.

For all the analytical results from this sampling event, see Appendices E through H. Appendix E is a legend for the abbreviations and acronyms used in Appendices F, G, and H. Appendices F, G, and H contain all results, for soil, soil gas and groundwater, respectively. Both detected values and non-detected values are provided.

Figures and tables in this section are formatted to show only analytes detected above MDLs. The sites in this section are organized in numeric and then alphanumeric order.

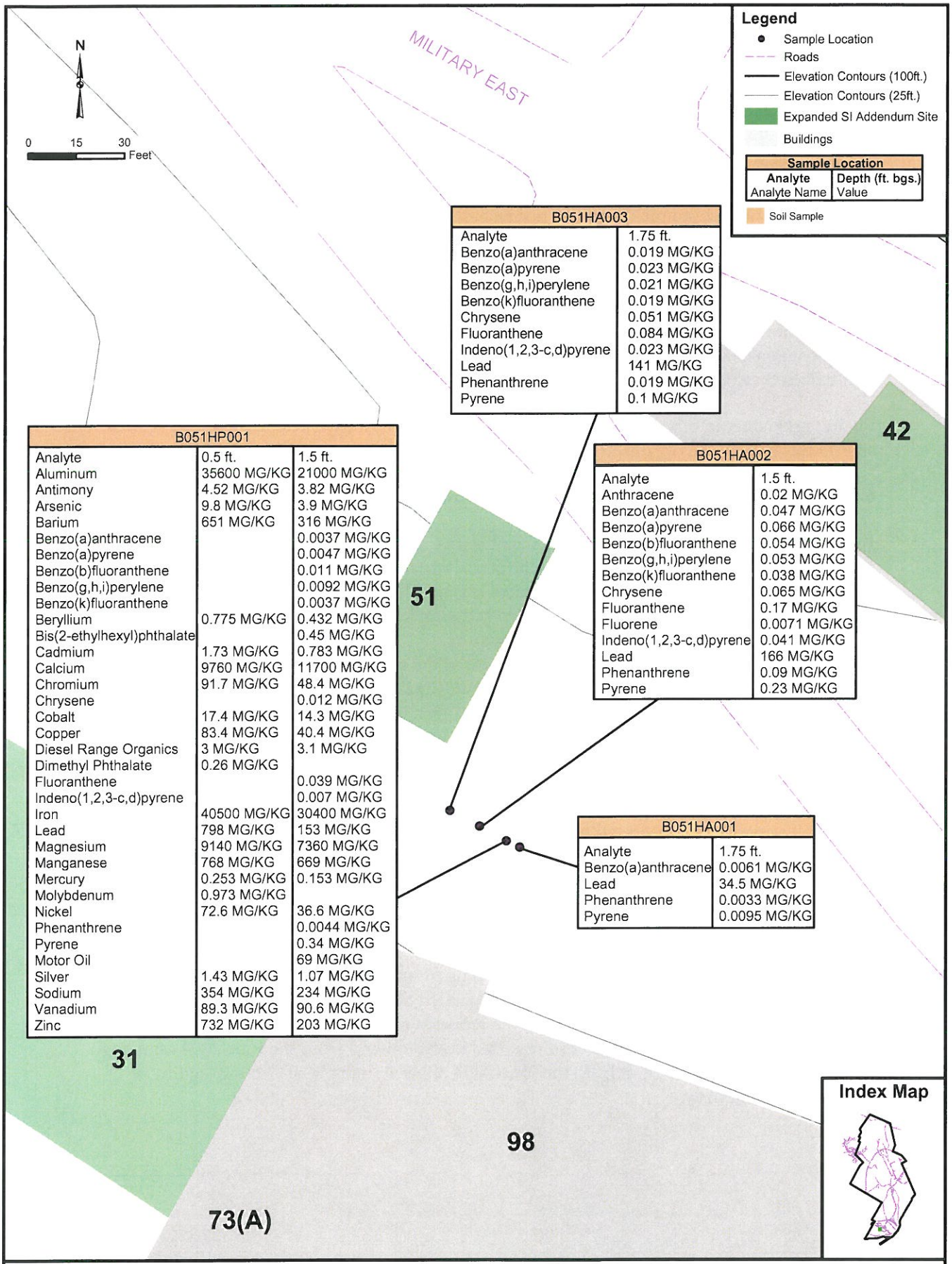
6.1 Former Drum Storage/Maintenance Area (Building 51)

No further investigation is recommended at the former drum storage area at Building 51. A risk evaluation will be performed.

Building 51 was used as a drum storage/maintenance area by the DoD and was sampled to determine the lateral extent of lead and PAHs in soil. The building is located on the hills above Buildings 31 and 98 (Figure 6-1). Two soil samples and a duplicate were included in the Expanded SI Report (BC, 2005a). Concentrations of lead did not exceed the risk to commercial/industrial worker of 750 mg/kg (RWQCB ESL). However, in the duplicate sample at 0.5-feet to 1.0-feet, lead concentration was 798 mg/kg and exceeded the RWQCB ESL. Lead concentrations decrease in concentration with depth (Table 6-1). Since the lead concentration may be near a source, additional samples were collected for this addendum.

Three soil samples were collected northwest and southeast of the Expanded SI boring, B051HP001 (Figure 6-1). Sample depths ranged from 0.5 feet bgs to 2.2 feet bgs. Fill material of silt and organics (i.e. leaves) was encountered at the surface to approximately 8-inches bgs. Sandstone underlies the fill material. Competent sandstone was encountered at depths of 2-feet bgs to 2.2-feet bgs. No groundwater was encountered.

Detected results of all samples collected at Building 51 are shown on Figure 6-1. A comparison of the lead data from this investigation and the Expanded SI also is provided in Table 6-1. Concentrations of lead are consistent with the reported results in the Expanded SI Report, around 150 mg/kg (BC, 2005a). Since the lead reported in shallow soil from the June 2004 sampling location is below the RWQCB ESL, the June 2004 duplicate sample of 798 mg/kg can be considered an anomaly.



BROWN AND CALDWELL

PROJECT: 128336-005
DATE: 2/28/2006
TITLE: Sampling Locations and Detected Results at Building 51
SITE: Benicia Arsenal, Benicia, California

Figure 6-1

S:\Benicia_expandedsi Addendum\Figure 6-1 B51.mxd

Table 6-1. Lead in Soil at Building 51			
	Depth (ft bgs)	ESL (mg/kg)	Concentration (mg/kg)
B051HP001+	0.5-1.0	750	**155+/798****
B051HP001+	1.5-2.0		153
B051HA001	1.75-2.2		34.5
B051HA002	1.5-2.0		166
B051HA003	1.75-2.2		141

**- Duplicate sample
+ - Documented in the Expanded SI Report (BC, 2005a)
BSL = Benicia Screening Level (FA/BC, 2002)
ESL = Environmental Screening Level (RWQCB, 2005)
Bolded values exceed their respective BSLs or ESLs
mg/kg = milligram per kilogram
bgs = below ground surface

PAHs were detected in the soil above laboratory MDLs and their concentrations are also listed on Figure 6-1 and in Table 6-2.

Table 6-2. Detected PAHs in Soil at Building 51						
	ESL (mg/kg)	B051HP001 Depth 0.5-1.0 feet bgs (mg/kg)+	B051HP001 Depth 1.5-2.0 feet bgs (mg/kg)+	B051HA001 Depth 1.75-2.2 feet bgs (mg/kg)	B051HA002 Depth 1.5-2.0 feet bgs (mg/kg)	B051HA003 Depth 1.7-2.2 feet bgs (mg/kg)
anthracene	2.8	<0.0016	<0.0015	<0.0013	0.02	<0.0059
bis(2-ethylhexyl) phthalate	660	<0.11	0.45	NA	NA	NA
benzo(a)anthracene	1.3	<0.001	0.0037	0.0061	0.047	0.019
benzo(a)pyrene	0.13	<0.0011	0.0047	<0.0013	0.066	0.023
benzo(b)fluoranthene	1.3	<0.0021	0.011	<0.0026	0.054	<0.012
benzo(g,h,i)perylene	27	<0.0021	0.0092	<0.0026	0.053	0.021
benzo(k)fluoranthene	1.3	<0.0018	0.0037	<0.0013	0.038	0.019
chrysene	13	<0.001	0.012	<0.0013	0.065	0.051
dimethyl phthalate	0.035	**0.26**	<0.13	NA	NA	NA
fluoranthene	40	<0.0021	0.039	<0.0026	0.17	0.084
fluorene		<0.0024	<0.0021	<0.0026	0.0071	<0.012
indeno(1,2,3-c,d)pyrene	1.3	<0.0023	0.007	<0.0013	0.041	0.023
phenanthrene	11	<0.0011	0.0044	0.0033	0.09	0.019
pyrene	85	<0.0019	0.34	0.0095	0.23	0.1

ESL = Environmental Screening Level for Commercial/Industrial land use (RWQCB, 2005)
NA = not analyzed
Bolded values exceed their respective BSLs or ESLs
mg/kg = milligrams per kilograms
+ - Documented in the Expanded SI Report (BC, 2005a).
bgs = below ground surface

PAH concentrations are consistent with the reported results in the *Expanded SI Report* (BC, 2005a). As mentioned in the Expanded SI report, the presence of dimethyl phthalate is not associated with Army activities.

The lead and PAH data collected at this location will be evaluated in the risk assessment to determine the next step.

6.2 Former Locomotive Building (Building 90)

No further investigation is recommended at Building 90. A risk evaluation will be performed.

One boring (B090GB001) was advanced to determine the presence or absence of VOCs in soil vapor at the Expanded SI boring B090HP001 where VOCs have impacted groundwater. The building is located in the highlands (Figure 1-2), where there is a 3-foot lens of saturated clayey silt overlying weathered sandstone at approximately 9-feet bgs. Depth to groundwater was 5.7-feet. Refusal into competent sandstone occurred at 13-feet bgs during the Expanded SI.

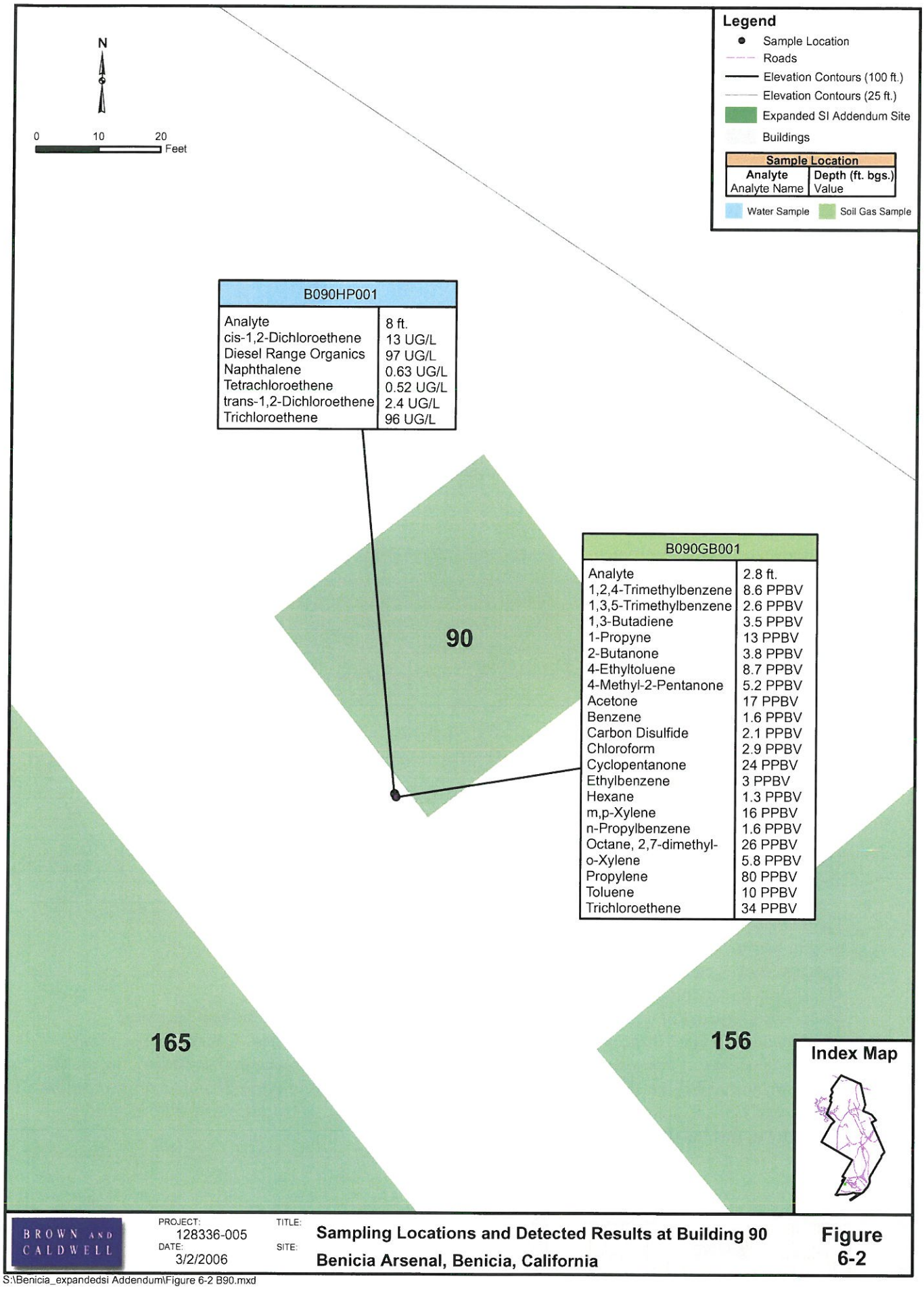
The groundwater sample collected from Expanded SI boring B090HP001 contained diesel fuel, cis-1,2 DCE, and TCE at concentrations of 97 µg/L, 13 µg/L, and 96 µg/L, respectively (BC, 2005a) (Figure 6-2). A building is adjacent to the groundwater sample location, therefore, a soil gas sample was collected. The complete list of detected VOCs in soil gas is shown on Figure 6-2, and the constituents with ESLs are shown in Table 6-3 below.

Table 6-3. Detected VOCs with ESLs in Soil Gas at Building 90

	ESL (ppbv)	B090GB001 Depth 3.0 feet bgs (ppbv)	B090GB001 Depth 3.0 feet bgs - Duplicate(ppbv)
acetone	1,800,000	17	17
benzene	290	1.6	<1.3
chloroform	1,500	2.9	2.0
ethylbenzene	1,200,000	3.0	2.1
methyl ethyl ketone (2-butanone)	590,000	3.6	3.8
methyl isobutyl ketone (4-methyl-2-pentanone)	47,000	4.0	5.2
m,p-Xylenes	110	16	13
o-Xylene	110	5.8	4.7
toluene	180,000	10	6.5
TCE	4,100	34	7.4

ESL = Environmental Screening Level for Indoor Air and Soil Gas, Commercial/Industrial land use (RWQCB, 2005)
NE = not established
ppbv = parts per billon by volume
bgs = below ground surface
TCE = trichloroethene

The soil gas concentrations do not exceed their ESLs, but because there is an adjacent building, a risk assessment is recommended.



BROWN AND CALDWELL

PROJECT: 128336-005
DATE: 3/2/2006
TITLE: Sampling Locations and Detected Results at Building 90
SITE: Benicia Arsenal, Benicia, California

Figure 6-2

S:\Benicia_expandedsi Addendum\Figure 6-2 B90.mxd

6.3 Former Battery Charge Building (Building 101)

No further investigation is recommended at former Building 101. A risk evaluation will be performed.

Built in 1942, building operations included steam cleaning of battery cases. The building is located on the eastern side of the industrial area (Figure 1-2). A floor drain was found on the eastern side of the building (Figure 6-3). One boring (B101GB001) was drilled next to the floor drain. The purpose of the boring was to collect a soil sample for lead analysis next to the drain because of a possible leak in the drain during former DoD steam cleaning of lead-acid battery cases.

Sandstone was encountered at 2-feet bgs at B101GB001, which correlates with the CSM for the site. The building was carved out of a nearby hill (see photo at right) and sandstone would be expected at shallow depth. The soil sample was collected on top of the sandstone at a similar depth as the bottom of the drain.

Only the foundation remains. The hillside was carved out for the building. This photo was taken in 2001 and not during this investigation.

Groundwater samples collected during the Expanded SI contained metals in groundwater above the MDLs (Table 6-4 and Figure 6-3) and there is a possibility that soil may be impacted with lead that was not detected in the groundwater samples.

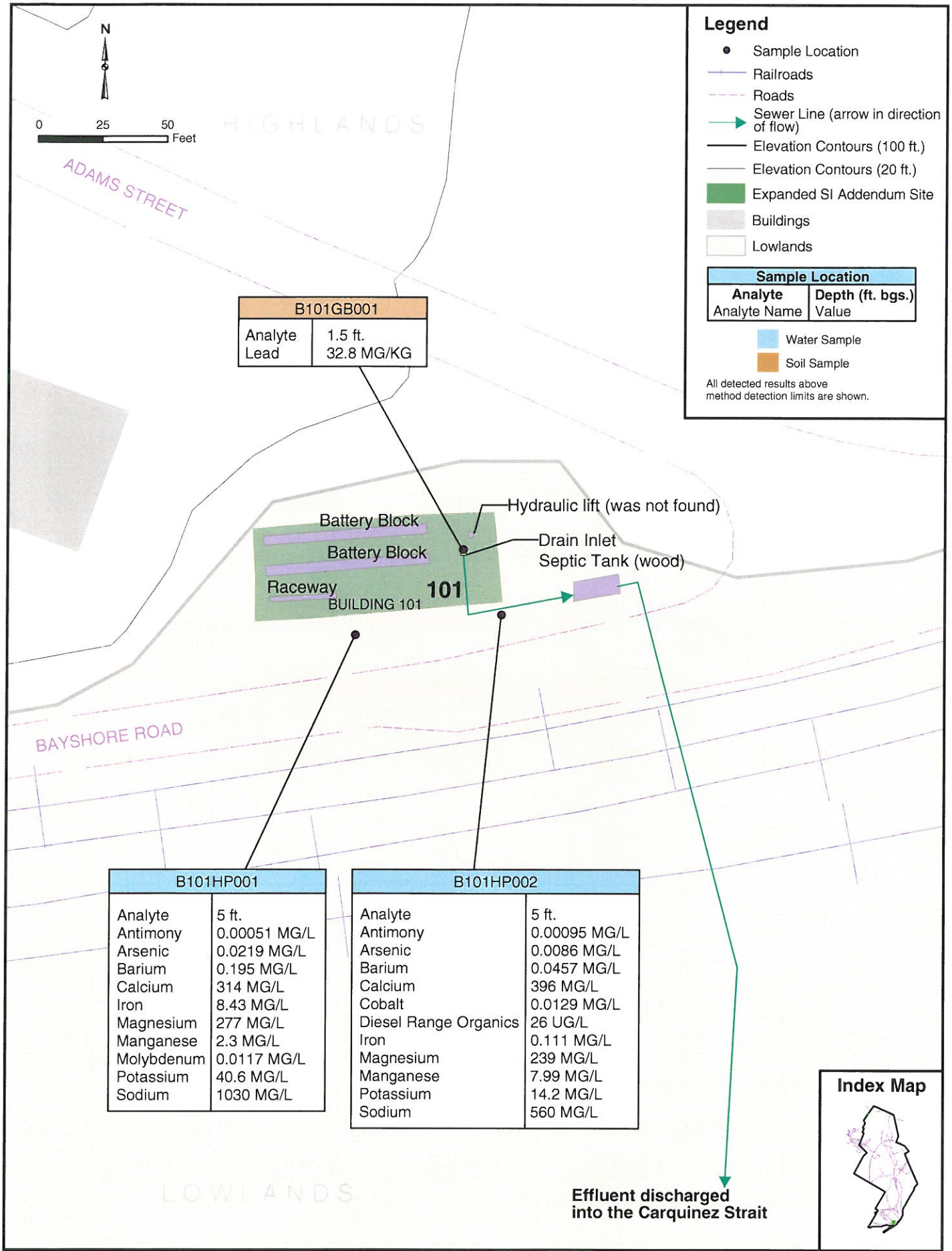
Table 6-4. Detected Groundwater Concentrations at the Former Battery Charge Building (Building 101) (Expanded SI)

Concentrations in mg/L, unless otherwise noted			
Metal	**B101HP001**	**B101HP002**	**ESL**
Antimony	0.00051	0.00095	0.030
Arsenic	0.0219	0.0086	0.036
Barium	0.195	0.0457	1
Calcium	314	396	NE
Cobalt	<0.005	**0.0129**	0.003
Diesel fuel	<24 µg/L	26 µg/L	640 µg/L
Iron	8.43	0.111	NE
Magnesium	277	239	NE
Manganese	2.3	7.99	NE
Molybdenum	0.0117	<0.01	0.24
Potassium	40.6	14.2	NE
Sodium	1,030	560	NE

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005)
NE = not established
Bolded values exceed ESLs.
µg/L = micrograms per liter

A soil sample was collected at 1.5-feet bgs and analyzed for lead. Lead was detected at a concentration of 32.8 mg/kg. The ESL for lead in soil is 750 mg/kg.

There are eight metals commonly used in batteries including lead, mercury, nickel, cadmium, lithium, silver, zinc, and manganese (Colorado Department of Public Health and the Environment, 2002). Lead-acid batteries, developed in the late 1800s, were the first commercially practical batteries. Cobalt has been only recently (since the 1990s) used in the development of longer lasting rechargeable lithium ion, nickel-cadmium, and nickel-metal hydride batteries. The source of cobalt in groundwater at concentrations that exceed ESLs is unknown, but is not associated with the type of batteries that were cleaned by the Army in this building.



BROWN AND CALDWELL

PROJECT: 128336-005
DATE: 3/1/2006

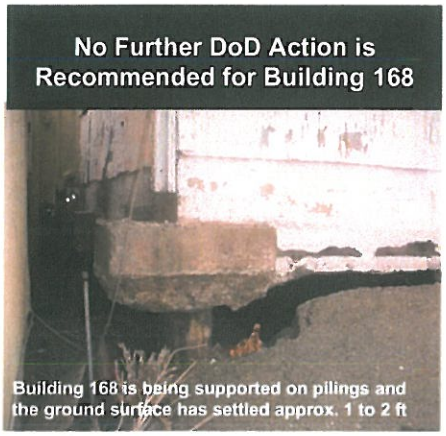
TITLE: Sampling Locations and Detected Results at Former Battery Charge Building (Building 101)
SITE: Benicia Arsenal, Benicia, California

Figure 6-3

S:\Benicia_expandedsi Addendum\Figure 6-3 B101.mxd

Based on the data, there appears to be no significant DoD impact. Therefore, no further investigation is recommended at the former battery charge building (Building 101). The data will be evaluated in the Arsenal risk assessment.

6.4 Former Bar Stock Building/Storage/Vehicle Shop for Motor Pool (Building 168)



Building 168 was built in 1945 as a vehicle shop during the World War II expansion at the former Arsenal. Historical records did not indicate whether maintenance work was performed. The building is located on the former marshland and is supported by pilings that have been driven to the top of the underlying sandstone. The land surface around these buildings has sunk 1 to 2 feet as shown in the photo at right.

Five borings (B168HP003 through B168HP007) were advanced in the area of diesel fuel reported in Expanded SI borings B168HP001 (100 µg/L) and SWAMPBHP002 (270 µg/L). The purpose of the addendum fieldwork is to determine the source of the diesel fuel and to delineate the impacted groundwater.

Diesel fuel was reported in shallow groundwater (5 to 10 feet bgs) samples in B168HP003, B168HP005, B168HP006, and B168HP007 (Table 6-5). All of these concentrations are less than the RWQCB ESL of 640 µg/L.

Table 6-5. Diesel Fuel Detected in Shallow Groundwater in the Vicinity of Building 168

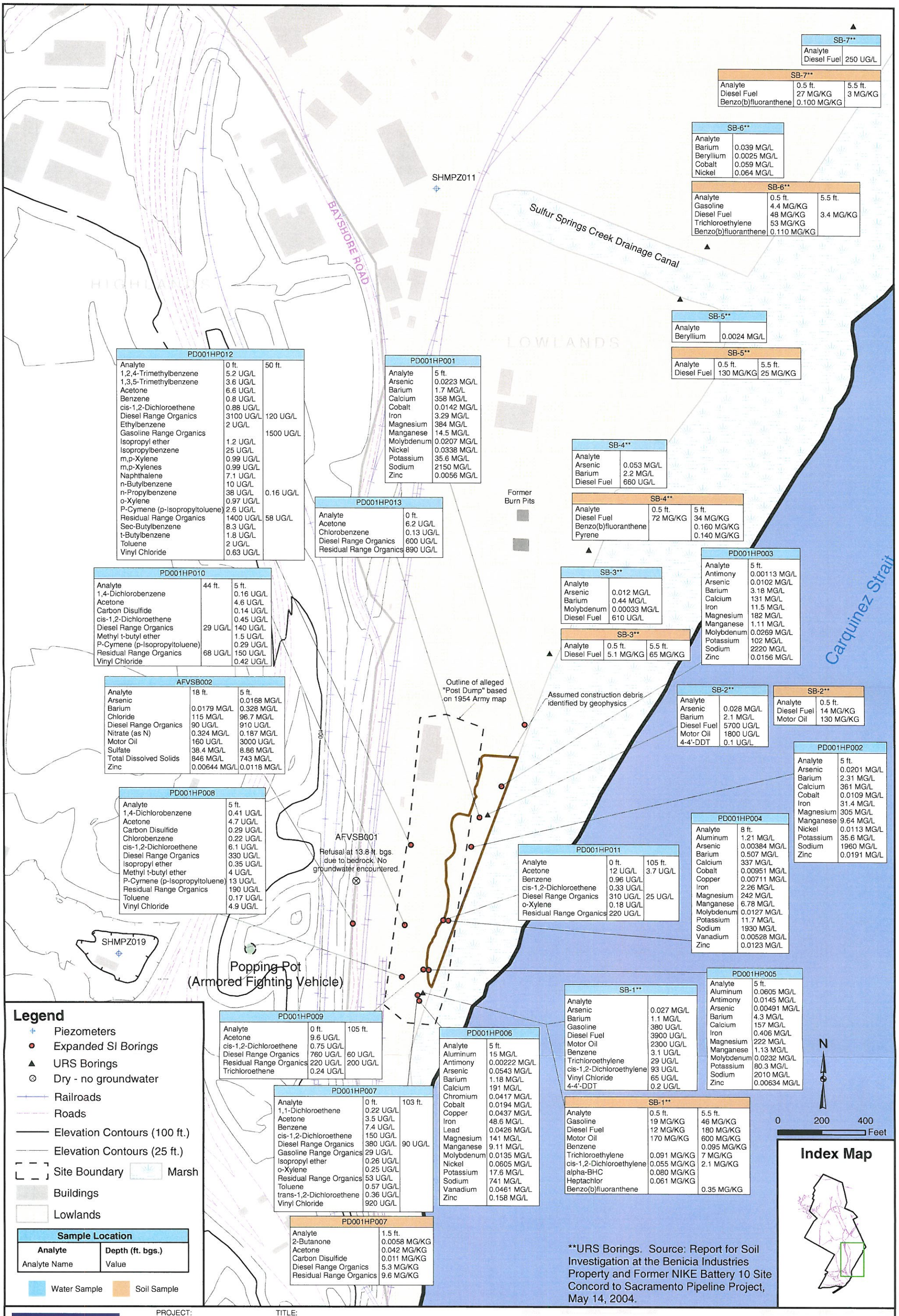
Analyte	Concentration (µg/L)	ESL (µg/L)
B168HP001	100	640
SWAMPBHP002	270	
B168HP003	170	
B168HP004	<23	
B168HP005	270	
B168HP006	140	
B168HP007	95	

ESL = Environmental Screening Level. Groundwater is not a current or potential drinking water source (RWQCB, 2005).
µg/L = micrograms per liter

Diesel fuel is delineated in shallow groundwater. An isoconcentration contour on Figure 6-4 shows the extent of the diesel fuel plume. Borings north of the plume with diesel fuel detections less than the MDL include SWAMPAHP007 and SWAMPAHP008. Borings to the west (SWAMPBHP001, B168HP004, and piezometer SHMPZ001) and east (B168HP002), of the plume define the extent of the shallow groundwater impact.

No further DoD action is indicated at Building 168 groundwater for the following reasons:

- Diesel fuel found in shallow groundwater near Building 168 has no known source area; and
- Concentrations do not exceed the ESL.



BROWN AND CALDWELL

PROJECT: 128336

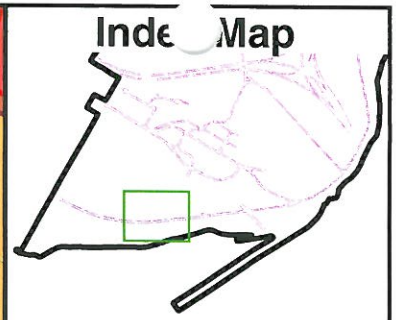
DATE: 3/6/2006

TITLE: **Sampling Locations and Detected Results at the Alleged "Post Dump"**

SITE: **Benicia Arsenal, Benicia, California**

Figure 6-5

S:\Benicia_expandedsi Addendum\Figure 6-5 Detected Results at Post Dumpsite.mxd



Legend

Sample Locations
- Non-Detections
- With Detections
- 270 Concentration in µg/L
- Dry - no groundwater
- Wells
- Area I boundary
- Lowland/Highland Boundary
- Storm Drains(1958) -arrows point in direction of flow
- Railroads
- Roads
- Elevation Contours (100 ft.)
- Elevation Contours (25 ft.)
- Buildings
- Lowlands
- Former Building

Concentration Contours
- 50 µg/L - 500 µg/L
- 500 µg/L - 5000 µg/L
- 5000 µg/L - 50000 µg/L
- > 50000 µg/L

Notes:
1- Unless otherwise noted, groundwater samples were collected at depths of > 15 ft bgs.

2 - All detected results are shown, including older data.

Figure 6-4

Diesel Fuel Detected in Shallow Groundwater Near Building 168

SITE:

Benicia Arsenal, Benicia, California

PROJECT: 128336

DATE: 3/1/2006

BROWN AND CALDWELL

S:\Benicia_expandedsi Addendum\Figure 6-4 Diesel Fuel B168.mxd

6.5 Alleged Post Dumpsite

No Further DoD Action is recommended at the Post Dumpsite

The alleged Post Dumpsite was reportedly in operation from 1940 through 1964 and located in the eastern side of the Arsenal (Figure 1-2). It is suspected that the disposal and burning of scrap lumber associated with the industrial area carpenter shops, and pilings and other waste material from repairs made to the Arsenal wharf were placed at this dumpsite. Thousands of gallons of gasoline were reportedly burned in pits at the north end of the site near Sulphur Springs Creek drainage canal (Figure 6-5). The majority of this information could not be substantiated; however, aerial photos and other interviews did substantiate the disposal of metal cleaning corrosives and the burning of scrap lumber in the pits. The area of the suspected dumpsite is the location of a reclaimed tideland with a high density of vegetation (see 1928 photo on Figure 3-1).

Previously, six borings (PD001HP001 through PD001HP006) were advanced and groundwater samples collected. The results are discussed in the *Expanded SI Report* (BC, 2005a).

Seven borings (PD001HP007 through PD001HP013) were advanced to determine the lateral extent of solvents, TPHD, TPHMO, and TPHG identified during the Expanded SI. The purpose of each boring is provided below:

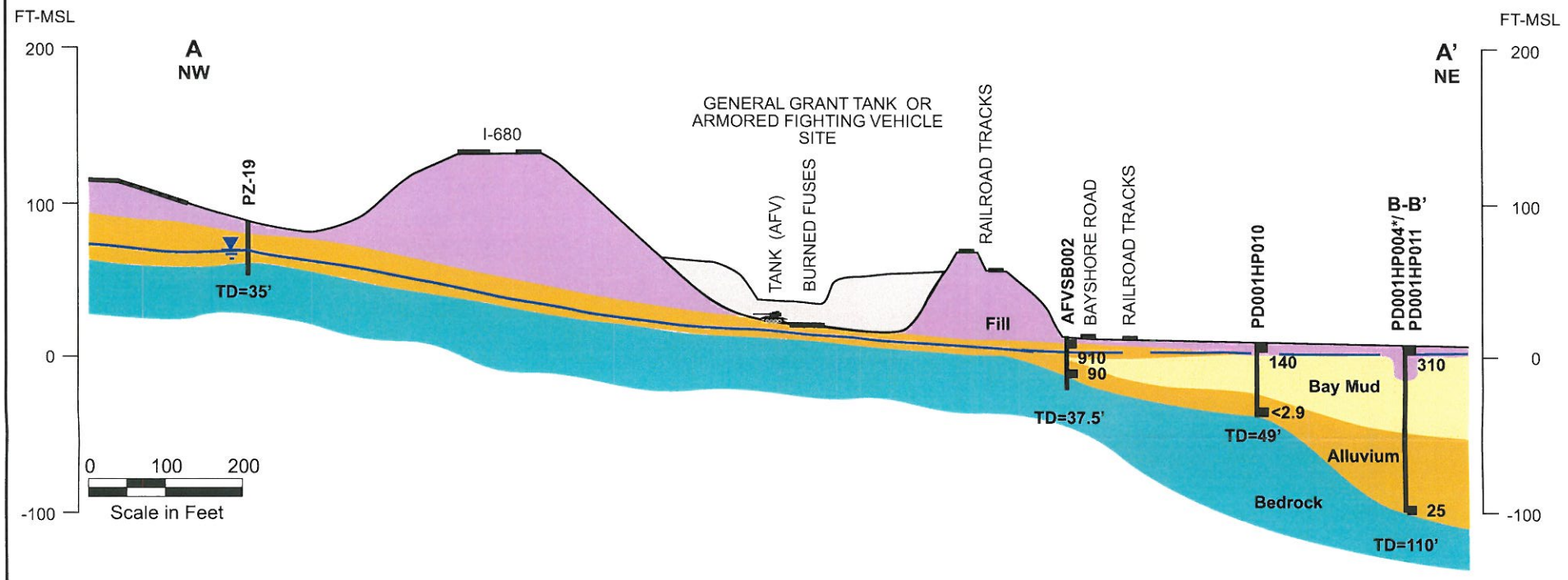
- PD001HP007 was drilled next to URS boring SB-1 to confirm solvents and fuels reported in soil and groundwater. PD001HP007 coincides with the location of Expanded SI boring PD001HP006. A historical soil sample collected by URS at 0.5-feet bgs reported TCE at 0.091 mg/kg and cis-1,2-DCE at 0.055 mg/kg. The deeper URS soil sample at 5.5-feet bgs reported higher concentrations of TCE (7 mg/kg) and cis-1,2-DCE (2.1 mg/kg) but the sample was likely saturated with groundwater. TCE and cis-1,2-DCE concentrations in shallow groundwater were 29 µg/L and 93 µg/L, respectively in the URS boring. Therefore, a soil sample at 1.5 to 2 feet bgs, above groundwater, and two samples from shallow and deep groundwater were collected during this field event.

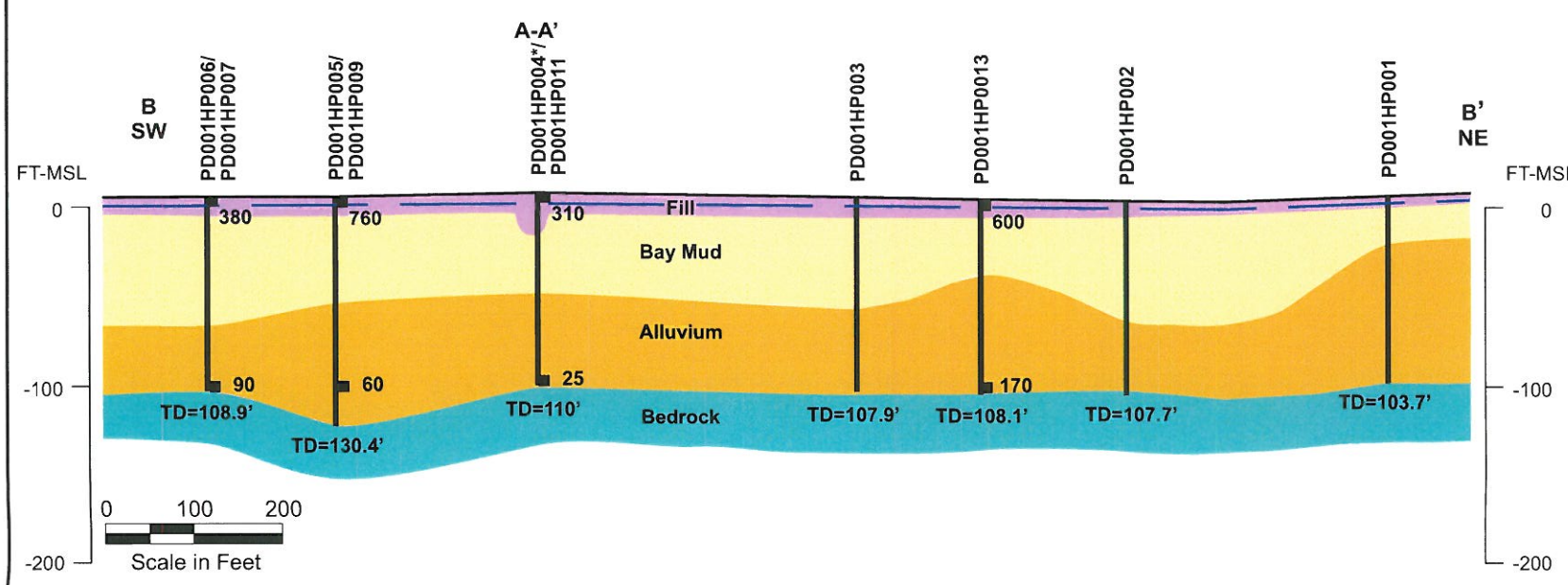
- PD001HP008 was advanced approximately 110-feet northwest of URS boring SB-1 to determine the lateral and vertical extent of fuels and solvents reported in groundwater at SB-1. A shallow groundwater sample was collected. Several attempts were made to collect a deep groundwater sample, but sufficient groundwater was not present; therefore a sample was not collected.

- PD001HP009 was advanced approximately 120-feet north-northeast of URS boring SB-1 and coincides with the location of Expanded SI boring PD001HP005 to determine the lateral and vertical extent of fuels and solvents reported in groundwater at SB-1.

- PD001HP010 was advanced approximately 240-feet east of Expanded SI boring AFVSB002 to determine the lateral and vertical extent of fuels in groundwater at AFVSB002 and solvents/fuels related to the alleged Post Dumpsite.

- PD001HP011 was advanced approximately 340-feet north-northeast of URS boring SB-1 and coincides with the location of Expanded SI boring PD001HP004 to determine the lateral and vertical extent of fuels and solvents reported in groundwater at SB-1.





Explanation

- **PZ-19** ⊕ Existing Piezometer Location
- **AFVSB001** ● Boring Location
- **Caltrans1** ▲ Approximate Soil Sample Locations Collected April 2002 and May 2002 (Environ Survey, 2002)
  Detected results are shown.
  Bolded values exceed ambient metals concentrations in soil.
- * PD001HP004 is located in a storm drain trench
- ■ **130** Diesel fuel range hydrocarbon concentration (ug/L)
- **TD=30** Total Depth, Feet Below Ground Surface
- Groundwater elevation (measured 11/26/02 and 11/07/04)
- — — Approximate groundwater elevation

Hydrostratigraphic Units	Geologic Units
Relatively Permeable Units	Bridge Expansion Fill (as of 11/02)
	Artificial Fill
	Alluvium -fining upwards sequences of silt to silty clay with some lenses of sand and clay
Relatively Non Permeable Units	Bay Mud - clays and sensitive fines
	Bedrock - (Sandstone, siltstone, and claystone)

Topographic contours as of 2002, prior to Benicia-Martinez Bridge Expansion Project. The landscape east and west of the I-680/I-780 interchange has dramatically changed with mostly cutting on the west side and filling to the east.

Figure 6-6
"Post Dump" and AFV Geologic Cross Sections with Diesel Fuel Concentrations in Groundwater
Expanded Site Inspection Addendum Report
Former Benicia Arsenal

- PD001HP012 was advanced approximately 690-feet north of URS boring SB-1 to determine the lateral and vertical extent of fuels and solvents reported in groundwater at SB-1.

- PD001HP013 was advanced next to URS boring SB-2 to confirm fuels reported in URS boring SB-2. Diesel fuel and motor oil were reported in shallow groundwater at 5,700 µg/L and 1,800 µg/L, respectively. The groundwater samples were also collected to determine the lateral and vertical extent of solvents reported at SB-1.

Figure 6-6 presents two geologic cross sections that include the alleged Post Dumpsite and the nearby AFV. These sections incorporate the lithology interpreted from the URS, the Expanded SI, the Expanded SI addendum, and the vertical resistivity surveys. Artificial fill covering the alleged Post Dumpsite consists of a mixture of gravelly sand to silty sand, approximately 2.5-feet to 10-feet thick. The marshland or Bay Mud is thinnest at the northern end (PD001HP001) approximately 20-feet thick to approximately 70-feet thick at PD001HP006. Below the marshland are sequences of silt and sand silts from 20-feet bgs to 130-feet bgs, where the top of the sandstone was encountered (PD001HP005).

Diesel fuel, motor oil, or vinyl chloride was reported above their respective groundwater RWQCB ESLs at PD001HP012 and PD001HP013 (Table 6-6). Data collected at URS borings SB-1 and SB-2 were not confirmed for all the analytes detected based on the similar samples collected near the same locations, PD001HP007 and PD001HP013, respectively. For example, TCE was reported in shallow groundwater at 29 µg/L in SB-1 but TCE was below MDLs at PD001HP007 while vinyl chloride was reported in both samples (65 µg/L in SB-1 and 920 µg/L in PD001HP007). Similar inconsistencies were found in comparing the soil results from the URS borings to this investigation. TCE reported in soil at SB-1 of 7 mg/kg was not confirmed at PD001HP007. TCE concentrations were below the MDL at 1.5 to 2 feet bgs in PD001HP007. Other occurrences were found for diesel fuel and motor oil. Therefore, it is difficult to understand how to use the URS data with the current data if the presence of constituents found during the URS investigation was not found during this investigation. Since there is such a discrepancy in the data sets, the most current data will be used to determine the impacts to soil and groundwater at the site.

TCE was found in shallow groundwater at PD001HP009 at concentrations of 0.24 µg/L, shown in Figure 6-7. No groundwater samples exceeded the TCE ESL of 360 µg/L. Groundwater samples containing cis-1,2 DCE were detected in six of the seven borings advanced (Table 6-6 and Figure 6-8) as shown on Figure 6-8, the highest concentration of cis-1,2 DCE is at the southern end of the alleged Post Dumpsite. Samples collected from PD001HP007 contained a concentration of 150 µg/L. No sample exceeded the RWQCB ESL in soil or groundwater.

Vinyl chloride was detected in shallow groundwater samples collected at PD001HP007 and PD001HP008. The RWQCB ESL in groundwater, 3.8 µg/L, was exceeded in samples collected at PD001HP007 (detected 920 µg/L) and in PD001HP008 (4.9 µg/L) as shown in Table 6-6.

Table 6-6. Fuels and Solvents in Soil and Groundwater at the Alleged Post Dumpsite

Boring Name	Depth (ft bgs)	Gasoline	Diesel fuel	Motor oil	Benzene	TCE	cis-1,2-DCE	VC
SB-1	0-0.5	19	12	170	<0.0055	0.091	0.055	ND
	5-5.5	46	180	600	0.095	**7**	2.1	ND
	GW (~5)	380	**3,900**	**2,300**	3.1	29	93	**65**
PD001HP007	1.5-2	<0.58	5.3	9.6	<0.00033	<0.0003	<0.00024	<0.0023
	0-5	29	380	53	7.4	<0.15	150	**920**
	103-108	<20	90	<32	<0.18	<0.15	<0.13	<0.25
SB-2	0-0.5	<1.1	14	130	<0.0053	<0.0053	<0.0053	ND
	GW (~5)	<50	**5,700**	**1,800**	<0.5	<0.5	<0.5	<0.5
PD001HP013	0-5	<20	600	**890**	<0.18	<0.15	<0.13	<0.25
	103-108	<20	170	<37	<0.18	<0.15	<0.13	<0.25
SB-3	0-0.5	<1.2	5.1	--	<0.0054	<0.0054	<0.0054	ND
	5-5.5	<2	65	--	<0.0087	<0.0087	<0.0087	ND
	GW (~5)	<50	610	--	<0.5	<0.5	<0.5	<0.5
SB-4	0-0.5	<1.2	72	--	<0.0052	<0.0052	<0.0052	ND
	4-5	<1.2	34	--	<0.0053	<0.0053	<0.0053	ND
	GW (~5)	<50	**660**	--	<0.5	<0.4	<0.5	<0.5
SB-5	0-0.5	<1.1	130	--	<0.0052	<0.0052	<0.0052	ND
	5-5.5	<1.6	25	--	<0.007	<0.007	<0.007	ND
	GW (~5)	NR	NR	NR	NR	NR	NR	NR
SB-6	0-0.5	4.4	48	--	<0.0052	**53**	<0.0052	ND
	5-5.5	<1.1	3.4	--	<0.0058	<0.0058	<0.0058	ND
	GW (~5)	NR	NR	NR	NR	NR	NR	NR
SB-7	0-0.5	<1.1	27	--	<0.0052	<0.0052	<0.0052	ND
	5-5.5	<1.3	3	--	<0.0058	<0.0058	<0.0058	ND
	GW (~5)	NR	250	NR	NR	NR	NR	NR
PD001HP008	5-10	<20	330	190	<0.18	<0.15	<0.17	**4.9**
PD001HP009	0-5	<20	**760**	220	<0.18	0.24	0.75	<0.25
	105-110	<20	60	200	<0.18	<0.15	<0.13	<0.25
PD001HP010	5-10	<20	29	68	<0.18	<0.15	0.45	0.42
	44-49	<20	140	150	<0.18	<0.15	<0.13	<0.25
PD001HP011	0-5	<20	310	220	0.96	<0.15	0.33	<0.25
	105-110	<20	25	<30	<0.18	<0.15	<0.13	<0.25
PD001HP012	0-5	<20	**3,100**	**1,400**	0.8	<0.15	0.88	0.63
	50-55	**1,500**	120	58	<0.18	<0.15	<0.13	<0.25
RWQCB ESL	Soil	400	500	1,000	0.38	0.73	3.6	0.019
	GW	500	640	640	46	360	590	3.8

Source: Report for Soil Investigation at the Benicia Industries Property and Former Nike Missile Battery 10 Site, Concord to Sacramento Pipeline Project by URS Corporation, May 14, 2004. Results are qualified in the URS report but are not carried forth in the table above for brevity. The complete tables are provided as an appendix in the *Expanded SI Report* (BC, 2005a).

Soil concentrations in mg/kg.

Groundwater concentrations in µg/L.

Bolded values exceed their respective ESLs.

cis-1,2-DCE = cis-1,2-dichloroethene

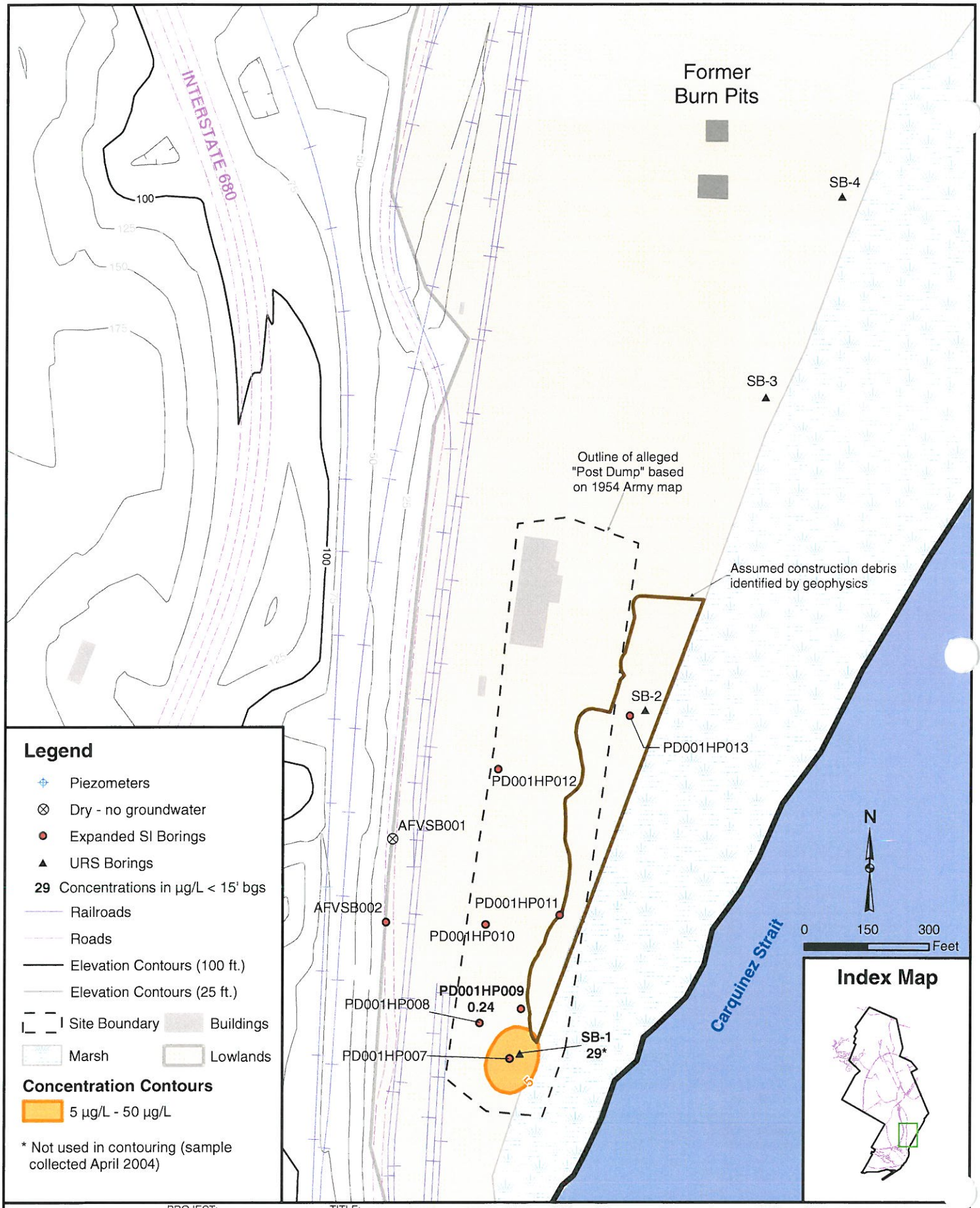
ESL = Environmental Screening Level (RWQCB, 2005). ESL values for soil are for shallow soils (<3 meters bgs) and commercial/industrial land use. Groundwater ESLs correspond to groundwater that is not a current or potential source of drinking water.

ND – not detected

NR – Concentrations not reported in the URS report.

TCE = trichloroethene

VC = vinyl chloride



BROWN AND CALDWELL

PROJECT: 128336

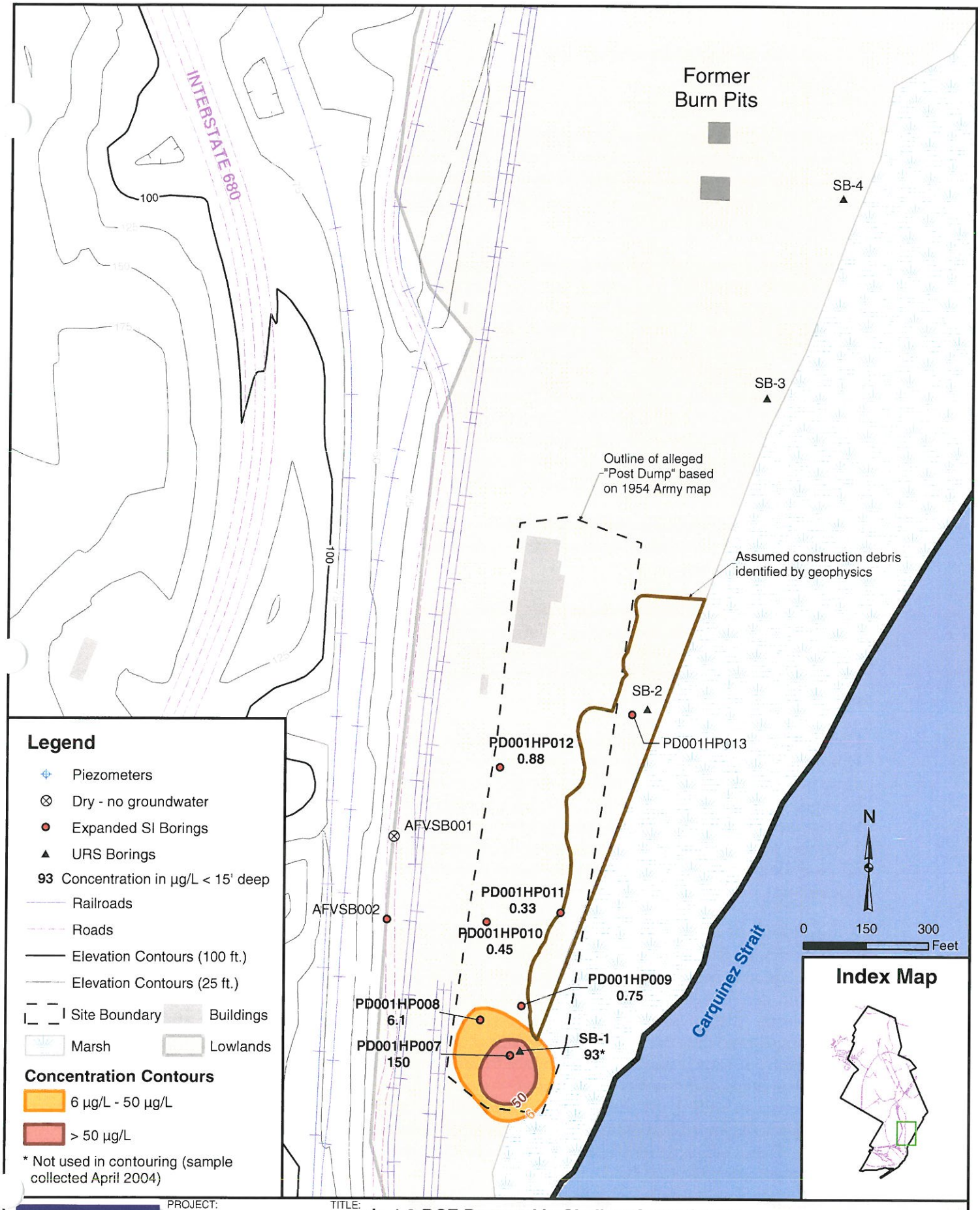
DATE: 3/9/2006

TITLE: **TCE Detected in Shallow Groundwater at the Alleged "Post Dump"**

SITE: **Benicia Arsenal, Benicia, California**

Figure 6-7

S:\Benicia_expandedsi Addendum\Figure 6-7 Post Dumpsite TCE.mxd



BROWN AND CALDWELL

PROJECT: 128336

DATE: 3/9/2006

TITLE: **cis-1,2-DCE Detected in Shallow Groundwater at the Alleged "Post Dump"**

SITE: **Benicia Arsenal, Benicia, California**

Figure 6-8

S:\Benicia_expandedsi Addendum\Figure 6-8 Post Dumpsite cis-1,2-DCE.mxd

Petroleum hydrocarbons were also detected in soil and groundwater samples collected. Shown in Table 6-6, soil concentrations of gasoline, diesel fuel, and motor oil were all below their respective ESLs. Only one location PD001HP012 contained gasoline above the ESL in groundwater. The deep groundwater sample (50-55 feet bgs) contained 1,500 µg/L of gasoline, above the ESL of 500 µg/L and is shown on Figure 6-9.

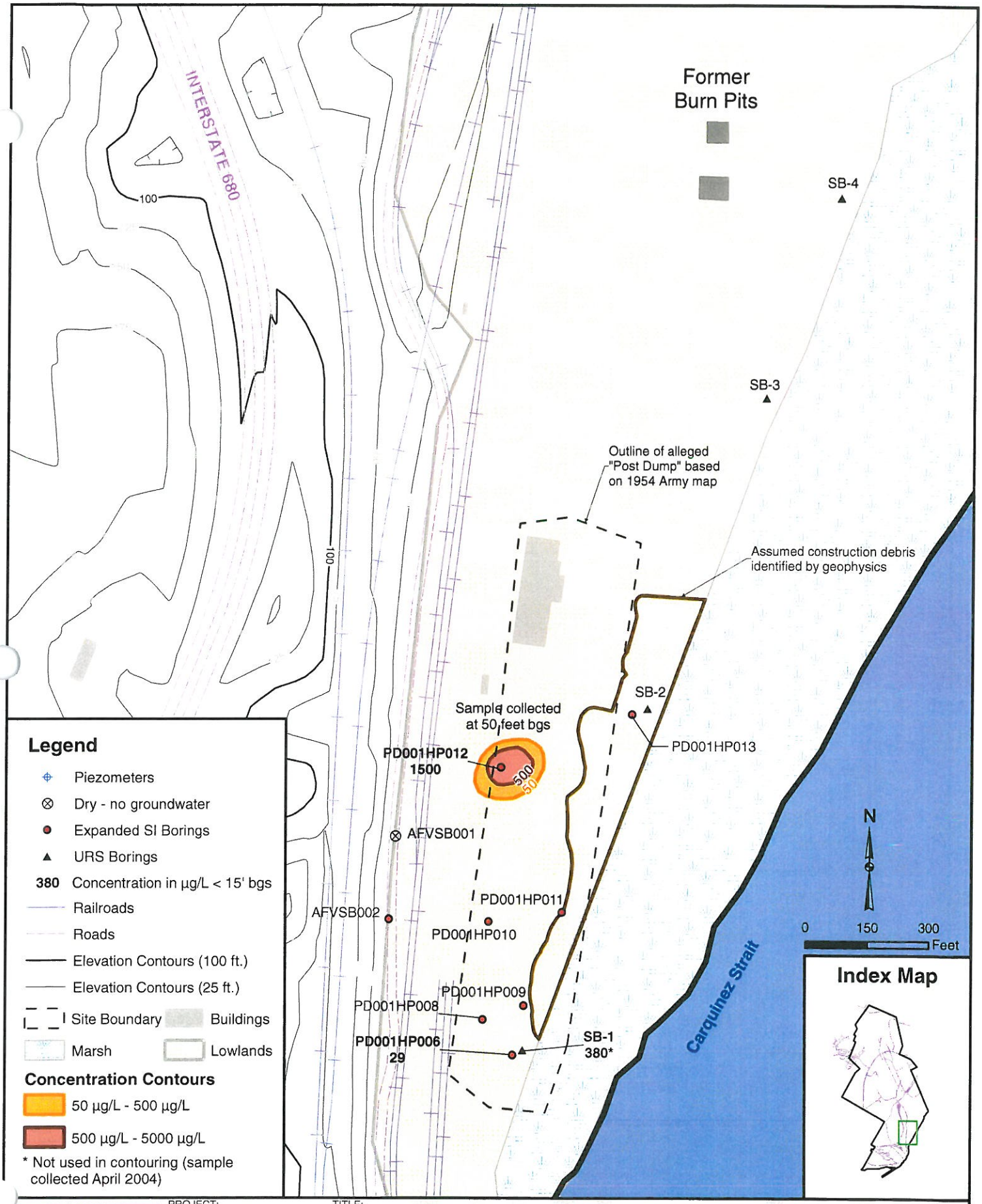
Diesel fuel and motor oil were detected in groundwater in all borings sampled and is shown graphically for diesel fuel on Figure 6-10. Five samples contain diesel fuel and motor oil above their respective groundwater ESLs of 500 and 1,000 µg/L as shown in Table 6-6, diesel fuel was detected at: 3,900 µg/L in SB-1, 5,700 µg/L in SB-2, 660 µg/L in SB-4, 3,100 µg/L in PD001HP012, and 760 µg/L in PD001HP009. Motor oil was detected at: 2,300 µg/L in SB-1; 1,800 µg/L in SB-2; 890 µg/L in PD001HP013; and 1,400 µg/L in PD001HP012. Diesel fuel and motor oil concentrations in SB-1 were much higher than concentrations reported at PD001HP007. Diesel fuel and motor oil concentrations were reported at 90 µg/L and less than 32 µg/L, respectively at PD001HP007. The data at SB-1 was not used in developing the isoconcentration contours presented on Figure 6-10 because the more recent data was used (PD001HP007). Similar discrepancies were reported at SB-2 and PD001HP013 (Figure 6-10).

The geophysical investigation determined wastes are not buried at the alleged Post Dumpsite. The data is interpreted to consist of silts and sands, probably represents fill material, as well as clay and/or marsh deposits.

The presence of breakdown products (cis-1,2-DCE and vinyl chloride) indicate that aerobic and anaerobic biodegradation is occurring. The clays provide a conducive environment for the anaerobic biodegradation and the presence of hydrocarbons are inducing an aerobic degradation. The fate of the remaining dissolved VOCs in groundwater to complete biodegradation is very optimistic.

Diesel range hydrocarbons are present throughout the shallow groundwater at the alleged Post Dumpsite, although the source is not known. If the Army did use a fuel, like diesel, to ignite the scrap lumber in the burn pits, then diesel range hydrocarbon concentrations in groundwater would be expected the greatest in that area, near URS borings SB-3 and SB-4, but that is not the case. The highest diesel range hydrocarbon concentrations were reported at PD001HP012, approximately 1,500 feet south of the burn pits. Additionally, the area of distribution covers the reclaimed tideland. Because there appears to be no source area for the diesel range hydrocarbons, further research was performed.

A hypothesis was developed to prove or disprove that the petroleum hydrocarbons reported in groundwater are from the natural degradation of biogenic compounds in the highly vegetated tideland buried beneath the pavement. Review of these data by a forensic specialist, Friedman & Bruya, Inc. determined that there appears to be hydrocarbons present that are likely due to a release of petroleum. Also present were a number of compounds that are either degradation products of petroleum, compounds that come from biological organisms that degrade petroleum or compounds that come from natural sources. The amount of each compound could not be quantified because the holding times of the sample had expired. Based on the wide aerial distribution of petroleum hydrocarbons identified, the absence of a source and the knowledge that the area is a covered tideland, it is presumed that natural sources is likely the predominant fraction reported in the samples. Diesel range hydrocarbons may be present but maybe only in the locations of highest concentration, like PD001HP012.



BROWN AND CALDWELL

PROJECT: 128336

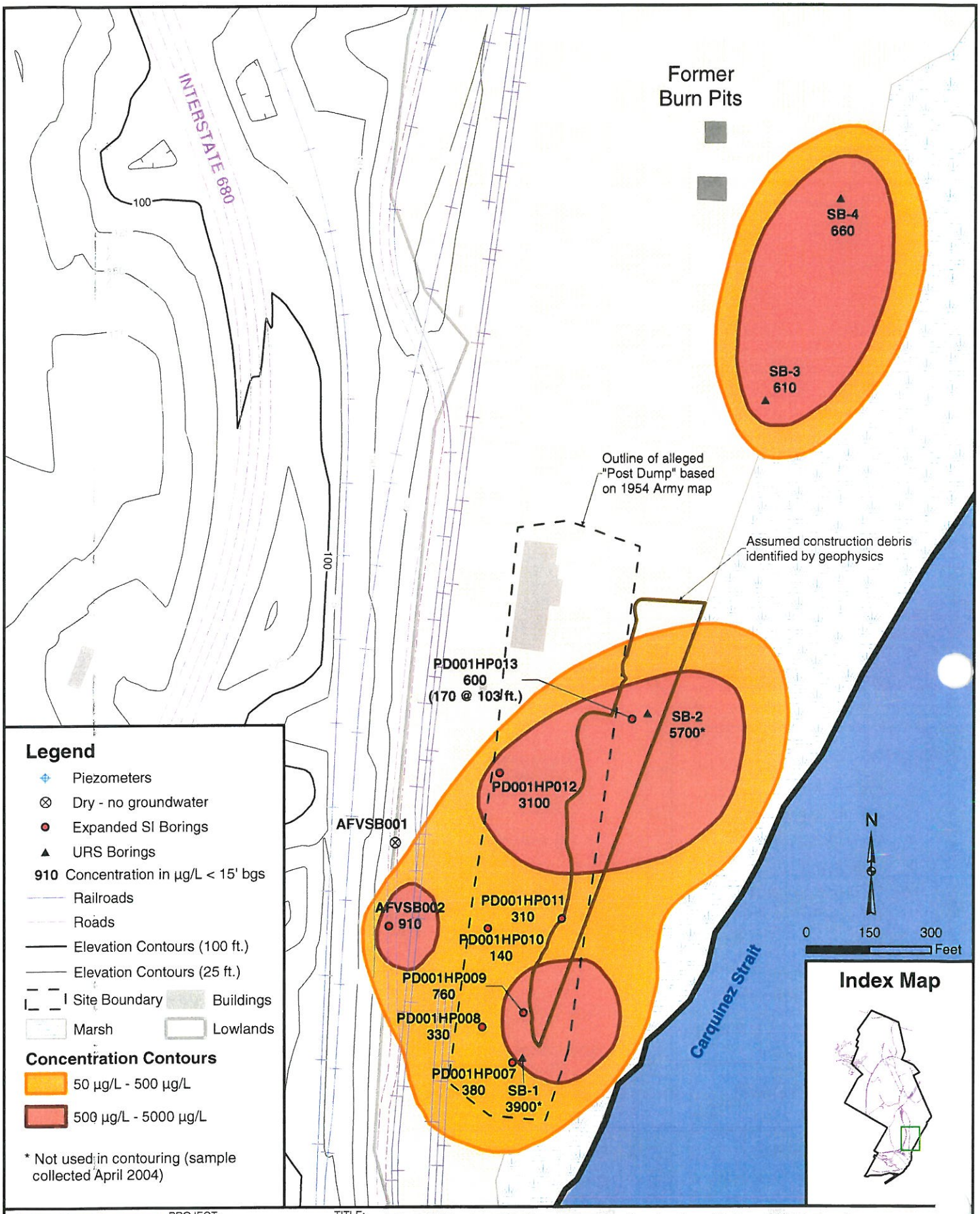
DATE: 3/9/2006

TITLE: **Gasoline Detected in Shallow and Deep Groundwater at the Alleged "Post Dump"**

SITE: **Benicia Arsenal, Benicia, California**

Figure 6-9

S:\Benicia_expandedsi Addendum\Figure 6-9 Post Dumpsite Gasoline.mxd



BROWN AND CALDWELL

PROJECT: 128336

DATE: 3/9/2006

TITLE: Diesel Range Hydrocarbons (Including Natural Sources) Detected in Shallow Groundwater at the Alleged "Post Dump"

SITE: Benicia Arsenal, Benicia, California

Figure 6-10

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The finding of 3,100 µg/L diesel range organics is unusual due to the limited water solubility of the compounds that make up diesel or similar petroleum products. Because of this, the 3,100 µg/L result is likely due to material that is not soluble in water. This non-water soluble material may exist as a sheen that is present on the surface of the water analyzed by the laboratory or to suspended particulates that are covered with non-water soluble petroleum and which are suspended in the water sample. If one settles and filters or centrifuges the sample prior to analyses, it is possible to determine if the diesel range organics are actually dissolved in the water sample. Settling and filtering or centrifuging will remove non-water soluble material and subsequent testing will provide a measure of the material that is actually dissolved in the water sample.

If it is found that material is actually dissolved in the water, it can come from two sources. It may be due to petroleum compounds that are dissolved in the water sample. If so, they will be PAH compounds like phenanthrene which can be identified using a GCMS 8270 analysis. If the dissolved material does not consist of PAHs, it is likely due to natural organics.

There are low levels of diesel range hydrocarbons present in deeper groundwater (within the alluvium below the Bay Mud) at concentrations less than 200 µg/L (Figure 6-6).

There is no known Army source of the petroleum hydrocarbons or the parent chemical for cis-1,2-DCE (TCE or PCE). Additionally, the lack of the parent solvent in groundwater indicates that there is no source. Therefore, no further DoD action is recommended.

6.6 Popping Pot (also known as the Armored Fighting Vehicle)

The AFV is located east of the alleged Post Dumpsite in low-lying hills (Figure 1-2). The AFV is a World War II era General Grant type tank that was gutted then modified for use as a "popping pot" to destroy unserviceable ordinance. The tank turret was removed and the tank hull was modified to be used as a furnace. A conveyor belt was constructed to feed ordnance to the furnace and a small fuel line supplied diesel fuel to keep the furnace burning. The diesel fuel was likely supplied by a nearby above ground tank a short distance up hill from the AFV.

Access restrictions and site conditions forced the investigation away from the Popping Pot (or AFV). Fuels reported in groundwater are attributed to the area of the Post Dumpsite.

Two CPT borings (AFVSB001 and AFVSB002) were advanced approximately 300 feet downgradient of the AFV. Groundwater samples were analyzed for metals, explosives, and petroleum hydrocarbons. Results are summarized in the *Expanded SI Report* (BC, 2005a).

Diesel fuel and motor oil were present in the deeper groundwater sample collected at the AFV. At the time of the borings, it was unknown if the source of the diesel fuel could be the alleged Post Dumpsite. As discussed in the previous section, petroleum hydrocarbons are present in groundwater in the area of the alleged Post Dumpsite. The source in unknown but is likely from natural sources. The petroleum hydrocarbons found at AFVSB002 is from the area of the alleged Post Dumpsite and not from the AFV. Therefore, no further investigation at AFV is recommended.

SECTION 7
CONCLUSIONS AND RECOMMENDATIONS

The Expanded SI recommended further investigation at nine sites because contaminants were not fully delineated and two sites were added to the investigation. This addendum to the Expanded SI presented data from six of those sites. Three sites could not be investigated (former Building 58(A), CL2, and the former septic tank at Building 194) because the landowners would not grant access to USACE and two sites (Building 27 UST and Building 161 UST) were investigated as part of the *Fuel Storage Tank Removal Action Addendum* (BC, 2006). Results for the six sites investigated in this addendum are summarized below.

7.1 Summary of Conclusions

- No significant DoD impact was reported at former drum storage area (Building 51) (Section 6.1).

- No significant impact was reported in soil gas from the underlying solvent-containing groundwater at the former locomotive building (Building 90) (Section 6.2).

- No significant DoD impact was reported at Building 101 (Section 6.3).

- No source or significant impact was reported at Building 168 (Section 6.4).

- TCE, cis-1,2-DCE and vinyl chloride were reported by another consultant to be present in groundwater at the alleged Post Dumpsite (Section 6.5). TCE was not detected in groundwater during this investigation, but the other signs of degradation, cis-1,2-DCE and vinyl chloride were present in a localized area. Biodegradation is occurring and is likely to continue. Diesel fuel and motor oil range hydrocarbons were reported in all of the shallow groundwater samples but a forensic analysis of the data indicated that a fraction of the result is due to natural sources.

- The diesel fuel and motor oil present in groundwater, approximately 300 feet downgradient of the AFV (Section 6.6) is not from the AFV but attributed to the area of the alleged Post Dumpsite.

7.2 Recommendations – Additional Activities

Based on the findings of this investigation, suspected DoD and non-DoD sources appear to have impacted soil gas at Building 90. No further investigation is recommended at the former drum storage area (Building 51), former locomotive building (Building 90), and the former battery charge building (Building 101). However, a risk evaluation is recommended for all these sites.

Access restrictions to the AFV are preventing any additional investigation to determine if there is any impact to soil from residues left because of former Army activities.

7.3 Recommendations – No DoD Action Indicated (NDAI)

FUDS policy outlines four categories of NDAI (I, II, III, and IV). A Category I NDAI decision applies to the Preliminary Assessment (PA) process. Sites are classified as Category I NDAI where USACE has determined that the hazards found were not attributable to DoD. Sites that continue through the CERCLA process could be designated as Category II (after SI efforts), Category III (after Remedial Investigation/Feasibility Study or Engineering Evaluation/Cost Analysis efforts) and Category IV (after Removal Action [RA] efforts) NDAI decisions.

For the sites included in this report, a Category II NDAI determination is based on the following criteria:

- the source can not be attributed to DoD activities,
- metals concentrations in soil are below ambient or ESLs concentrations,
- soil and groundwater concentrations are less than ESLs or MCLs based on the location of the site, whether it is located in the lowlands or the highlands, and
- the only detected chemicals cannot be attributed to a DoD source (e.g. MtBE, Kinder Morgan fuel pipeline).

A summary of recommendations for Category II NDAI and additional activities are listed in Table 7-1.

Table 7-1. Summary of Recommendations for the Expanded SI Addendum Sites

Site	DoD Use	DoD Activity	Recommendation
51	Stable/ Maintenance	Maintenance	Risk Assessment
90	Locomotive Building	Repair/ Maintenance	Risk Assessment
101	Battery Charge Building	Steam cleaning battery cases	Risk Assessment
168	Bar Stock Building/Storage/Vehicle Shop for Motor Pool	Maintenance	NDAI
Popping pot (aka AFV)	Incineration	Disposal	Access restrictions prevent any additional investigation to determine if there is any impact to soil from residues left due to former Army activities.
Post Dumpsite	Dump	Disposal	NDAI

SECTION 8
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