Final

Phase IV
Field Sampling Plan

University of California, Berkeley
Richmond Bay Campus
Former Richmond Field Station Site
Richmond, California

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Prepared for
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ACRONYMS AND ABBREVIATIONS

µg/L	Micrograms per liter
µrem/hr	Microrems per hour
AGI	Amplified Geochemical Imaging
AST	Aboveground storage tank
BAPB	Biologically active permeable barrier
Bay Trail	East Bay Regional Parks District's Bay Trail
BCDC	San Francisco Bay Conservation and Development Commission
bgs	Below ground surface
CCR	Current Conditions Report
CRM	Cultural resource monitor
CSM	Conceptual site model
DQO	Data quality objective
DTSC	Department of Toxic Substances Control
Eco-SSL	Ecological soil screening level
EPA	U.S. Environmental Protection Agency
ERA	Ecological risk assessment
ETA	Eastern Transition Area
FSP	Field Sampling Plan
FSW	Field Sampling Workplan
H_2S	Hydrogen sulfide
HASP	Health and Safety Plan
HHRA	Human health risk assessment
IDW	Investigation-derived waste
ISM	Incremental sampling methodology
LRDP	Long Range Development Plan
MCL	Maximum Contaminant Level
MFA	Mercury fulminate area
NOS	Natural Open Space
NGVD	National Geodetic Vertical Datum
Order	Site Investigation and Remediation Order No. IS/E-RAO 06/07-004 for the Richmond Field Station
ORNL	Oak Ridge National Laboratory
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethylene
PID	Photoionization detector
QAPP	Quality Assurance Project Plan
QC	Quality control
RAW	Remedial Action Workplan
RBC	Richmond Bay Campus

ACRONYMS AND ABBREVIATIONS (Continued)

RES	Research, Education, and Support
RFS	Richmond Field Station
RI/FS	Remedial Investigation/Feasibility Study
RSO	Radiation Safety Office
SCR	Site Characterization Report
SVOC	Semivolatile organic compound
TCE	Trichloroethylene
TDS	Total dissolved solids
TPH-e	Total extractable petroleum hydrocarbons
TPH-p	Total purgeable petroleum hydrocarbons
UC	University of California
VOC	Volatile organic compound
WTA	Western Transition Area

1.0 PROJECT DESCRIPTION

On May 15, 2014, The Regents of the University of California (UC) approved establishment of a new major research facility on properties it owns in Richmond, California, composed of portions of the Former Richmond Field Station (RFS) and the Regatta Property west of the Former RFS (see Figure 1). The Richmond Bay Campus (RBC) will provide for development of additional research facilities for both UC Berkeley and the Ernest Orlando Lawrence Berkeley National Laboratory for academic teaching, applied research, and collaborations with private industry focused on energy, environment, and health. The RBC Long Range Development Plan (LRDP) (UC 2014) identifies the developable portion of the new campus as Research, Education, and Support (RES), and the remainder as Natural Open Space (NOS). Locations of the RBC and RES and NOS land uses are shown on Figure 2.

UC Berkeley has been conducting investigation and cleanup actions at the Former RFS under oversight of the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), in compliance with the Site Investigation and Remediation Order, Docket No. IS/E-RAO 06/07-004 for the Richmond Field Station (RFS Order), dated September 15, 2006. The RFS Order provides for investigation and cleanup of 96 acres of upland and 13 acres of tidal marsh and transition habitat within the Former RFS Site.

The property defined under the RFS Order is referred to as the "Former RFS Site," "Former RFS," or "Site." The Former RFS Site does not encompass the entire RFS; two outboard parcels located off shore are not included in the RFS Order. Also, the Regatta Property, which is included in the RBC, is not included in the RFS Order. Figure 1 shows the Former RFS Site in relation to the RBC, Regatta Property, and outboard parcels.

In response to the RFS Order, UC Berkeley prepared multiple planning and reporting documents. The Final Current Conditions Report (CCR), dated November 21, 2008, included a comprehensive summary of current conditions and data gaps at the Former RFS (Tetra Tech, Inc. 2008). The Final Field Sampling Workplan (FSW) identified a phased-sampling strategy to address data gaps identified in the CCR (Tetra Tech 2010). Phases I, II, and III have been completed, and results are presented within the Final Site Characterization Report (SCR) for the RES and groundwater within the Former RFS (Tetra Tech 2013a). As a follow-up to recommendations within the SCR, UC Berkeley published the Final Removal Action Workplan (RAW) identifying the selected cleanup remedy and final actions for areas designated for RES and for groundwater within the Former RFS (Tetra Tech 2014a), and thereby documenting completion of Phases I, II, and III (Tetra Tech 2013a). Phases IV and V will address remaining data gaps identified in the CCR or subsequent investigations within the areas designated as NOS. This field sampling plan (FSP) presents the scope of Phase IV activities.

The scope of Phase IV was based on data gaps identified in the CCR; data collected during Phase I, II, and III events; and additional discussions with DTSC. Figure 3 shows locations of Phase IV activities consisting of:

- Soil sampling in the Upland meadows designated as NOS (Big Meadow, EPA Meadow North, and West Meadow) to determine if historical industrial and commercial activities have impacted soil conditions
- Exploratory excavation in the Bulb, within the Western Transition Area (WTA) to identify a source of the magnetic anomaly reported in a 2006 magnetometer survey

- Soil gas sampling to attempt to identify the source of carbon tetrachloride contamination in shallow groundwater at piezometer CTP in the Big Meadow to follow up previous investigations
- Placement of additional piezometers along the border of the Eastern Transition Area (ETA) and within the remediated portion of Western Stege Marsh, and west of the Biologically Active Permeable Barrier (BAPB), to evaluate groundwater in the vicinity of the BAPB

This FSP describes the site history and previous investigations, purpose of the investigation, and data quality objectives for all proposed Phase IV activities. This FSP also describes the process, design and sampling methods of soil sampling in the Upland meadows, and of soil gas sampling within the carbon tetrachloride area, and the installation of piezometers and groundwater monitoring within the BAPB area. Details of the Bulb exploratory excavation will be included as an addendum to this FSP, with appropriate DTSC review and approval.

1.1 PHYSICAL SETTING

The Site is at 1301 South 46th Street, Richmond, California, along the southeastern shoreline of the City of Richmond on the San Francisco Bay and northwest of Point Isabel (see Figure 1). It consists of upland areas developed for academic teaching and research activities, an upland remnant coastal terrace prairie, a tidal salt marsh, and a transition zone between the upland areas and marsh. Between the late 1800s and 1948, several companies, including the California Cap Company, manufactured explosives at the Site. In 1950, The UC Regents purchased the property from the California Cap Company. UC Berkeley initially used the RFS for research for the College of Engineering; later, it was also used by other campus departments.

The RBC LRDP (UC 2014) identifies the developable portion of the new campus as RES and the remainder as NOS. Locations of the RBC and RES and NOS land uses are shown on Figure 2.

The RBC LRDP, approved by The UC Regents on May 15, 2014, describes the long-term development plan for the RBC (UC 2014); the Former RFS Site constitutes a portion of the Richmond Bay Campus. In the LRDP, two land uses are defined: RES and NOS (Figure 2). Of land within the boundaries of the Former RFS Site, the NOS consists of 26.2 acres and the RES encompasses 82.5 acres of developable property. The selected remedy for the portions of the Site designated for RES and for groundwater within the Site is presented in the Final RAW (Tetra Tech 2014a). Phase IV focuses primarily on the portions of the Site designated as NOS.

This FSP includes investigations at three areas at the Former RFS Site (see Figure 4):

1) The Upland Area consists of 96 acres of land bounded by Meade Street to the north, South 46th Street to the east, the Transition Area to the south, and Meeker Slough and Regatta Boulevard to the west (see Figure 2; Figure 4).
2) The Transition Area, made up of the WTA and ETA, occupies approximately 5.5 acres and is bounded to the north by the Upland Area at the location of a buried, former seawall believed to have been the edge of the historical mudflats; and to the south by Western Stege Marsh at the 5-foot elevation upper extent of the marsh (National Geodetic Vertical Datum [NGVD] 29). The Transition Area is believed to consist entirely of artificial fill placed on historical mudflats.

3) The Western Stege Marsh, including the original marsh and remediated portion, occupies approximately 7.5 acres, and is bounded by the Transition Area to the north, the RFS connector trail to the East Bay Regional Park District Bay Trail (Bay Trail) and Eastern Stege Marsh to the east, the Bay Trail to the south, and Meeker Slough and Marina Bay housing development to the west.

The Site includes a number of distinct and varied habitats resulting from both natural and human activities. The Upland Area hosts numerous research facilities with associated out-buildings surrounded by landscaped trees and plants. The eastern and central portions of the Upland Area are largely developed with few natural ecological conditions present. The western portion of the Upland Area contains one of the largest and best-preserved areas of native coastal grasslands within the Big Meadow – grasslands once prevalent throughout the San Francisco Bay Area (see Figure 4).

The Transition Area and southern portion of the West Meadow consist of mainly coastal scrub and mixed ruderal scrub. Most of the coastal scrub habitat in the Transition Area is disturbed and intermixed with non-native invasive grasses and forbs.

The southern portion of the Site is the least developed and consists of a low salt marsh, middle salt marsh, high salt marsh, and tidal wetlands. Plants include both native and non-native species, and attract a variety of special-status species birds such as the California clapper rail (*Rallus longirostris obsoletus*).

1.2 INVESTIGATION PURPOSE

Section 5.3.1 of the Order required preparation of a FSW to conduct site investigations to address data gaps identified in the CCR that warrant additional characterization or evaluation. The FSW specified five phases of field investigations to address these data gaps (Tetra Tech 2010). The FSW is a site-wide document covering all investigation phases and a site-wide project background, objectives, conceptual site model (CSM), schedule for investigating the Site, a Quality Assurance Project Plan (QAPP), and a facility-wide Health and Safety Plan (HASP). An updated CSM, including results from the FSP Phase I through III investigations, is included in the SCR (Tetra Tech 2013a).

The FSW also serves as the FSP for Phase I, a site-wide groundwater investigation, conducted from 2010 to 2012. The Phase I FSW field effort consisted of installation and sampling of 51 piezometers throughout the Site (see Figure 5), as well as semi-annual groundwater monitoring of the piezometers in 2011 and 2012. Since 2012, annual site-wide groundwater monitoring has been conducted in the spring. Data acquired from the installed and developed piezometers — including chemical results from groundwater samples, geological information, and depth to water measurements — were referenced to develop a hydrogeologic model of the Site, and to improve understanding of overall site-wide groundwater quality.

Phase II investigated soil conditions at current and former transformer locations, the Corporation Yard along the eastern property boundary, and aboveground storage tanks (AST).

Phase III consisted of further delineation of mercury in the mercury fulminate area (MFA); characterization of soils in the former Dry House explosion area, Building 128, and Building 201 soil mounds; grab groundwater sampling for further delineation of carbon tetrachloride near piezometer CTP; and additional delineation of polychlorinated biphenyl (PCB) contamination in the transformer and Corporation Yard areas.

The scope of the Phase IV FSP is consistent with the phased approach to the site-wide investigation presented in the FSW, and addresses identified data gaps as well as areas identified by DTSC as needing further investigation:

- Soil investigations in the Upland meadows consisting of the Big Meadow, EPA Meadow North, and the West Meadow
- Exploratory excavation to investigate the magnetic anomaly in the Bulb within the WTA
- Additional sampling to identify a possible source of the carbon tetrachloride detected in shallow groundwater (approximately 20 feet below ground surface [bgs]) in the carbon tetrachloride area
- Further characterization of groundwater in the vicinity of the BAPB

The areas proposed for Phase IV sampling are shown on Figure 3, and described below. A complete discussion of these areas appears in Section 2.2, Previous Investigations.

- <u>Big Meadow, EPA Meadow North, and West Meadow.</u> These Upland meadows designated as NOS, with a combined acreage of 15.6 acres, are composed of disturbed, undeveloped coastal terrace prairie and non-native grasslands habitat. As proposed in the RBC LRDP (UC 2014), these areas will remain undeveloped and protected as open space habitat. Soil sample results will be used to evaluate the soil and evaluate potential risks to human and ecological receptors.
- <u>The Magnetic Anomaly.</u> The magnetic anomaly identified in the Bulb is within the WTA and within fill placed on mudflat adjacent to the Western Stege Marsh. In November 2005, a former RFS employee alleged that drums containing ore-like materials had been buried in the Bulb in the late 1960s (Tetra Tech 2008). The former employee claimed he had been told to avoid handling the materials because they were allegedly radioactive. In response to this information, DTSC conducted a magnetometer survey of the Bulb in 2006, and discovered a magnetic anomaly approximately 170 feet south-southwest of the concrete-lined pad (identified as 'impoundment' on Figure 6) indicating possible presence of buried ferrous metal material at the location of the anomaly. The purpose of the exploratory excavation is to determine the source of the detected magnetic anomaly. No removal of drums is anticipated during the exploratory investigation. If drums are discovered, samples of the drum contents, if accessible, may be collected and characterized through submittal of samples to an analytical laboratory and through use of real-time radiation detection instrumentation.
- <u>Carbon Tetrachloride Area.</u> The carbon tetrachloride area is within the Upland Area portion of the Site in the Big Meadow. Carbon tetrachloride was detected at concentrations exceeding drinking water standards in all shallow groundwater samples collected from piezometer CTP, screened between 7 and17 feet bgs, as well as during subsequent, ongoing yearly monitoring (Tetra Tech 2013b). An evaluation of groundwater sampling data did not identify immediate or potential threats to human health or the environment; however, continued seasonal monitoring confirmed elevated concentrations of carbon tetrachloride in groundwater samples collected from piezometer CTP (Tetra Tech 2012; 2013a, 2013b). Grab groundwater samples collected during the FSP Phase III field investigation indicated presence of carbon tetrachloride near piezometer CTP, but because of slow recharge during sampling, the results were used only to determine the presence or absence of carbon tetrachloride. A soil gas investigation in the vicinity of piezometer CTP will help determine if contaminated soil in the area is a source of the carbon tetrachloride detected in shallow groundwater.

- <u>BAPB Area Groundwater.</u> Between December 2010 and May 2012, Zeneca's consultant, Terraphase Engineering, Inc., completed additional investigations of the BAPB, which extends from Campus Bay onto the Former RFS Site in the ETA and the remediated portion of Western Stege Marsh. Their activities consisted of installing and sampling additional monitoring wells, and are documented in the Draft Groundwater Investigation Within and In the Vicinity of the BAPB at the UC RFS (Terraphase 2012). DTSC agreed that the BAPB was operating as designed, but in its letter responding to the report, DTSC required additional investigations to further assess effectiveness of the BAPB, including the objective to "collect grab groundwater samples from locations upgradient, downgradient, and to the west of the BAPB to assess the distribution of dissolved metals and VOCs in groundwater" (DTSC 2013). In October 2013, Terraphase completed additional groundwater well installations and sampling (Terraphase 2014). Results from these investigations indicate groundwater concentrations of metals and VOCs in certain wells exceeding aquatic screening criteria (Terraphase 2012, 2014). Four piezometers are proposed upgradient and crossgradient of the BAPB. Piezometers MW-43, MW-45, and MW-46 were installed by Terraphase on behalf of Zeneca in 2013 downgradient of the BAPB. Groundwater data to be acquired from these new piezometers as part of the Phase IV field investigation will be assessed in conjunction with the data collected by Terraphase along the BAPB to evaluate if additional groundwater sampling activities are warranted for this area. The additional data will help determine whether any identifiable sources of metals and VOCs derive from historical activities at the Site.

This sampling plan includes background and history of the Phase IV investigation areas, purpose of sampling, DQOs, sample locations, and chemicals of potential concern for the Phase IV data gaps investigation. Site-specific sampling strategies to address these data gaps are included in this FSP, and are based on historical data and updated sampling information from Phase I through III investigations. Detailed protocols and field methods are included in the Final Phase I FSW by reference only.

2.0 SITE HISTORY AND PREVIOUS INVESTIGATIONS

Section 2 overviews site history, features, past remediation activities, and previous investigations relevant to the Phase IV investigation areas. A complete site history and accounts of previous investigations appear in the FSW (Tetra Tech 2010). Phase IV investigation areas are shown on Figure 3.

2.1 PHASE IV AREAS SITE HISTORY

This section describes site histories, features, and past remediation activities for each area within the Phase IV scope.

2.1.1 Upland Meadows: Big Meadow, EPA Meadow North, and West Meadow

The soil sampling investigation will be conducted in the Big Meadow, EPA Meadow North, and West Meadow, which are adjacent to areas developed by the California Cap Company. The carbon tetrachloride source investigation will also be conducted in the Big Meadow, in the vicinity of piezometer CTP (Figure 3). The Big Meadow is west of the eucalyptus grove parallel to Owl Way. This portion of the Site was part of the Leviston Estates, and likely used for grazing livestock (Amme 1993). Around 1910, a road subdivision was built, but aerial photographs from the mid-1900s do not show housing development. The property was obtained through donations and purchases by the University mostly in the 1950s. No other commercial or industrial activities have occurred in the Upland meadows (Tetra Tech 2008). The Big Meadow has been used for University research, including geotechnical studies via groundwater well installation and monitoring on the eastern edge of the meadow.

The California Cap Company operations did not extend to the Upland meadows, and UC has maintained the meadows as native and non-native grassland, except for constructions of Buildings 280A and 280B, the former cement flume west of Buildings 280A and 280B, and the EPA Region IX Laboratory. Building 280 was constructed in the early 1960s under contract with the Federal Aviation Administration to simulate runway landings under conditions of restricted visibility, and to study runway lighting. The building was cut in two pieces in the early 1990s to facilitate pavement research studies in B280A. Building 280B has mainly been used for general storage since the 1980s. The cement flume, used for Kissimee River restoration hydrology and geomorphology research, was removed in 2011. The EPA Region IX Laboratory, constructed in 1993, is a full-service facility specializing in chemical analysis, biological analysis, and field sampling services.

2.1.2 Western Transition Area and Bulb

The exploratory excavation to investigate the magnetic anomaly will occur within a 2-acre portion in the southern part of an area known as “the Bulb” in the WTA. The WTA is bounded north by the Upland Area at the location of a buried, former seawall believed to have been the edge of the historical mudflats, and south by the original Western Stege Marsh at the 5-foot elevation upper extent of the marsh (NGVD 29). The WTA is believed to consist entirely of artificial fill placed on historical mudflats. It was originally created in the 1950s and 1960s from various sources including spent pyrite cinders from the former Stauffer operations placed in the former tidal mudflat area south of the former seawall (Figure 3). The WTA has not been subject to removal actions except for a small, time-critical removal action in 2008 (Tetra Tech 2009).

The Bulb may have been used historically for disposal of university solid waste. In response to information conveyed during an interview with a former RFS employee, DTSC's Geologic Services Unit conducted a magnetometer survey within the Bulb to investigate potential presence of buried metal drums in this area. The magnetometer survey showed a strong anomaly centered 170 feet south-southwest of the concrete pad (constructed during the 2003 remediation activities).

2.1.3 Eastern Transition Area and Remediated Marsh

The investigation in the vicinity of the BAPB will proceed along the border of the ETA and the remediated portion of the Western Stege Marsh south of the former seawall (Figure 3). The ETA and Western Stege Marsh formerly contained contaminated sediments and pyrite cinders removed during remediation activities in 2002 through 2004, and replaced by clean backfill. The ETA contained a City of Richmond sanitary sewer line, as well as two research ponds constructed in the early 1960s by the UC Berkeley Sanitary Engineering Department for sewage treatment research (one rectangular oxidation pond and one circular digester pond).

Remediation activities in the ETA consisted of excavating contaminated soils and backfilling the areas with clean upland soil. The sanitary sewer line was removed, along with a layer of pyrite cinders (approximately 2 feet thick and 10 feet wide) used as bedding material for the sewer line. The two research ponds were also both demolished and removed. Pyrite cinders were identified as continuing along the unremoved portion of the sanitary sewer pipe in the WTA in subsurface soils; these pyrite cinders remain in place.

In 2003, the BAPB was extended along the downgradient boundary of Campus Bay Site's Lot 3 onto the southern side of the ETA to precipitate divalent metals in groundwater before they potentially migrate to the Western Stege Marsh area (see Figure 5). The BAPB is 2 feet wide, approximately 1,830 feet long, and is generally installed between elevations of +10 feet and -10 feet (NGVD29), thus providing a 20-foot vertical barrier. The portion of the BAPB on UC property is approximately 840 feet long, and the final grade elevation is less than +10 feet NGVD29 in some areas. The barrier consists of 10 percent marine sediments; 85 percent leafy compost and ground-up, manure-free, composted grubbing vegetation; and 5 percent calcium carbonate (limestone) (LFR 2005). A report submitted to DTSC by Terraphase, Zeneca's consultant, included an initial assessment of the efficacy of the BAPB (Terraphase 2012); the report concluded that the BAPB was working as designed. Terraphase will continue to sample the wells installed along the BAPB to confirm conclusions of the initial assessment.

2.2 PREVIOUS INVESTIGATIONS

This summary of previous investigations is derived from the CCR, the SCR, and the Phases I, II, and III Sampling Results Technical Memoranda, unless noted otherwise (Tetra Tech 2008; 2012; 2013a, 2013b). The SCR includes a comprehensive presentation of Site history and Site-wide sampling results of previous investigations through March 2013 (Tetra Tech 2013a).

2.2.1 Upland Meadows

Multiple samples described in the list below have been collected in the Big Meadow and West Meadow using incremental sampling methodology (ISM). A figure showing locations of these samples, and the sampling reports for the ISM samples, are included in Appendix A.

- Big Meadows DU1 and DU2, and EPA Meadow: Samples were collected from 0 to 8 inches bgs to assess worker protection for members of The Watershed Project planting and weeding in certain areas.
- Pampas Grass Area near Building 201: One sample was collected to characterize the soil near the EPA building for worker protection.
- CTP Meadows: Two samples were collected from 0-6 inches bgs to assess worker protection for students weeding and planting in two areas of the meadows.
- CTP Flume: Two samples were collected to assess the condition of the soil mounded on the sides of the flume before the flume was removed.

No results from these samples exceeded commercial screening criteria developed in the SCR (Tetra Tech 2013a).

2.2.2 Western Transition Area and the Bulb

Except for the radiation survey of soils excavated during installation of piezometers Bulb1 and Bulb2, no formal investigation of the subsurface magnetic anomaly has been conducted. DTSC's magnetic anomaly survey and map are included as Attachment 1. Some investigation has occurred to assess thickness of fill at the Bulb, and to identify chemicals of concern for air monitoring during the exploratory excavation. In December 2002, 33 soil and sediment samples were collected within the Bulb area at eight locations at depths between approximately 0 and 8 feet bgs (borings BLB-1 to BLB-8). At these eight locations, surface elevations ranged from 5.0 feet (referenced to the NGVD 29) near the shoreline to 8.7 feet NGVD at the central portion of the Bulb. Elevations of the top of the sediment (that is, the former tidal flat) ranged from approximately 0.6 to 4.9 feet NGVD. Thickness of fill at the sampled locations ranged from 2.5 to 7.5 feet, with an average thickness of 4.6 feet in 2002. Some elevations have changed because portions of the Bulb have since been subject to re-grading, including construction of the concrete pad in 2003 for the Phase 2 remediation activities. A review of the boring logs indicated encounter with minimal wood debris in 3 of the 10 borings, at depths of approximately 3 feet bgs, but no other debris was encountered.

During installation of piezometers Bulb1 and Bulb2, soil samples were collected and submitted to Eberline Analytical for gross alpha, gross beta, and tritium analyses. A soil sample was also collected from piezometer CTP and analyzed to indicate background concentrations for comparison to results from the Bulb soil samples. Activities measured in soil samples collected at locations of Bulb1 and Bulb2 were not statistically different from those in the soil sample collected at location CTP. "Not statistically different" in this case was defined as activity less than the background levels or within the 2 sigma error (95 percent confidence level) associated with each measurement (Tetra Tech 2011).

Groundwater elevation at the Bulb has been recorded between approximately 4 and 5 feet bgs during past groundwater level measurement events (Tetra Tech 2012). The area identified as the potential drum burial area is at an approximate surface elevation of 2 to 3.25 feet NGVD, and is covered with grasses, fennel, iceplant, and poison oak.

Soil sampling was conducted on July 24, 2014 to establish chemicals to be considered for air monitoring during the excavation activities. The sample was collected from the soil cuttings from eight boreholes randomly spaced throughout the estimated excavation boundary. The boreholes were advanced until the Bay Mud layer was exposed at approximately 4 feet bgs. Materials encountered in the boreholes consisted of loosely-compacted sand, silty sand, and gravely fill material above the Bay Mud. Traces of pyrite cinders were identified at the fill/Bay Mud interface.

The soil sample was collected from various depths to best represent soil and fill material excavated at the entire area. Soil was not collected from below the Bay Mud interface because of low potential for the silty-clayey Bay Mud to become airborne. The soil sample was analyzed for semi-volatile organic compounds (SVOC), metals, organochlorine pesticides, and polychlorinated biphenyls (PCB). Results indicate a concentration of 5.7 mg/kg for Aroclor-1254, which is above the human health screening criteria for PCBs, the Toxic Substances Control Act (TSCA) criteria of 1 mg/kg for high occupancy usage. All concentrations of metals, pesticides, and SVOCs were below applicable screening criteria (Table 1). The results are presented in Tables 2 through 6.

In support of the July 24, 2014 soil sampling event, the EH&S Health Physicist conducted a radiation survey during the field activities, since the magnetic anomaly could potentially include uranium ore material buried in waste drums. The radiation survey was performed using a Canberra InSpector 1000 (S/N 02084500) with a 1.5- by 1.5-inch LaBr IPROL-1 probe (S/N 04074637) (LaBr probe) to detect gamma rays at energies ranging from 30 kiloelectron volts to 3.0 megaelectron volts; the high resolution is excellent for nuclide identification while retaining a high efficiency. The LaBr probe was lowered down each borehole to monitor for increasing levels of radioactivity that might indicate presence of buried radioactive material. The average background reading at the surface was approximately 10 microrems per hour (µrem/hr), and the probe's reading increased to approximately 13-15 µrem/hr when lowered into the boreholes. The EH&S Health Physicist determined that the increase was likely due to the increased geometry of detecting naturally occurring activity in the ground or concrete; an exposed piece of concrete pipe was surveyed with no elevated level of exposure. Attachment 2 provides additional details of the investigation.

2.2.3 Carbon Tetrachloride Source Area Investigation

The Phase I field sampling activities consisted of a site-wide groundwater sampling investigation to evaluate overall groundwater characteristics. Carbon tetrachloride was detected at concentrations exceeding the California and federal MCLs at piezometer CTP during multiple sampling events; therefore, a follow-on investigation was conducted during the Phase III sampling event that aimed to confirm or deny the presence of carbon tetrachloride in the shallow groundwater zone.

Concentrations of carbon tetrachloride reported in the groundwater samples collected from piezometer CTP during Phase I field sampling activities exceeded the federal MCL of 5 micrograms per liter (µg/L) in multiple sampling events. Concentrations detected during the five rounds of sampling were 19 and 20 µg/L (duplicate sample), and 16, 25, 14, and 18 µg/L. The general groundwater flow direction at the

Big Meadow is to the southwest (Tetra Tech 2013a). Downgradient samples collected from piezometers GEO, B277, and B280A contained detectable concentrations of carbon tetrachloride during all five rounds of sampling—ranging from 0.5 to 1.4 μg/L (see Appendix B).

As part of the Phase I investigation, four piezometers were installed in the intermediate groundwater zone to assess vertical gradients across the Site. One of the deeper piezometers, CTPdeep, was next to piezometer CTP. During the first three rounds of groundwater sampling, the vertical groundwater gradient between piezometers CTP and CTPdeep was downward. Therefore, during the fourth round of groundwater sampling in April 2012, samples were collected from both piezometer CTP (screened from 7 to 17 feet bgs) and piezometer CTPdeep (screened from 30 to 40 feet bgs). The concentration of carbon tetrachloride in piezometer CTP was 22 μg/L, consistent with previous sampling events. The sample collected from piezometer CTPdeep was non-detect for carbon tetrachloride, at a detection level of 0.5 μg/L.

As part of Phase III sampling activities, grab groundwater samples were collected from 20 borings advanced to depths of 17 or 20 feet bgs (depending on the location). The grab groundwater samples were analyzed for VOCs via EPA Method 8260. Because grab groundwater sampling results are not considered high-quality data, the concentrations detected were not compared to screening criteria. The objective of the investigation was to confirm or refute the presence of an upgradient source of carbon tetrachloride. Seven VOCs were detected in the grab groundwater samples, including acetone, benzene, carbon tetrachloride, tetrachloroethylene (PCE), chloroform, toluene, and trichloroethylene (TCE).

Carbon tetrachloride was detected in 7 of the 21 grab groundwater samples collected at CTP09, CTP12, CTP13, CTP14, CTP15, CTP17, and piezometer CTP (Appendix B), with concentrations ranging from 0.23 to 7.5 μg/L; the highest concentration was detected at piezometer CTP17, next to piezometer CTP. The investigation results do not indicate presence of an obvious upgradient off-site source of contamination, and the source may be from historical activities near Building 280B.

At no point during the groundwater investigation, or any other investigation, were soil or soil gas samples collected in the vicinity of piezometer CTP. Results of the groundwater investigations are included as Appendix B.

2.2.4 BAPB Area Groundwater Characterization

The BAPB was installed in 2003 to precipitate divalent metals from groundwater before it migrates to the marsh area. Results from grab groundwater and monitoring well samples collected by Zeneca's consultant adjacent to the BAPB in 2012 and 2013 indicate groundwater concentrations of targeted metals exceeding aquatic screening criteria (cadmium, copper, lead, mercury, nickel, selenium, and zinc) (Table 7). PCE was also detected at concentrations exceeding aquatic screening criteria (Terraphase 2012, 2014).

Sediment samples collected to characterize investigation-derived waste (IDW) during BAPB well installation in 2013 indicate presence of arsenic in sediments around the BAPB at concentrations exceeding the background level (Terraphase 2014).

The BAPB is primarily south and downgradient of the ETA. The ETA was created when upland fill materials were placed on top of the former tidal mudflat. Prior to placement of clean soil on top of the former tidal mudflat, portions of the tidal mudflat were subject to placement of pyrite cinders directly onto the mudflats and to pollutant releases from multiple on-site and off-site locations, including Kaiser Shipyards and other City of Richmond industries, the San Francisco Bay, the California Cap Company, and Stauffer Chemical (Tetra Tech 2008). Remediation was completed in the entire ETA between 2002 and 2004, and the area was backfilled with clean soils and sediments. The Regional Water Quality Control Board approved the backfill used between 2002 and 2004.

The highest concentrations of chemicals detected in soil and sediment in the ETA were detected primarily in subsurface samples from the sediments of the former tidal mudflat beneath the upland fill material. Concentrations of pyrite cinder-related metals (arsenic and lead) exceeding commercial screening criteria were found in samples collected within the ETA during investigations in 2006.

Groundwater samples collected in the ETA include grab groundwater samples collected in 2001 and 2006 (locations A4-5, A4-9, A4-12, A4-13, and UCB-1), and monitoring well samples from piezometer ETA, installed as part of the FSP Phase I investigation, collected from 2010 through 2014. Results from the grab groundwater samples indicate elevated concentrations of metals (arsenic, cadmium, copper, lead, nickel, and zinc) exceeding the aquatic screening criteria used in the Terraphase BAPB investigation (URS Corporation 2002a; Tetra Tech 2008; Terraphase 2012, 2014). Results from piezometer ETA indicate concentrations of copper exceeding its aquatic screening criterion (Tetra Tech 2012, 2013b; Terraphase 2012, 2014).

In grab groundwater samples collected upgradient of the ETA, nickel, copper, and zinc concentrations exceeded the aquatic screening criteria used in the Terraphase BAPB investigation (Terraphase 2012, 2014); only nickel exceeded its aquatic screening criterion in samples collected from piezometer B163. The SCR reported that metals are naturally occurring in groundwater, and the concentrations detected do not indicate a contaminant release or plumes (Tetra Tech 2013a). The SCR conclusions apply to RFS-wide groundwater concentrations; the SCR was prepared prior to the additional groundwater data collected by Terraphase near the BAPB. A map of sampling locations in the vicinity of the BAPB is included in Appendix C.

3.0 PHASE IV SAMPLING DESIGN

This section discusses the purpose of the data gaps investigations, DQOs, and sampling process design.

3.1 PURPOSE OF INVESTIGATION

The sampling strategy for Phase IV consists of: (1) collection of discrete soil samples in the Big Meadow, EPA Meadow North, and West Meadow; (2) exploratory excavation in the Bulb at the magnetic anomaly; (3) collection of soil gas samples in the Big Meadow; and (4) additional groundwater characterization near the BAPB in the ETA and remediated portion of Western Stege Marsh. Soil sample results from the Upland meadows will provide data to assess risk posed to human and ecological receptors. Exploratory excavation in the Bulb will determine if the source of a magnetic anomaly discovered during the 2006 DTSC survey can be identified through excavation; the source of the anomaly may or may not be removed from the area, pending identification of the source. Soil gas data from the Big Meadow will either locate the source or help determine if the source of carbon tetrachloride in groundwater is, or is not present in nearby soils. Groundwater sampling results will provide analytical data to characterize current groundwater conditions in the vicinity of the BAPB.

3.2 DATA QUALITY OBJECTIVES

DQOs are intended to help ensure collection of data appropriate for support of defensible decisions. The DQO process is a seven-step iterative approach to prepare plans for environmental data collection activities. It is a systematic approach for defining the criteria that a data collection design should satisfy, including when, where, and how to collect samples or measurements; for determining tolerable decision error rates; and for identifying the number of samples or measurements that should be collected (EPA 2006). The seven steps for DQO development are specified in the QAPP (Tetra Tech 2010). The DQOs for the Phase IV FSP are outlined below.

3.2.1 DQOs for Soil in the Upland Meadows

Step 1: State the Problem

- Only limited soil sampling data are available for the Upland meadows designated as NOS; therefore, additional data are necessary to determine if chemicals are present that pose unacceptable risks to human health or the environment.
- The Upland meadows were identified during discussions with DTSC in 2009 as needing characterization of ecological risk from soil.
- If contaminants are present in soil, unacceptable exposures to human and ecological receptors are possible.

Step 2: Identify the Goals of the Study

- What are the concentrations of metals, PCBs, polycyclic aromatic hydrocarbons (PAH), pesticides, and VOCs in soil in the Upland meadows?

- Are contaminants of concern present within the study area in quantities or concentrations requiring an immediate action, or consideration of further evaluation in a Remedial Investigation/Feasibility Study (RI/FS) or SCR?

Step 3: Identify Information Inputs

- Information provided within historical documents including the CCR, FSW, Phases I, II and III FSPs, SCR, RAW, and historical aerial photographs.
- Chemical concentrations detected in samples previously collected via ISM sampling within the areas investigated.

Step 4: Define the Boundaries of the Study

- The sampling includes portions of the Big Meadow, EPA Meadow North, and West Meadow designated as NOS. The Upland meadow portion of the NOS and sampling grid appear on Figure 7.
- Initially, the soil from 0 to 0.5 feet bgs will be sampled on an approximately 125-foot grid spacing, and the soil from 1.5 to 2 feet bgs will be sampled on an approximately 125- by 250-foot grid spacing. If surface soils have elevated concentrations of chemicals, additional samples will be collected from deeper intervals (0-6 feet bgs for burrowing mammals and plants and 0-10 feet bgs for future maintenance workers). A separate FSP would be prepared for this supplemental sampling.
- No temporal boundaries are imposed upon this investigation.

Step 5: Develop the Decision Rules

- Chemical concentrations in soil detected in this investigation will be screened against applicable screening levels as described in Step 6.
- Chemical concentrations in soil detected in this investigation will be used in an ecological risk assessment (ERA) if warranted. The need for an ERA will be determined by comparing soil concentrations to ecological screening benchmarks; and the methodology will be developed with concurrence of DTSC.
- For areas requiring further investigation, one or several of the following may occur: further data evaluation or data gap sampling (by expansion of the lateral or vertical boundary of the study area to subsurface or surface soils), consideration of further evaluation in an RI/FS or SCR, or immediate consideration for remedial or response action.

Step 6: Specify Performance or Acceptance Criteria

- Maintenance workers may potentially be exposed to chemicals as deep as 10 feet bgs if deep utility corridors are installed. Off-site receptors may be exposed to chemicals via the inhalation pathway during potential excavation activities. Therefore, chemical concentrations in soil will be screened against human health screening criteria for maintenance workers and the off-site receptor inhalation pathway, as developed in the SCR.
- Invertebrates, birds, and non-burrowing mammals may potentially be exposed to chemicals as deep as 2 feet bgs, and plants and burrowing mammal may potentially be exposed to chemicals as deep as 6 feet bgs; therefore chemical concentrations in soil will be screened against EPA's Ecological Soil Screening Levels (Eco-SSL) (EPA 2010) for plants,

invertebrates, birds, and mammals (Table 1). If an Eco-SSL is not available, Oak Ridge National Laboratory (ORNL) phytotoxicity and earthworm toxicity benchmarks will be used (Efroymson and others 1997a, 1997b). The data will also be used in an ERA, if warranted, based by comparing soil concentrations to the ecological screening benchmarks.

- Decision errors associated with the sampling event will be evaluated. Decision errors are generally depicted as implications of false positive or false negative results. False positive results are detections of chemicals above screening results that do not accurately represent the geographic area the sample result is intended to represent. False positive results overestimate chemicals concentrations within an area of interest, and generally result in unnecessary costs and resources required to further characterize the area or conduct cleanup activities. False negative results are detections of chemicals below screening criteria that do not accurately represent the geographic area the sample result is intended to represent. False negative results are underestimates of chemicals within an area of interest, and generally result in leaving contaminants in place that could result in unacceptable exposures to human health or the environment.
- Triplicate discrete soil samples will be collected during the investigation to help determine the confidence associated with representing soil conditions within a very short distance (1 to 2 feet) according to results from discrete samples, and therefore will help evaluate potential for false positive or false negative results for the areas sampled. Triplicate results will be used to help determine the margin of error within the discrete samples. Triplicates will be collected at a minimum of 10 percent of the discrete sample locations; higher frequency of triplicates may be sampled per the discretion of UC Berkeley.
- If analytical results and associated margin of error are near screening criteria values, risk of false positive and false negative results increases, and additional sampling or sampling techniques may be required—for example, a detected concentration of 10 mg/kg with a margin of error of 25 percent and a screening level of 12 mg/kg. If the analytical results and associated margin of error are well above or well below the screening criteria, the data will be considered usable for decision making—for example, a detected concentration of 10 mg/kg with a margin of error of 25 percent and screening level of 100 mg/kg.

Step 7: Optimize Design for Obtaining Data

- Soil samples will be collected from 0-0.5 feet bgs at every location, and from 1.5-2 feet bgs at half of the total number of locations because contamination is not suspected at depth. Samples will be collected using a hand auger and analyzed for metals, PCBs, PAHs, and VOCs (1.5-2 feet bgs only; VOCs are not expected to be detectable in surface soil), which have been identified as potential chemicals of concern. Additionally, samples collected adjacent to Building 280A and Building 280B will be analyzed for pesticides, as shown on Figure 6.
- Soil sampling locations are randomly distributed on a gridded basis to provide overall coverage of the Upland meadows.
- Following receipt and review of the laboratory results from this soil investigation, any additional sampling, if deemed necessary, will be considered under a future FSP.

3.2.2 DQOs for the Exploratory Excavation to Investigate the Magnetic Anomaly

Step 1: State the Problem

- A 2006 magnetometer survey conducted by DTSC revealed an anomaly centered 170 feet south-southwest of the concrete pad in the Bulb. The detection pattern suggests presence of a ferrous body at an unknown depth. No additional investigation of this anomaly has occurred.
- If a source of the magnetic anomaly is discovered, it could contain contaminants which could cause exposure to both human and ecological receptors.
- If contaminants are present in soil, exposure to both human and ecological receptors is possible.
- A Radiological Sampling Plan will be prepared and submitted to DTSC as an addendum to this Phase IV FSP. The California Department of Public Health Radiologic Health Branch will be provided with the Radiological Sampling Plan for review.

Step 2: Identify the Goals of the Study

- What is source of the magnetic anomaly?
- Does radioactive contamination or chemical contamination including metals, PCBs, VOCs, SVOCs, total extractable petroleum hydrocarbons (TPH-e), total purgeable petroleum hydrocarbons (TPH-p), or pesticides exist in subsurface soils in the vicinity of the anomaly due to the source of the anomaly?
- Are radioactive or chemical contaminants present within the study area in quantities or concentrations requiring a time-critical response?
- Are radioactive or chemical contaminants present within the study area in quantities or concentrations requiring consideration of the Bulb for further evaluation via an RI/FS or SCR?

Step 3: Identify Information Inputs

- Interview notes from the former employee alleging drum burial.
- Information from the 2006 magnetometer survey, which included a surface scan of approximately half of the Bulb area (see Figure 7).
- Information from the radiation survey conducted on July 24, 2014 during the collection of soil samples to identify chemicals of concern for air monitoring in preparation for the proposed exploratory excavation, as described in Section 2.2.2 and in the addendum to this FSP.
- Boring logs and depth-to-water measurements.

Step 4: Define the Boundaries of the Study

- The Bulb is surrounded by the Western Stege Marsh, Meeker Slough, and the WTA. The magnetic anomaly is approximately 170 feet south-southwest of the concrete pad in the Bulb (see Figure 6).
- The magnetometer survey revealed an area approximately 20 by 36 feet that exhibits nano-Tesla levels (also known as gamma units) above other portions of the study. The source of the anomaly could range from moderately-sized metallic objects in shallow soils to

very large metallic objects at greater depths. Exploratory excavation will occur in this area to 20 feet bgs (conditions-dependent) to determine the source of the anomaly. The lateral boundaries of the extent of potential contamination from debris have not been determined; however, the study area will be limited to the area of the magnetic survey.

- Horizontal expansion of the study area may occur based on preliminary review of the data collected. No vertical expansion of the study area is anticipated. If additional sampling is recommended during Phase IV, an addendum to this FSP will be prepared.
- No temporal boundaries are imposed upon this investigation.

Step 5: Develop the Decision Rules

- The real-time data from this investigation will be reviewed daily by UC Berkeley's EH&S Radiation Safety Officer (RSO), and will be screened against applicable radiological screening levels (see addendum to this FSP). In addition, chemical data will be screened against the lesser of the applicable human health screening criteria (maintenance worker and the inhalation pathway for the off-site receptor from Tetra Tech 2013a) (see Table 1).
- The radionuclide analytical data will be screened against a background level for the Site to be developed prior to the excavation.
- Chemical concentrations in soil determined by this investigation will be used in a human health risk assessment (HHRA) or ERA if warranted. The need for a HHRA or ERA will be determined based on results of a comparison of soil concentrations to ecological screening benchmarks; and the methodology will be developed with concurrence of DTSC. Soil samples will be collected at the direction of DTSC during excavation activities. Specific soil sampling locations are not proposed.
- If a source of the magnetic anomaly is discovered, UC Berkeley and DTSC will review the potential scenarios to remove the source, or leave it in place.
- If no source is discovered or if the Bulb is recommended for further investigation, one or several of the following may occur: further data evaluation or data gap sampling (by expansion of the lateral or vertical boundary of the study area to subsurface or surface soils), consideration of further evaluation via an RI/FS or SCR, or immediate consideration for remedial or response action, including a potential removal action for the magnetic anomaly source.

Step 6: Specify Performance or Acceptance Criteria

- Specific screening levels and endpoints for the real-time radiologic sampling will be outlined in the addendum to this FSP, which will present UC Berkeley's EH&S sampling procedures, screening values, and actions. The California Department of Public Health Radiologic Health Branch will review the plan.
- Screening levels and endpoints for discrete soil samples analyzed for radiologic contaminants will be established after data have been received and reviewed by UC Berkeley and DTSC.
- Maintenance workers may potentially be exposed to chemicals as deep as 10 feet bgs if deep utilities are installed. Off-site receptors may be exposed to chemicals via the inhalation pathway during excavation activities. Therefore, chemical concentrations in soil will be screened against human health screening criteria for maintenance workers and the off-site receptor inhalation pathway, as developed in the SCR (Tetra Tech 2013a) (Table 1).

- Invertebrates, birds, and non-burrowing mammals may potentially be exposed to chemicals as deep as 2 feet bgs, and plants and burrowing mammal may potentially be exposed to chemicals as deep as 6 feet bgs; therefore chemical concentrations in soil will be screened against EPA's Eco-SSLs (EPA 2010) for plants, invertebrates, birds, and mammals (Table 1). If an Eco-SSL is not available, ORNL phytotoxicity and earthworm toxicity benchmarks will be used (Efroymson and others 1997a, 1997b). The data will also be used in an ERA, if warranted, based on results of a comparison of soil concentrations to the ecological screening benchmarks.
- Triplicate samples will be collected at a minimum of 10 percent of the non-radiological samples, with a minimum of one triplicate sample; higher frequency of triplicates may be sampled per the discretion of UC Berkeley. Results from triplicate samples will be evaluated consistent with Section 3.2.1, Step 6 regarding false positive results, false negative results, and comparison of results to screening criteria.

Step 7: Optimize Design for Obtaining Data

- The source of the magnetic anomaly will be investigated through exploratory excavation, beginning at the location of the strongest reading from the magnetometer survey (see Figure 7); depth and lateral extent will depend on findings. The excavation activity will be logged and areas of debris or staining will be noted. If a source is identified, additional action will proceed following discussion with UC Berkeley and DTSC.
- Real-time radiologic sampling data will be collected and analyzed as presented in the addendum to this FSP.
- Discrete soil samples will be collected at the direction of DTSC during the excavation activities. Samples may be analyzed for metals, PCBs, VOCs, SVOCs, TPH-e, TPH-p, or pesticides.
- Following receipt and review of the laboratory results from this soil investigation, any additional sampling, if deemed necessary, will be considered under a future FSP.

3.2.3 DQOs for the Carbon Tetrachloride Source Investigation

Step 1: State the Problem

- Carbon tetrachloride concentrations have exceeded California and federal MCLs in shallow groundwater (approximately 20 feet bgs) in the Big Meadow at piezometer location CTP during five rounds of groundwater monitoring. Carbon tetrachloride was detected in downgradient piezometers, including GEO, B280A, and B277, at concentrations less than the federal MCL, but exceeding the California MCL.
- The source of carbon tetrachloride in the CTP is unknown.
- Characterization of the distribution of shallow soil gas (2 to 3 feet bgs) in the vicinity of piezometer location CTP may improve understanding of a potential carbon tetrachloride source.
- If a source of carbon tetrachloride is present in soil, it may continue to contaminate groundwater. If a source of carbon tetrachloride is present in soil gas, exposure to ecological receptors is possible. Currently, no human receptors are in the area of investigation.

- The investigation area is a sensitive ecological area due to the presence of coastal terrace prairie; therefore the investigation will be conducted to minimize disruption to the Big Meadow.

Step 2: Identify the Goals of the Study

- Do results of soil gas indicate a source or direction of possible source?
- What are the concentrations of carbon tetrachloride in soil gas adjacent to piezometer CTP?
- Is carbon tetrachloride present within the study area at concentrations requiring a time-critical response, or consideration of further evaluation via an RI/FS or SCR?

Step 3: Identify Information Inputs

- Information from historical use records and sampling documents such as the CCR, FSW, Phases I, II, and III FSPs, SCR, RAW, and annual groundwater monitoring reports.
- Previous sampling concentrations of carbon tetrachloride found in shallow groundwater.

Step 4: Define the Boundaries of the Study

- The shallow soil gas within an area approximately 300 by 300 feet, and centered on piezometer CTP, believed to be the source of carbon tetrachloride (see Figure 8).
- No temporal boundaries are imposed upon this investigation.

Step 5: Develop the Decision Rules

- Detections of carbon tetrachloride in soil gas may be considered evidence of a possible source of carbon tetrachloride in soil and therefore groundwater.
- The soil gas samplers may also detect carbon tetrachloride off-gassing from groundwater. Based on data evaluation, UC will recommend whether detections of carbon tetrachloride can be attributed to possible soil sources or to off-gassing from groundwater.
- If an area is recommended for further investigation, one or several of the following may occur: further data evaluation or data gap sampling (by expansion of the lateral or vertical boundary), further investigation utilizing membrane interface probe technology, consideration of further evaluation via an RI/FS or SCR, or immediate consideration for remedial or response action. Any further activities would be conducted under a separate FSP.

Step 6: Specify Performance or Acceptance Criteria

- Soil gas sample results will be reviewed, and elevated levels will help identify potential sources of contamination in soil. Results from the passive soil gas samples are not intended for use in a human health or ecological risk evaluation.
- Three triplicate samples will be collected from the 32 proposed soil gas locations. Results from triplicate samples will be evaluated consistent with Section 3.2.1, Step 6 regarding false positive results and false negative results. False negative results are possible if the soil gas sampling results do not accurately represent the area of interest. The proposed grid spacing is considered acceptable for identifying a significant source of carbon tetrachloride contamination in soil or groundwater. No practical sampling techniques or processes are available to determine if the results represent false negative results, other than additional sampling at greater frequency.

Step 7: Optimize Design for Obtaining Data

- Passive soil gas samples will be collected using Amplified Geochemical Imaging (AGI) Universal Sampler (previously known as Gore-Sorber®) technology, and will be analyzed for VOCs. The probes will be installed centered around piezometer CTP and expanding into an array (see Figure 8). Attachment 3 contains a SOP for the AGI Universal Sampler. Soil gas samplers will be placed between 2 and 3 feet bgs, consistent with the manufacturer-recommended depths for near surface sampling. Soil gas results will not be affected by barometric conditions at the surface.
- If a source cannot be located using soil gas sampling, UC Berkeley will consult with DTSC regarding considerations for additional investigation or sampling techniques to identify a potential source in soil of the shallow groundwater contamination, or determine no further action, if appropriate.
- Following receipt and review of the laboratory results from this soil investigation, any additional sampling, if deemed necessary, will be conducted under a separate FSP. Active soil gas sampling may be considered for the following investigation or evaluation.

3.2.4 DQOs for BAPB Area Groundwater

Step 1: State the Problem

- Some metals and VOC concentrations have exceeded the aquatic screening criteria used in the Terraphase BAPB investigations (Terraphase 2012, 2014) in shallow groundwater samples collected along the BAPB and in the ETA.
- Additional characterization of the shallow groundwater is needed to understand the distribution of contaminants in the ETA to determine whether conditions have changed since completion of remediation in 2004, and to improve understanding of the potential for migration of contamination from the Uplands Area and former Zeneca site through shallow groundwater toward Western Stege Marsh, particularly in the area immediately west and upgradient of the BAPB. The predominant groundwater flow direction in the vicinity of the BAPB is to the southwest. The future land use for the northern portion of the ETA is research, education, and support; the southern portion of the ETA, the areas west of the BAPB, and the area with the BAPB will remain as natural open space.
- If contaminants are present in shallow groundwater, exposure to downgradient aquatic receptors is possible.

Step 2: Identify the Goals of the Study

- What are the concentrations of metals and VOCs in shallow groundwater upgradient and crossgradient of the BAPB?
- Is legacy contamination from historical operations at the Site contributing to the elevated contaminant concentrations in groundwater at the BAPB?
- Are additional groundwater remedial activities warranted for the BAPB area?
- Are metals or VOCs in groundwater present within the study area at concentrations requiring inclusion into the ongoing groundwater monitoring program?

Step 3: Identify Information Inputs

- Information from CCR, FSW, Phases I, II, III FSPs, SCR, RAW, and annual groundwater monitoring reports.
- Metals and VOC concentrations from piezometer ETA detected during groundwater monitoring events.
- Chemical concentrations in soil and sediment samples previously collected in the ETA and along the BAPB.
- Boring logs and depth-to-water measurements.
- Metals and VOC concentrations in grab groundwater samples collected in the ETA and in the vicinity of the BAPB.

Step 4: Define the Boundaries of the Study

- Three piezometers will be installed in the ETA, and one piezometer will be installed in the Western Stege Marsh, just downgradient of the Uplands Area (see Figure 9).
- The shallow groundwater zone is of primary interest.
- No temporal boundaries are imposed upon this investigation.

Step 5: Develop the Decision Rules

- Four piezometers will be installed and developed, and groundwater will be sampled for metals and VOCs. Analytical data will be compared to screening criteria and existing groundwater data. Sample data will be used to assess the need for additional piezometers to confirm the lateral or vertical boundary of the study area.

Step 6: Specify Performance or Acceptance Criteria

- Chemical concentrations in groundwater will be compared to the aquatic screening criteria established by Zeneca’s consultant, Terraphase, to evaluate the BAPB area groundwater, to be consistent with the 2013 and 2014 evaluation (Terraphase 2012, 2014). Aquatic screening criteria for groundwater in the vicinity of the BAPB are presented in Table 7.
- False positive results would occur if elevated levels of contaminants detected in groundwater are not representative of groundwater within the geographic area of interest. Evaluation for false positive results will occur if concentrations detected are not consistent with piezometer placement (in regards to groundwater gradients) compared with previous investigation results. False negative results would occur if reported concentrations underestimate actual groundwater concentrations. No practical sampling techniques or processes are available to determine if the results represent false negative results, other than collecting additional groundwater samples from additional monitoring wells.

Step 7: Optimize Design for Obtaining Data

- The need to supplement groundwater data in the vicinity of the BAPB will be addressed through installation of four piezometers, installed to the specifications of the FSW. The depths of piezometers will be based on the subsurface materials encountered during the investigation. The screen lengths and depths will be constructed to intercept only the shallow water-bearing zone expected to be less than 15 feet bgs. The target sample intervals will be based on the general depth of the shallow water-bearing zone as determined by previous investigations, the depth of the BAPB, avoidance of cinder intervals, and other information inputs identified in Step 5 of the DQOs. Following installation and development of these piezometers, groundwater samples will be collected at proposed sampling locations shown on Figure 9.

- Following receipt and review of laboratory results from either the groundwater or future soil investigations, any additional groundwater sampling—if deemed necessary—will proceed using the same methodology.

3.3 SAMPLING PROCESS DESIGN AND SAMPLING METHODS

The sampling strategy for Phase IV consists of collection of discrete shallow soil samples in the Upland meadows, exploratory excavation at the magnetic anomaly, collection of soil gas samples in the Big Meadow, and groundwater characterization in the vicinity of the BAPB. This section describes the sampling process design and sampling methods for the Upland Meadows soil sampling, the carbon tetrachloride area soil gas sampling, and the BAPB area piezometer installation and groundwater monitoring; the details of the Bulb exploratory excavation will be included as an addendum to this FSP. The QAPP, Appendix A of the FSW (Tetra Tech 2010), provides sampling methods for most of the field investigation. Proposed activities not described in the QAPP are described in detail. All sampling locations will be recorded.

The QAPP also provides specific sampling and analysis information to assist the field crew during field activities, including sample identification numbers for the various sampling locations and a summary of the test methods to be performed on each sample. Procedures for decontamination and management of IDW from sampling activities are provided in the QAPP (Tetra Tech 2010), and will be utilized by the field crew during sampling activities.

Standard information for planning and conducting field sampling during Phase IV, such as field equipment calibration and maintenance, sample collection methodology, and sample packaging and documentation, is outlined in the QAPP (Tetra Tech 2010), and is referenced in Table 8.

3.3.1 Upland Meadows Sampling

Soil samples in the Upland meadows will be collected within an approximately 125-foot grid. Samples will be collected from 0 to 0.5 feet bgs at all locations and 1.5 to 2 feet bgs at half of the total number of locations (resulting in an approximately 125-foot x 250-foot grid spacing), as shown on Figure 7, to assess any impacts from historical site use. The samples will be analyzed for metals, PCBs, PAHs, pesticides, and VOCs, as shown on Table 9. Pesticides will be analyzed in a limited number of samples, mostly in samples collected near buildings (see Figure 7).

Shallow soil samples will be collected using a hand auger. At each sampling location, the hand auger will be decontaminated before collection of the surface sample, and again when the top of the second sample is reached, if applicable, to reduce possibility of cross contamination between sampling depths. Additionally, only the amount necessary for the sample will be collected from the entire length of the horizon; the rest of the plug will be replaced to maintain the integrity of the valuable top 6 inches of the coastal terrace prairie.

Protection of Native Plant Species

Native plant species will likely be present in the proposed soil sampling areas. Consequently, no vehicles will be used and sample locations will be biased toward locations not occupied by native plants to minimize impacts on the grasslands. In addition, all activities in the Upland Meadows will adhere to the requirements of the Coastal Terrace Prairie Management Plan (Appendix G of the RBC Environmental Impact Report [Tetra Tech 2014b]).

3.3.2 Carbon Tetrachloride Area Soil Gas Sampling

The source investigation for the carbon tetrachloride found in shallow groundwater will consist of soil gas samples within a grid centered around piezometer CTP in the Big Meadow (see Figure 8). The soil gas investigation will be conducted using AGI Universal Samplers, a passive soil gas sampling technique. The AGI Universal Samplers will be installed with a slide hammer and tile probe following the manufacturer's specifications. AGI Universal Sampler technology guidelines for installing and retrieving the samplers are included as Attachment 3. Because the hole is very small (approximately ½ to 1 inch in diameter), this method will minimize disturbance to the grasslands. Samplers will be installed at a depth of approximately 3 feet, following the manufacturer's recommendations, and left in place for 10 days. The locations will be flagged and clearly labelled for easy retrieval. Sample collection consists of pulling up the entire probe and sending the probes to the manufacturer for analysis. Borings will be backfilled with soil removed during installation. Although the samplers are not affected by rain or other weather conditions, to protect the grasslands, the work will not occur under wet or rainy conditions.

Before sampling begins, water level measurements will be recorded at piezometers B280B, NRLF, CTP, GEO, and B280A.

Protection of Native Plant Species

Native plant species will likely be present in the proposed soil sampling areas. Consequently, no vehicles will be used and sample locations will be biased toward locations not occupied by native plants to minimize impacts on the grasslands. Although the passive soil gas samplers are not affected by rain or other weather conditions, to protect the grasslands, sampling activities will not occur under wet or rainy conditions.

3.3.3 BAPB Area Groundwater Sampling

Activities associated with piezometer installation in the vicinity of the BAPB consist of logging soils and drilling, completing, developing, and sampling four, 2-inch-diameter piezometers (see Figure 9). Soil samples will not be analyzed in the laboratory because all piezometers will be installed within previously remediated areas backfilled with clean backfill. A BCDC permit will be obtained to complete the proposed work.

Before drilling begins, water level measurements will be recorded at piezometers Bulb1, Bulb2, WTA, ETA, MFA, and B163. If tidal fluctuations in the shallow groundwater levels are observed, the well screen intervals in the new piezometers will be adjusted so that the complete range of water levels will be captured by the well screens.

A direct-push rig will be used to collect soil in an acetate sleeve to log soil types for site lithology characterization and to select depths of the screened interval for each piezometer. Soil will also be screened for VOCs by use of a photoionization detector (PID), and results will be recorded in a field log book. A hollow-stem auger will then be used to install the four piezometers. Depths of piezometers and lengths of well screens will depend on the subsurface materials and groundwater levels encountered during the investigation. Screen lengths and depths will be constructed to intercept only the shallow water-bearing zone above the bottom of the BAPB, estimated to extend between 15 and 20 feet below the sediment surface. Target sample intervals will be based on the general depth of the shallow water-bearing zone as determined by previous investigations, depth of the BAPB, and other information inputs identified in Step 5 of the DQOs. Piezometers will not be screened through pyrite cinders; instead, the screening interval length will be decreased to place the screening interval and bentonite seal below the cinder-affected soil horizon. If cinders cannot be avoided at a particular location, the boring location will be moved horizontally 5 feet to a new location where cinders are not present. Piezometers will be completed and developed consistent with methods specified in the FSW, with the exceptions discussed above (Tetra Tech 2010). Drilling equipment will be selected to minimize damage to the investigation area.

Once the piezometers are developed, groundwater samples will be collected according to low-flow technology protocol as outlined in the FSW to minimize disturbance in the water column, and will be analyzed for dissolved metals (field filtered) and VOCs. In addition, water levels and water quality parameters such as total dissolved solids (TDS), dissolved oxygen, pH, oxidation-reduction potential, specific conductance, and temperature, will be measured at each location. Development water and purge water will be collected and disposed of as IDW.

Protection of Marshland Nesting Birds

The proposed piezometer locations and their immediate surroundings may provide habitat for special status species such as the California clapper rail. Piezometer installation will not occur during the nesting season (February 1 – August 31) to avoid adversely affecting special-status bird species.

3.3.4 Analytical Methods and Quality Control

Soil samples will be submitted for analysis using the analytical methods listed in the QAPP (Tetra Tech 2010) and referenced in Table 8. Samples for chemical analysis will be submitted to California state-certified laboratories pre-approved by UC Berkeley and DTSC. Additional descriptions of the analytical methods, including selection of analytical laboratories and project analytical requirements, are provided in the QAPP.

To assess the quality of field data and sample representativeness, field quality control (QC) samples will be collected and analyzed at 10 percent of soil sampling locations in the Upland meadows and at 10 percent of the soil gas sampling locations in the Big Meadow. Field QC soil and soil gas samples will be collected in triplicate (stepping out 2 feet in two directions from the original location for soil, and 3 feet for soil gas) at the same depth intervals as the original samples. A field QC sample will be collected as a duplicate groundwater sample at one of the four BAPB Area groundwater monitoring piezometers. Laboratory QC samples will be collected at 5 percent of soil and groundwater sampling locations, and will be analyzed in accordance with referenced analytical method protocols to ensure laboratory procedures are conducted properly and the quality of the data is known. Two trip blanks for the soil gas sampling investigation within the carbon tetrachloride area will be collected and analyzed: one trip blank will accompany the passive soil gas samplers to the field and the second trip blank will accompany the samplers from the field to the laboratory. Testing, inspection, and maintenance procedures for field equipment are also critical for acquisition of accurate data. Procedures for these QC practices are explained in the QAPP (Tetra Tech 2010).

Curtis and Tompkins laboratory in Berkeley, California will analyze all soil and groundwater samples. The soil gas samplers will be returned to the manufacturer (AGI) for analysis for VOCs.

HASPs for all field activities not covered in the facility-wide FSP HASP (Tetra Tech 2010) will be provided to DTSC prior to mobilization.

4.0 PROJECT ROLES AND RESPONSIBILITIES

This section presents key staff and responsibilities. Additional project organization information pertaining to sampling and laboratory quality is presented in the QAPP (Tetra Tech 2010).

Name and Affiliation	Roles	Responsibilities
Greg Haet (UC Berkeley Office of Environment, Health & Safety)	Project Coordinator	Directs environmental health and safety compliance of the project. Receives notices, comments, approvals, and related communications from DTSC and forwards them to Respondents' representatives. Reports to and interacts with the DTSC for all Order tasks and/or public outreach.
Karl Hans (UC Berkeley Office of Environment, Health & Safety)	Project Scientist/On-Site Office of Environment, Health & Safety Coordinator	UC on-site environmental health and safety project coordinator at the Richmond Field Station. Assists in managing the project and and interacting with DTSC and Respondents. Reviews all submittals and notifications to DTSC and other agencies for quality and completeness.
Jason Brodersen, P.G. (Tetra Tech, Inc.)	Project Consultant/Project Geologist	Provides direction and supervision of hazardous waste site cleanup work. Provides expert advice on environmental management during investigation and remediation phases of the project. Primary author and coordinator of completion of RFS Order-required reports and other technical deliverables.
To Be Determined	Field Team Leader	On-site field manager capable of identifying existing and predictable hazards during the exploratory excavation; has authorization to take prompt corrective measures to eliminate hazards.
Gene Barry, P.E. (4LEAF, Inc.)	Project On-Site Coordinator	Performs construction management and oversight duties during various construction phases of the project and other on-site activities. Assists the project consultant and project coordinators in managing project information and data and completing project deliverables.
Carolyn Mac Kenzie (UC Berkeley Office of Environment, Health & Safety, Radiation Safety Team)	Radiation Safety Officer	Provides direction for implementation of radioactive materials and radiation monitoring conducted for the Bulb exploratory excavation.

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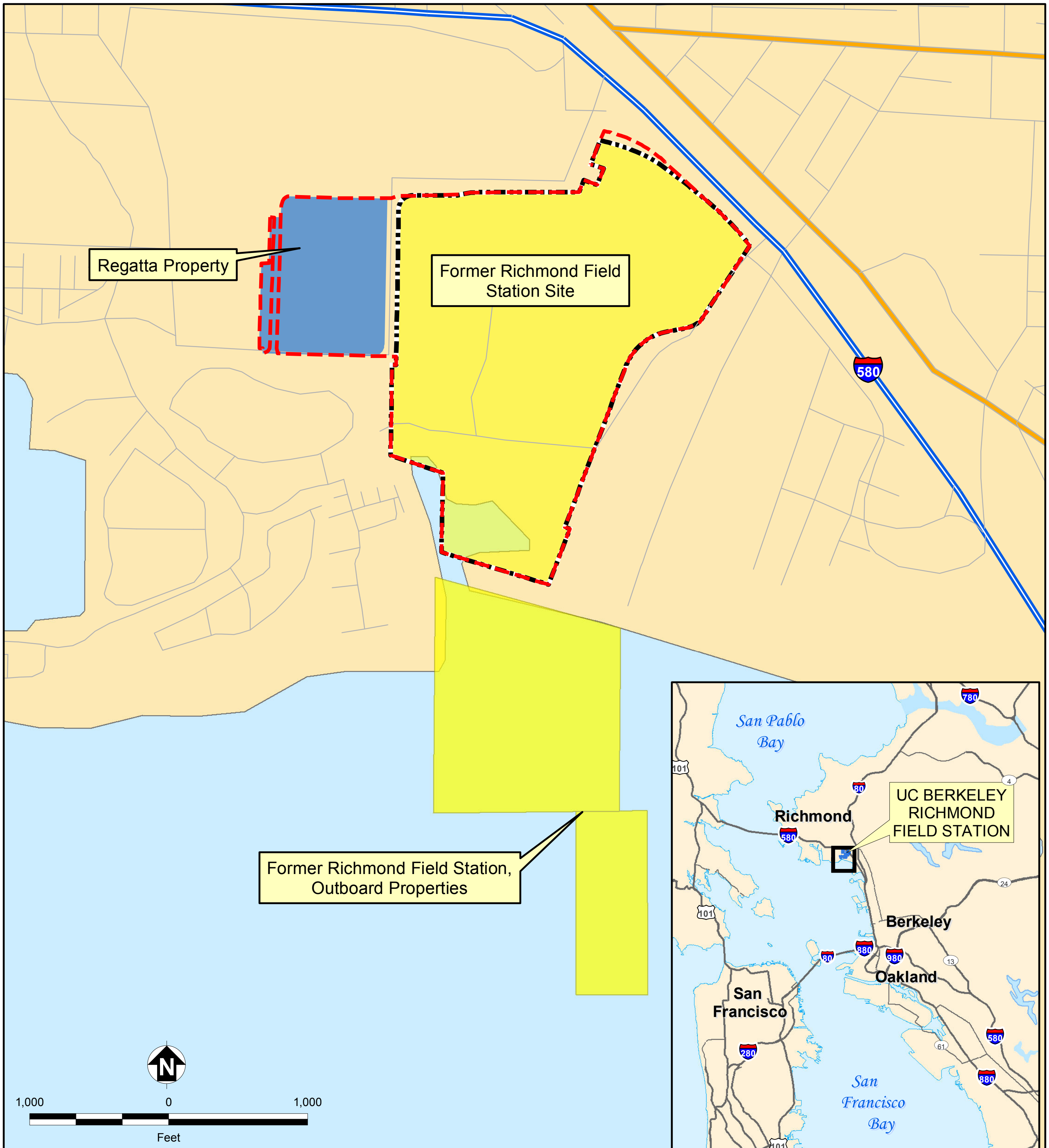
FIGURES



Former Richmond Field Station
Former Richmond Field Station Site
Regatta Property
Richmond Bay Campus

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 1
SITE LOCATION MAP

Phase IV Field Sampling Plan

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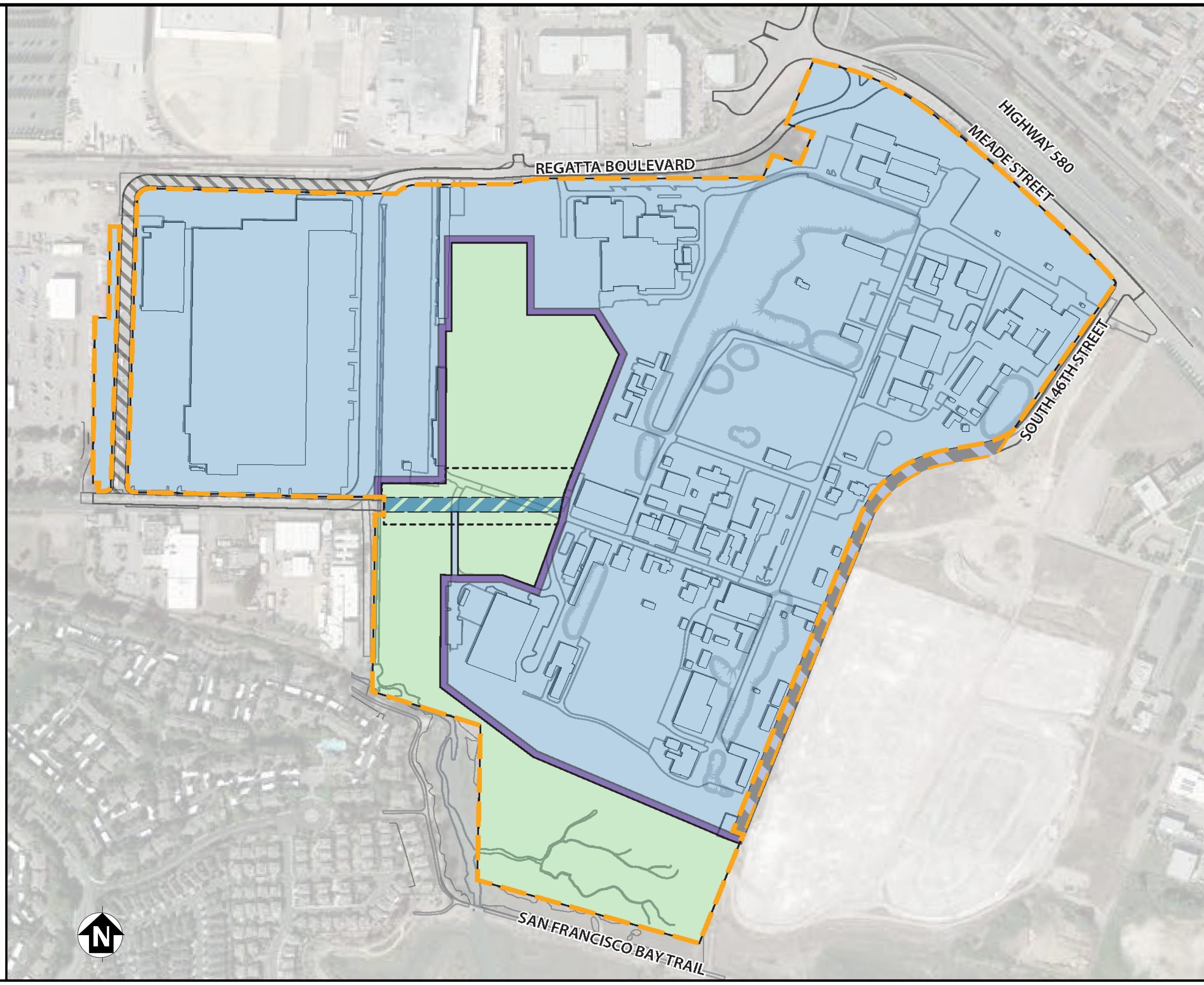

LEGEND

- Property Boundary 134.0 acres
- Natural Open Space 25.0 acres
- Research, Education & Support 107.6 acres
- Potential Road Alignment through Natural Open Space* 0.8 acres
- Zone of Potential Road Alignment through Natural Open Space
- Private Road: 1/3 UC Undivided Interest 0.6 acres
- 25' Buffer Zone
- City of Richmond Realigned Regatta Boulevard

* NOTE: The potential road alignment is illustrative. A road with similar dimensions may be aligned differently but will fall within the Zone of Potential Road Alignment through Natural Open Space.

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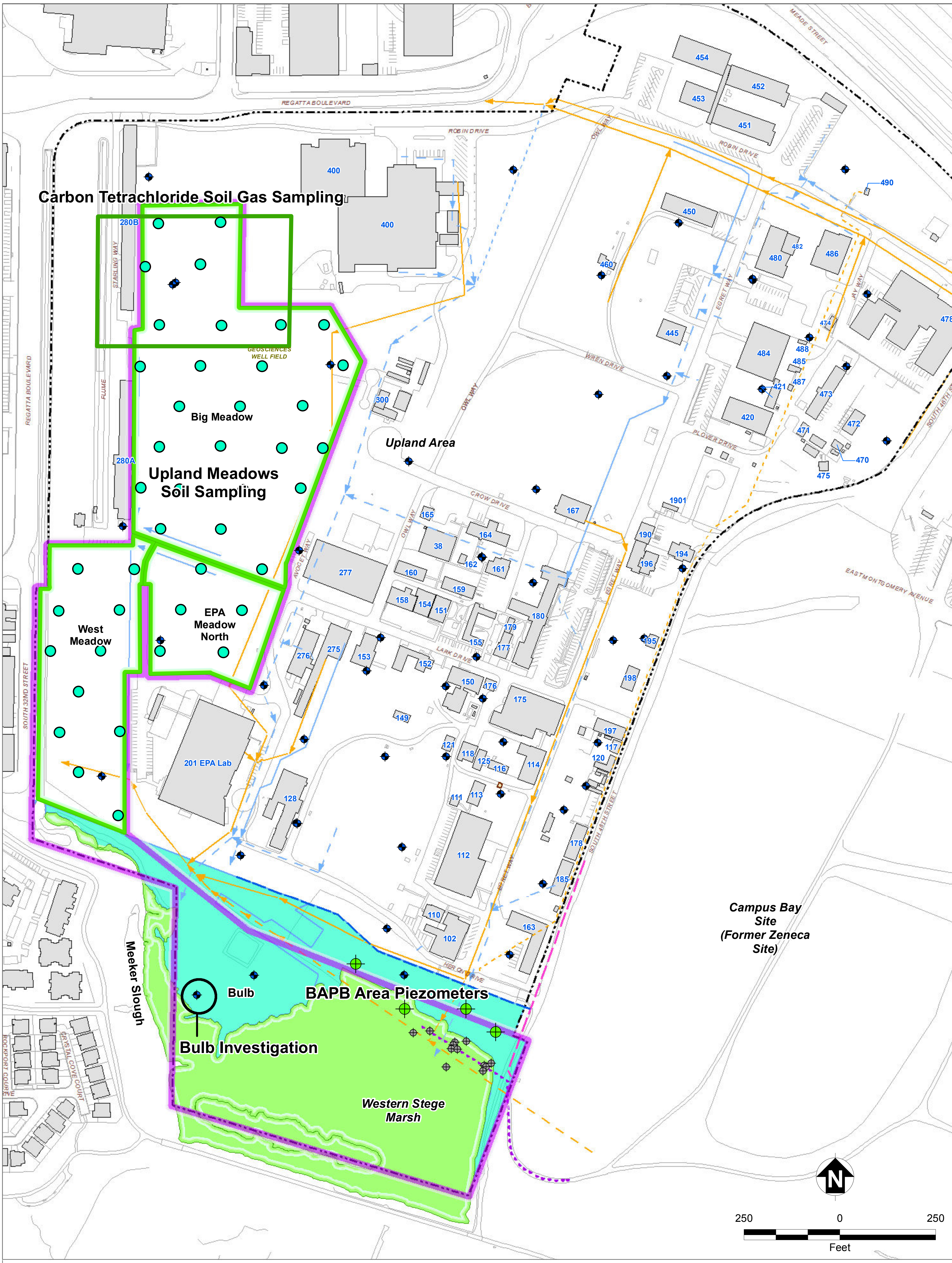
Richmond Field Station Site
University of California, Berkeley

FIGURE 2
RICHMOND BAY CAMPUS
LAND USES

Phase IV Field Sampling Plan



- Proposed Bulb Investigation
- Proposed Upland Meadows Area Soil Sampling Location
- Proposed BAPB Area Piezometer Location
- Western Stege Marsh
- Transition Area
- Designated Natural Open Space
- Carbon Tetrachloride Investigation Area
- Existing Piezometer
- BAPB Wells on RFS Property
- Former Richmond Field Station Site Boundary

Sanitary Sewer Lines:
- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

Storm Drain Lines:
- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 3
PHASE IV SAMPLING AREAS

Phase IV Field Sampling Plan

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- Former Richmond Field Station Site Boundary
- Upland
- Transition Area
- Eastern Transition Area (Remediated)
- Western Transition Area
- Western Stege Marsh
- Remediated portion of Western Stege Marsh

Notes:
Meadow extents shown are the portion of the meadows within the designated Natural Open Space.

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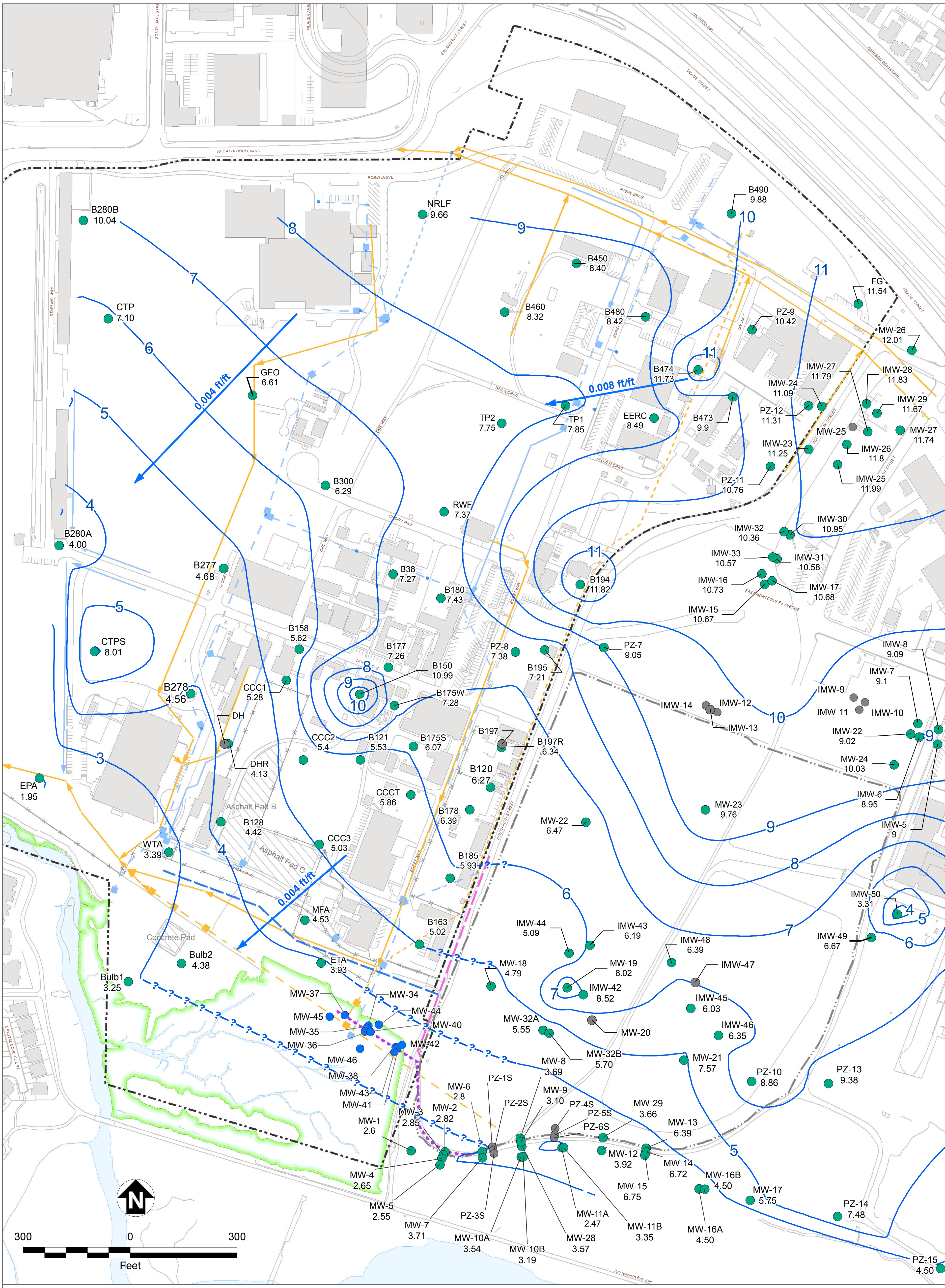
Richmond Field Station Site
University of California, Berkeley

FIGURE 4
SITE MAP

Phase IV Field Sampling Plan



- Piezometer Groundwater Elevation Measured in April 2013
- Piezometer Groundwater Elevation Not Measured in April 2013
- BAPB Wells on RFS Property Not Measured in April 2013
- 1 Estimated April 2013 Groundwater Contour
- ? Contour Estimated due to Proximity to BAPB Wall, Slurry Wall, or Marsh
- Estimated Horizontal Groundwater Gradient Direction (Value)
- Existing Building
- Asphalt/Concrete Pad
- Surface Water
- Marsh Boundary
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Fenceline
- BAPB Wall

- Former Seawall (Approximate)
- Slurry Wall
- Lot 3 (Campus Bay)

Storm Drain Lines:
- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:
- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

Note:
Groundwater contours given in NGVD29..
Horizontal groundwater gradient directions are estimated based on the estimated groundwater contours.

BAPB Biologically Active Permeable Barrier
ft/ft feet per foot

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Richmond Field Station Site
University of California, Berkeley

FIGURE 5
SHALLOW GROUNDWATER ELEVATION CONTOURS, APRIL 1, 2013

Phase IV Field Sampling Plan

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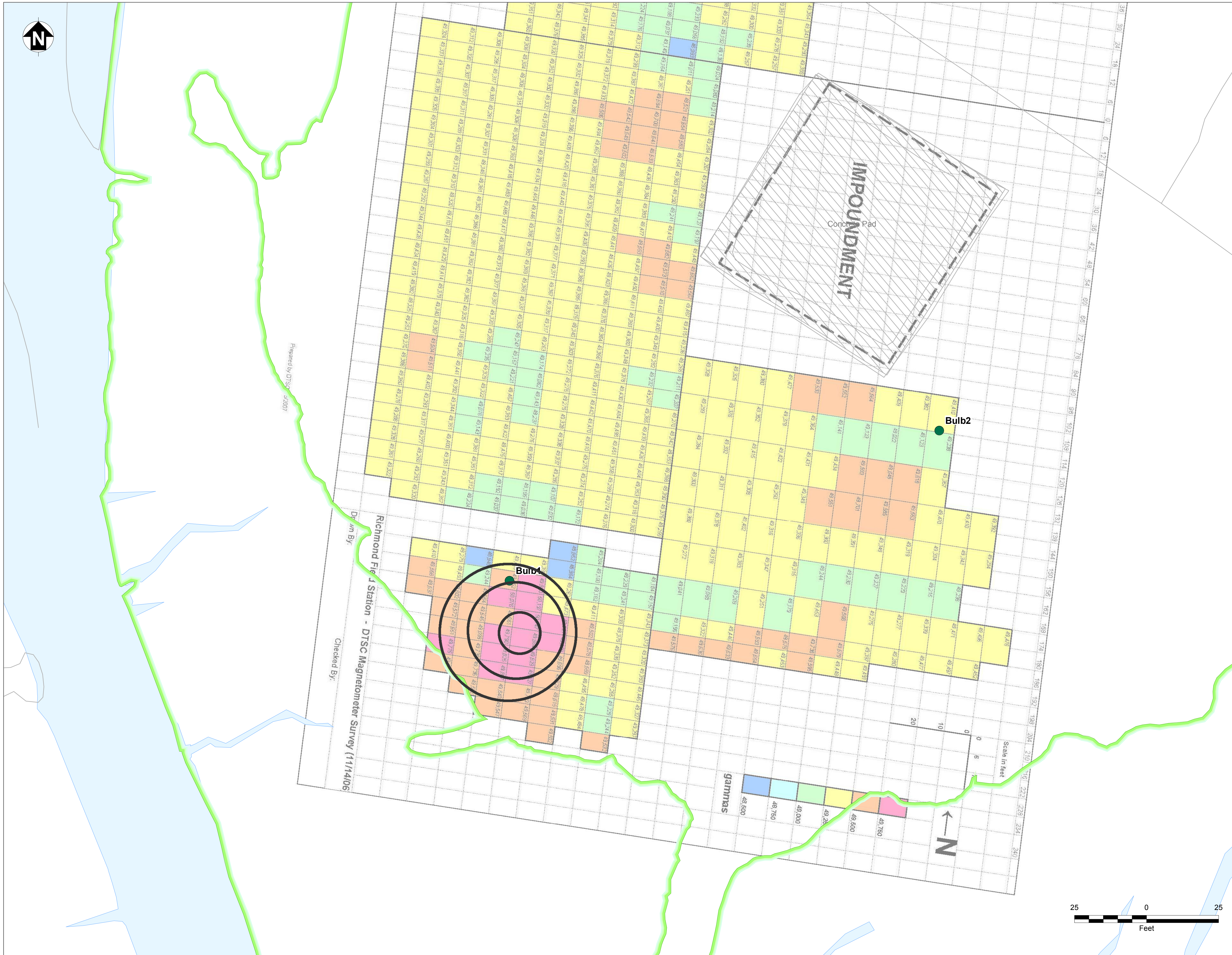

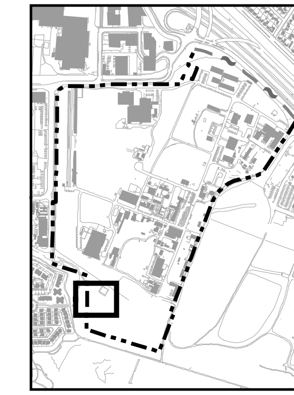

Proposed Investigation Area[1]
Asphalt/Concrete Pad
Marsh Boundary
Surface Water
Piezometer Location

DTSC Magnetometer Survey Results[2]

49,750 gammas
49,500 gammas
49,250 gammas
49,000 gammas
48,750 gammas
48,500 gammas

Note
1. Starting with the innermost circle, area will be investigated, stepping out vertically and horizontally as necessary

2. Magnetometer Survey Map georeferenced using Geographical Information Systems software. "IMPOUNDMENT", corresponding to the concrete pad, was the only landmark; therefore, survey result locations are approximate.

Reference: Magnetometer Survey at University of California Richmond Field Station, Richmond Department of Toxic Substance Control, December 15, 2006 (Appendix B)

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Richmond Field Station Site
University of California, Berkeley

FIGURE 6
PROPOSED BULB M6AGNETIC ANOMALY INVESTIGATION AREA

Phase IV Field Sampling Plan

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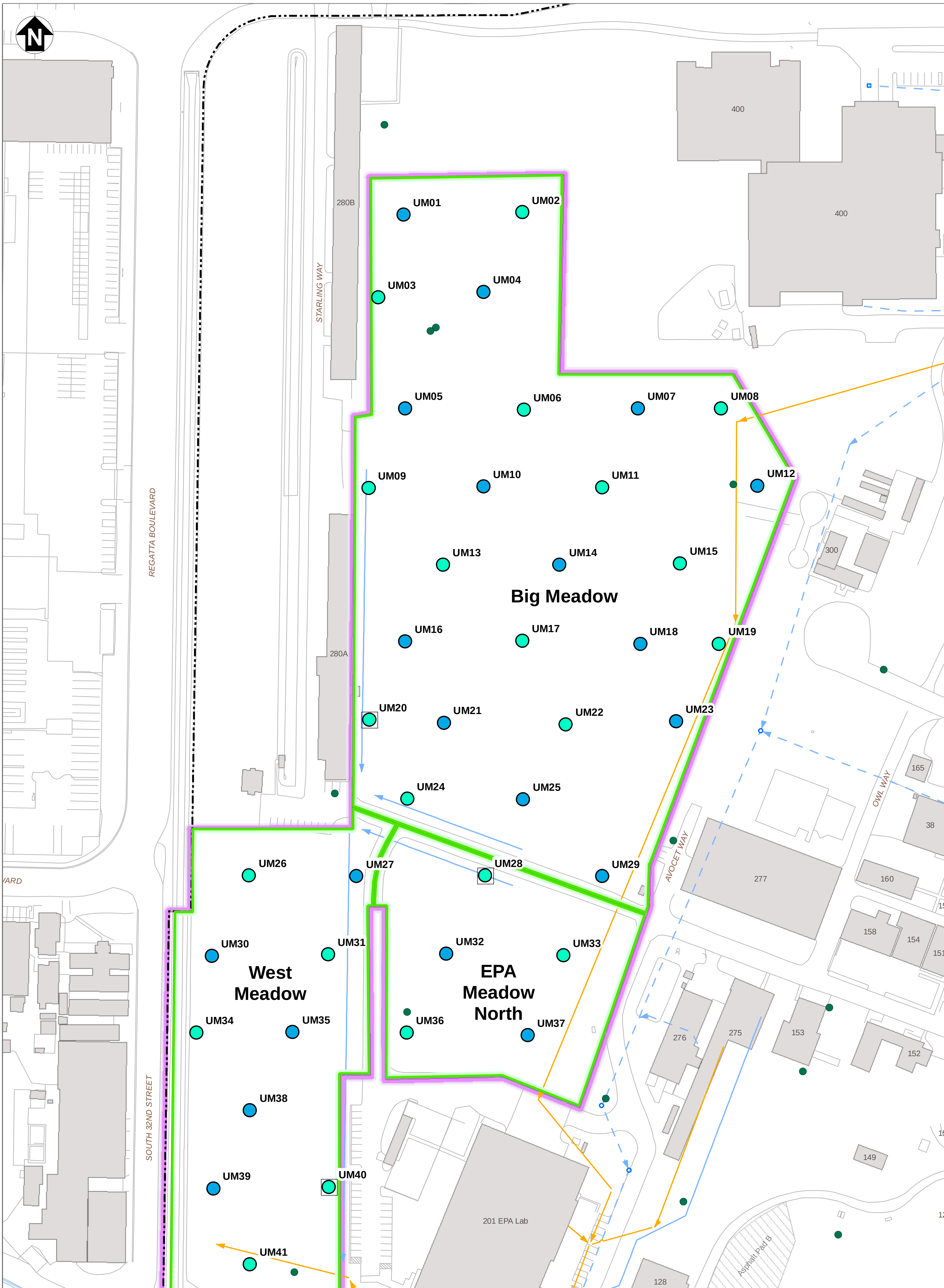

Proposed Soil Sampling Locations

- 0-0.5 feet bgs Soil Sampling Location
- 0-0.5 and 1.5-2 feet bgs Soil Sampling Location
- Sample Location to Include Pesticide Analysis
- Designated Natural Open Space
- Existing Buildings
- Asphalt/Concrete Pads
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Piezometer Location

Storm Drain Lines:

- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:

- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

125 0 125
Feet

Notes:
Meadow extents shown are the portion of the meadows within the designated Natural Open Space.

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Richmond Field Station Site
University of California, Berkeley

FIGURE 7
PROPOSED UPLAND MEADOWS SOIL SAMPLING LOCATIONS

Phase IV Field Sampling Plan

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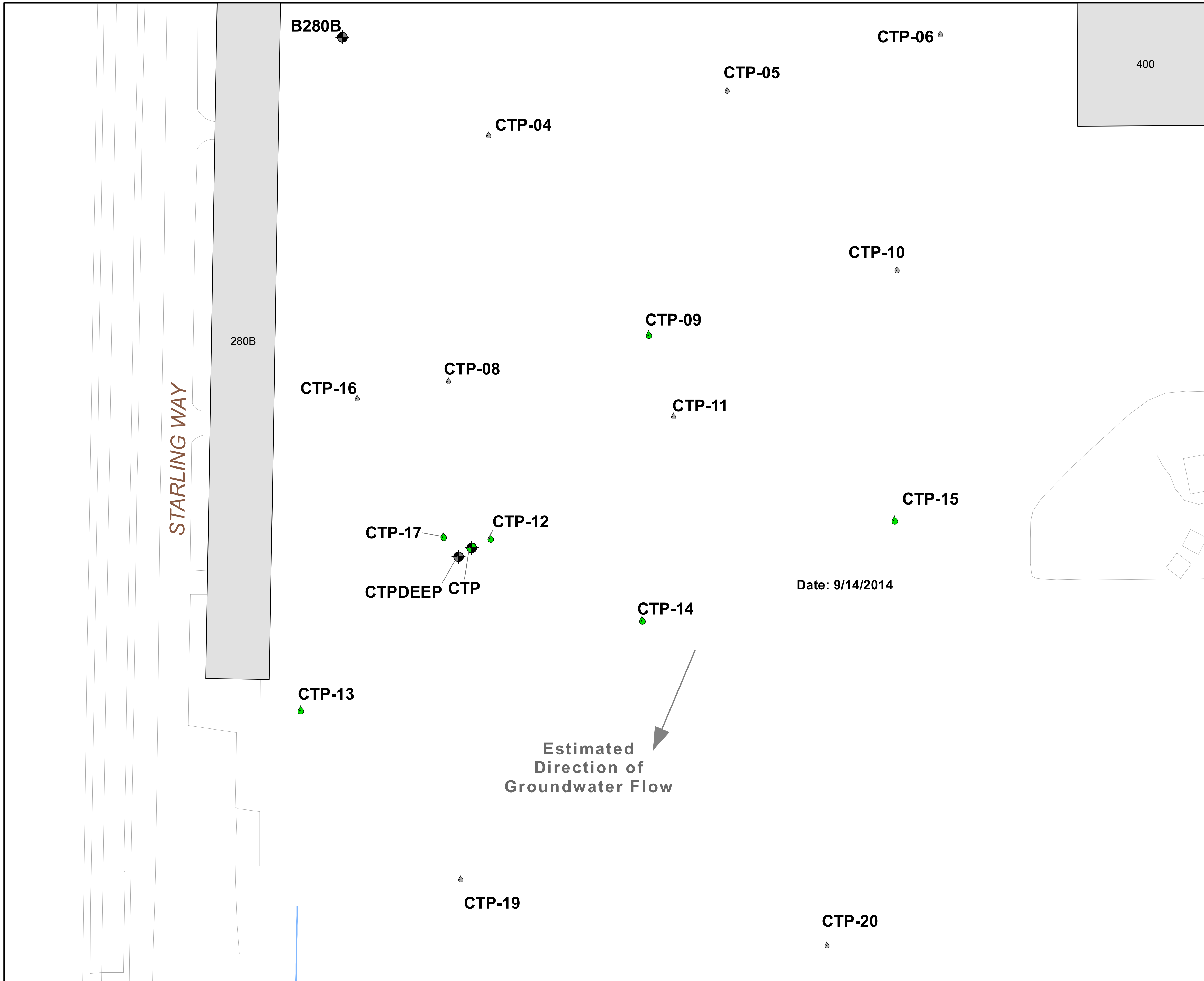
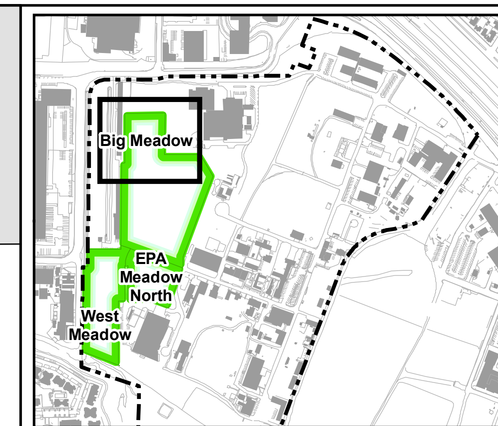




Phase I FSW Piezometer Groundwater[1]

- < 2.63 µg/L (Commercial Vapor Intrusion RBC for Carbon tetrachloride)
- ≥ 2.63 µg/L (Commercial Vapor Intrusion RBC for Carbon tetrachloride)

Phase III FSW Grab Groundwater[2]

- Non-detect
- Carbon tetrachloride Detected
- Existing Building
- Roads and Other Landscape Features

Notes:

1 The maximum concentration at each location is represented.

2 Grab groundwater samples are not considered to be high quality data, therefore the concentrations detected were not compared to screening criteria. The target of the investigation was to confirm or deny the existence of an upgradient source of carbon tetrachloride, therefore this figure indicates whether carbon tetrachloride was detected at each location.

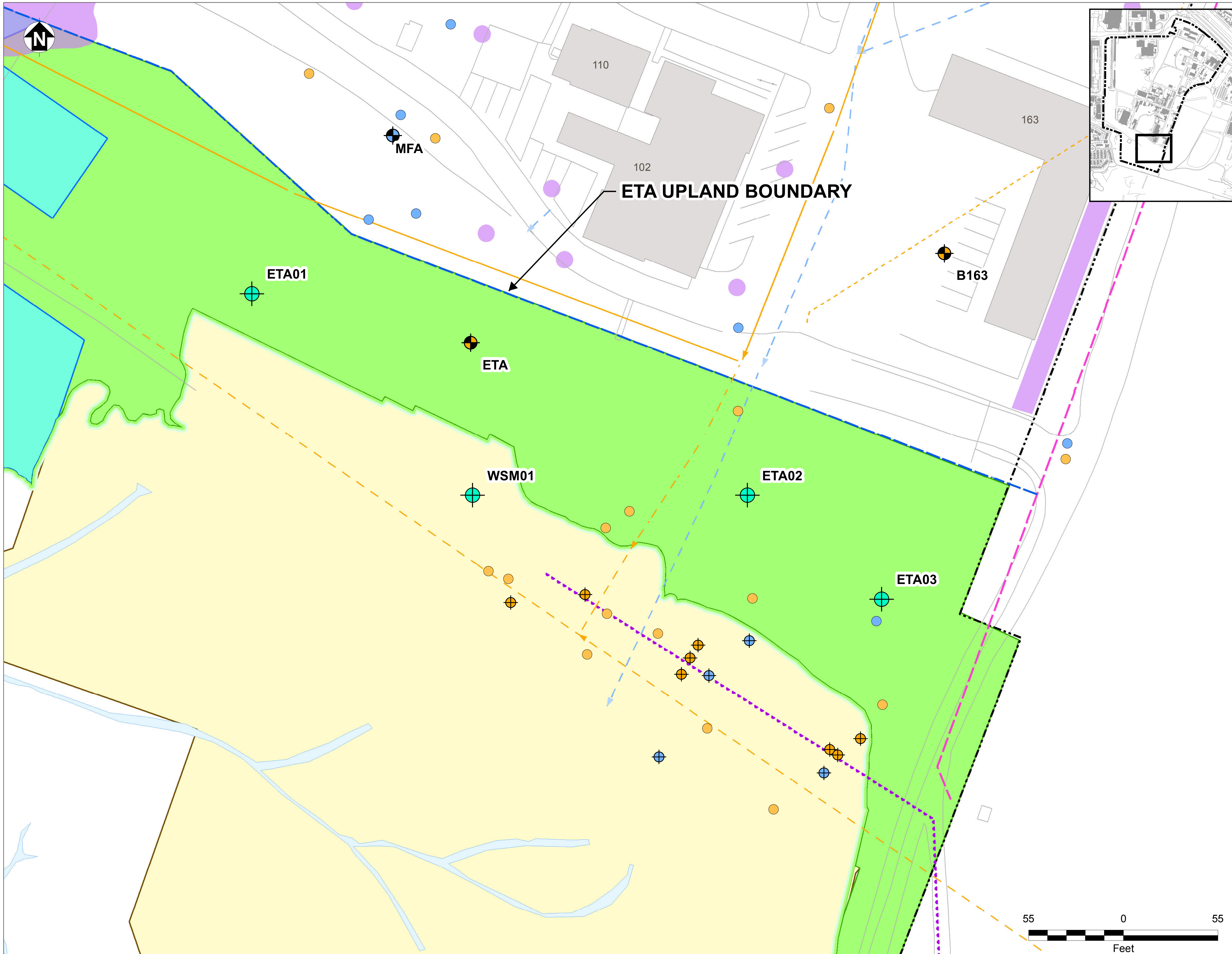
0 25 50 100
Feet

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE 8
PROPOSED SOIL GAS SAMPLING LOCATIONS

Phase IV Field Sampling Plan



Proposed Piezometer Location
FSW Piezometers, Exceeded Aquatic Screening Criteria
FSW Piezometers, Did not Exceed Aquatic Screening Criteria
Biologically Active Permeable Barrier Wells on RFS Property, Exceeded Aquatic Screening Criteria
Biologically Active Permeable Barrier Wells on RFS Property, Did not Exceed Aquatic Screening Criteria
Grab Groundwater Exceeded Aquatic Screening Criteria
Grab Groundwater, Did not Exceed Aquatic Screening Criteria
Marsh Boundary
Existing Buildings
Known Pyrite Cinders Area
Surface Water
Eastern Transition Area
Western Transition Area
Remediated portion of Western Stege Marsh

Sanitary Sewer Lines:

Existing Sewer Line
Removed Sewer Line
Abandoned Sewer Line

Storm Drain Line:

Open Swale
Underground Culvert
Underground Culvert, Abandoned
Biologically Active Permeable Barrier Wall
Former Seawall (Approximate)
Slurry Wall
Former Richmond Field Station Site Boundary
Roads and Other Landscape Features

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Richmond Field Station Site
University of California, Berkeley

FIGURE 9
PROPOSED BAPB AREA GROUNDWATER SAMPLING LOCATIONS
Phase IV Field Sampling Plan

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TABLES

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	
Metals (6020A/7471A)							
Aluminum	100000	6860000	50	--	--	--	1
Antimony	2720	--	5	78	--	0.27	0.25
Arsenic	16 [4,5]	16 [4,5]	18	60	43	46	0.25
Barium	52600	686000	500	330	--	2000	0.25
Beryllium	128	1330	10	40	--	21	0.25
Cadmium	73	762	32	140	0.77	0.36	0.25
Chromium	100000	--	1	0.4	--	130	0.25
Cobalt	34.1	356	13	--	120	230	0.25
Copper	100000	--	70	80	28	49	0.25
Iron	100000	--	--	--	--	--	1
Lead	320 [5,6]	--	120	1700	11	56	0.25
Manganese	5300	68600	220	450	4300	4000	0.25
Mercury	1920	412000	0.3 [7]	0.1 [7]	30.5 [7]	38.5 [7]	0.02
Molybdenum	34000	--	2	--	--	--	0.25
Nickel	1180	12300	38	280	210	130	0.25
Selenium	33500	27400000	0.52	4.1	1.2	0.63	0.25
Silver	34000	--	560	--	4.2	14	0.25
Thallium	68.0	--	1	--	--	--	0.25
Vanadium	34000	--	2	--	7.8	280	0.25
Zinc	100000	--	160	120	46	79	1
VOCs (EPA 8260B)							
Acetone	100000	475000	--	--	--	--	20
Benzene	27.9	0.320	--	--	--	--	5
1,2-Dichloropropane	83.7	0.993	--	--	--	--	5
Ethylbenzene	393	5.94	--	--	--	--	5
Naphthalene	450	3.57	--	--	--	--	5
Toluene	95700	1440	200	--	--	--	5
Trichloroethene	93.7	1.03	--	--	--	--	5
o-Xylene	68100	725	--	--	--	--	5

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	
Chlorinated Pesticides (EPA 8081A)							
Aldrin	0.75	654	--	--	--	--	1.7
alpha-BHC	2.01	1780	--	--	--	--	1.7
beta-BHC	7.04	6040	--	--	--	--	1.7
delta-BHC	2.01	1780	--	--	--	--	1.7
gamma-BHC (Lindane)	11.5	10300	--	--	--	--	1.7
alpha-Chlordane	9.76	9420	--	--	--	--	1.7
gamma-Chlordane	9.76	9420	--	--	--	--	1.7
4,4′-DDD	52.8	46400	--	--	--	--	3.3
4,4′-DDE	37.3	33000	--	--	--	--	3.3
4,4′-DDT	37.3	33000	--	--	--	--	3.3
Dieldrin	0.79	696	--	--	0.022	0.0049	3.3
Endosulfan I	27500	--	--	--	--	--	1.7
Endosulfan II	27500	--	--	--	--	--	3.3
Endosulfan sulfate	27500	--	--	--	--	--	3.3
Endrin	1370	--	--	--	--	--	3.3
Endrin aldehyde	1370	--	--	--	--	--	3.3
Heptachlor	2.82	2460	--	--	--	--	1.7
Heptachlor epoxide	1.39	1230	--	--	--	--	1.7
PCBs (EPA 8082)							
Aroclor-1242	1 [8]	5620	--	--	--	--	12
Aroclor-1248	1 [8]	5620	--	--	--	--	12
Aroclor-1254	1 [8]	5620	40	--	--	--	12
Aroclor-1260	1 [8]	5620	--	--	--	--	12
PAHs by Selected Ion Monitoring (EPA 8270C-SIM)							
Acenaphthene	100000	--	20	--	--	--	5
Acenaphthylene	100000	--	20	--	--	--	5
Anthracene	100000	--	20	--	--	--	5
Benzo(a)anthracene	5.87	11500	--	--	--	--	5
Benzo(a)pyrene	0.963	1150	--	--	--	--	5

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	
BAP (EQ)	0.4 [9]	0.4 [9]					
Benzo(b)fluoranthene	5.87	11500	--	--	--	--	5
Benzo(k)fluoranthene	5.87	11500	--	--	--	--	5
Benzo(g,h,i)perylene	75600	--	--	--	--	--	5
Chrysene	58.7	115000	--	--	--	--	5
Dibenz(a,h)anthracene	0.963	2670	--	--	--	--	5
Fluoranthene	100000	--	--	--	--	--	5
Fluorene	100000	--	20	30	--	--	5
Indeno(1,2,3-cd)pyrene	5.87	11500	--	--	--	--	5
Naphthalene	450	3.57	--	--	--	--	5
Phenanthrene	100000	--	20	--	--	--	5
Pyrene	75600	--	--	--	--	--	5
SVOCs (EPA 8270C)							
Acenaphthene	100000	--	20	--	--	--	67
Acenaphthylene	100000	--	20	--	--	--	67
Anthracene	100000	--	20	--	--	--	67
Benzo(a)anthracene	5.87	11500	--	--	--	--	67
Benzo(a)pyrene	0.96	1150	--	--	--	--	67
Benzo(b)fluoranthene	5.87	11500	--	--	--	--	67
Benzo(k)fluoranthene	5.87	11500	--	--	--	--	67
Benzo(g,h,i)perylene	75600	--	--	--	--	--	67
bis(2-Ethylhexyl)phthalate	647	1330000	100	--	--	--	330
Chrysene	58.7	115000	--	--	--	--	67
Dibenz(a,h)anthracene	0.963	2670	--	--	--	--	67
Di-n-butylphthalate	100000	--	--	--	--	--	330
Fluoranthene	100000	--	--	--	--	--	67
Fluorene	100000	--	20	30	--	--	67
Indeno(1,2,3-cd)pyrene	5.87	11500	--	--	--	--	67
2-Methylnaphthalene	10100	--	20	--	--	--	67
Naphthalene	450	3.57	--	--	--	--	67

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	
Pentachlorophenol	12.2	628000	--	--	--	--	670
Phenanthrene	100000	--	20	--	--	--	67
Pyrene	75600	--	--	--	--	--	67
TPH (EPA 8015B)							
Diesel Range Organics	500 [10]	500 [10]	--	--	--	--	1
Gasoline Range Organics	500 [10]	500 [10]	--	--	--	--	1
Motor Oil Range Organics	2500 [10]	2500 [10]	--	--	--	--	

Notes:

All values are in mg/kg. Only chemicals that have been detected at the Richmond Field Station Site are listed in this table.

1 Screening criteria are risk-based concentrations as calculated in Appendix C of the Site Characterization Report (Tetra Tech 2013a), with the following exceptions: arsenic, lead, Aroclors-1248, -1254, -1260, BAP (EQ), and TPH (see notes 4, 5, 6, 7, 8, and 9). Risk-based concentrations are shown with 3 significant figures, except where the default value of 100,00 mg/kg applies (where calculated value exceeds 100,000 mg/kg). Risk-based concentrations shown are the minimum values between the cancer and noncancer multi-pathway risk-based concentrations. For the off-site receptor, the values shown are the minimum values between the cancer and noncancer inhalation pathway risk-based concentrations calculated for the unrestricted use scenario.

2 Human health screening criteria were developed for all chemicals detected at the site. If a chemical is detected in the future that is not included in the table, risk-based concentrations will be calculated for it, and DTSC will be consulted.

3 Ecological screening criteria are Eco-SSLs from EPA (2010) for plants, invertebrates, birds, and mammals. If an Eco-SSL is not available, ORNL phytotoxicity and earthworm toxicity benchmarks were selected (Efroymson and others 1997a, 1997b).

4 The background level for arsenic (16 mg/kg) was established for the adjacent Campus Bay Site and approved by DTSC for the former RFS Site (Erler & Kalinowski, Inc. 2007; DTSC 2007). The arsenic remedial goal is a not to exceed value, except in cases where arsenic is associated with cinders in soil (see note 5).

5 If lead or arsenic is associated with cinders, manage on site per Section 5.2.3 of the SMP (Appendix C of the RAW, Tetra Tech 2014). If not associated with cinders, investigate further, determine if source is present, and dispose of off-site.

6 A risk-based concentration was not calculated for lead. Rather, the industrial CHHSL of 320 mg/kg (Cal/EPA OEHHA 2009) was used for the maintenance worker scenario. A risk-based concentration for the off-site receptor pathway is not available.

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	

Notes (continued):

7 The mercury screening criteria for plants and invertebrates are ORNL benchmarks and have a high level of uncertainty. Risk decisions for mercury will be based on comparison of site concentrations to back-calculated screening criteria for birds and mammals. These values were derived as follows: the DTSC Human and Ecological Risk Office, Ecological Risk Assessment Section back-calculated $HgCl_2$ no-effect based screening levels for the Robin and the Ornate Shrew based on ORNL No Observable Adverse Effect Level chronic Toxicity Reference Values (Japanese Quail, 0.45 mg/kg-day; Mink, 1.01 mg/kg-day). An area use factor of one and a conservative bioaccumulation factor of one was assumed. Ingestion rates were estimated from Nagy (1991) and incidental soil ingestion rate from US EPA (1993). The mercury soil screening level for the Robin is 30.5 mg/kg and for the Ornate Shrew is 38.5 mg/kg.

8 Based on the TSCA High Occupancy, no further conditions threshold criterion for total PCBs from EPA (2005).

9 The ambient level for BAP (EQ) (0.4 mg/kg) is based on the 95 UCL concentration of the ambient dataset for BaP (EQ) in surface soils in Northern California (DTSC 2009; Environ Corporation and others 2002).

10 Criteria for TPH constituents are based on the RWQCB ESL (RWQCB 2013).

--	Not available	DDT	Dichlorodiphenyltrichloroethane
95 UCL	95th percentile Upper Confidence Limit of the arithmetic mean	DTSC	California Department of Toxic Substances Contro
BAP (EQ)	Benzo(a)pyrene equivalent	EPA	U.S. Environmental Protection Agency
BHC	Hexachlorocyclohexane	ESL	Environmental Screening Level
Cal/EPA	California Environmental Protection Ageny	mg/kg	Milligrams per kilogram
CHHSL	California human health screening level	mg/kg-day	Milligram per kilogram per day
COC	Chemical of concern	PCB	Polychlorinated biphenyl
DDD	Dichlorodiphenyldichloroethane	RBC	Risk-based concentration
DDE	Dichlorodiphenyldichloroethylene	RSL	Regional Screeing Level

Table 1. Human Health and Ecological Screening Criteria and Reporting Limits for Soil

Analyte Group (Method)/Analyte	Human Health Screening Criteria [1,2]		Ecological Screening Criteria [3]				Laboratory Soil Reporting Limit
	Maintenance Worker Screening Criteria	Off-Site Receptor Screening Criteria	Plants	Invertebrates	Birds	Mammals	

Notes (continued):

RWQCB	California Regional Water Quality Control Board	SVOC	Semivolatile organic compound
OEHHA	Office of Environmental Health Hazard Assessment	TPH	Total petroleum hydrocarbons
SIM	Selective ion monitoring	TSCA	Toxic Substances Control Act
SMP	Soil management plan	VOC	Volatile organic compound

References:

Cal/EPA OEHHA. 2009. "Revised California Human Health Screening Levels for Lead." Integrated Risk Assessment Branch, OEHHA, Cal/EPA. September.

DTSC. 2007. Letter to Doug Mosteller from Barbara Cook Concurring on the Recommendation of 16 mg/kg Arsenic as a Good Estimator of the Upper Range of the Ambient Distribution of Arsenic at the Campus Bay Site. October 1.

DTSC. 2009. Use of the Northern and Southern California Polynuclear Aromatic Hydrocarbon (PAH) Studies in the Manufactured Gas Plant Site Cleanup Process. July.

Environ Corporation, Entrix, IRIS Environmental, and Env America. 2002. Background Levels of Polycylic Aromatic Hydrocarbons in Northern California Surface Soil. Prepared for: Pacific Gas and Electric Company and U.S. Navy. June 7.

Nagy, K.A. 1991. Food requirements of wild animals: predicitive equations for free-living mammals, reptiles, and birds. Nutri. Abs. Revs. Ser. B 71(10): 1R-12R.

EPA. 1993. Wildlife Exposure Handbook. EPA/600/R-93/187a.

EPA. 2005. PCB Site Revitalization Guidance Under the Toxic Substances Control Act. November. Available online at: http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/pcb-guid3-06.pdf.

EPA. 2012. "Regional Screening Levels." Screening Levels for Chemical Contaminants. November.

Erler & Kalinowski, Inc. 2007. Technical Memorandum: Background Concentrations of Arsenic in Soil at Campus Bay, Campus Bay Site, Richmond, California. July 23.

RWQCB. 2013. “February 2013 Update to Environmental Screening Levels.” February. Available on-line at: http://www.waterboards.ca.gov/rwqcb2/water_issues/programs/esl.shtml.

Tetra Tech. 2013. Site Characterization Report, Research, Education, and Support Area and Groundwater within the Richmond Field Station Site. May 28.

Table 2. Metals Soil Sampling Results

Screening Criteria	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Thallium	Vanadium	Zinc
Maintenance worker	*100,000*	*2,720*	*1.58*	*52,600*	*128*	*73.0*		*100,000*	*34.1*	*100,000*	*100,000*	*320*		*5,300*	*1,920*	*34,000*	*1,180*		*33,500*	*34,000*		*68.0*	*34,000*	*100,000*
Off-Site Receptors	*6,860,000*	--	*745*	*686,000*	*1,330*	*762*		--	*356*	--	--	--		*68,600*	*41,200*	--	*12,300*		*2,740,0000*	--		--	--	--
Other			*16*[a]																					
Sample Location																								
RFS-MAG-DU1	NA	0.43	11	240	0.61	0.40	NA	67	18	89	NA	31	NA	NA	0.76	1.2	93	NA	0.36	0.71	NA	0.26	40	97

Notes:
All values are reported in mg/kg.
Screening criteria based on the Final Removal Action Plan, Table 3-1, July 18, 2014.

a Background concentration

-- Not applicable
mg/kg Milligrams per kilogram
NA Not available

Table 3. PCB Soil Sampling Results

Screening Criteria	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1248	Aroclor-1254	Aroclor-1260
Maintenance worker	*NA*	*NA*	*NA*	*3.50*	*3.50*	*3.50*	*3.50*
Off-Site Receptor	*NA*	*NA*	*NA*	*5,620*	*5,620*	*5,620*	*5,620*
Other	*1*[a]	*1*[a]	*1*[a]	*1*[a]	*1*[a]	*1*[a]	*1*[a]
Sample Location							
RFS-MAG-DU1	0.068 U	0.14 U	0.068 U	0.068 U	**5.7**	0.068 U	0.34

Notes:
All values are reported in mg/kg.
Bold values indicate that the result exceeded the Category I criterion.
Screening criteria based on the Final Removal Action Plan, Table 3-1, July 18, 2014 (Tetra Tech 2014).

a Other criteria for PCBs are based on TSCA criteria for high occupancy areas with no cap.

NA Not available
TSCA Toxic Substances Control Act
U Not detected

Table 4. Pesticide Soil Sampling Results

Screening Criteria	4,4'-DDD	4,4'-DDE	4,4'-DDT	Aldrin	alpha-BHC	alpha-Chlordane	beta-BHC	Carbazole	Chlordane	delta-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan sulfate	Endrin	Endrin aldehyde	gamma-BHC (Lindane)	gamma-Chlordane	Heptachlor	Heptachlor epoxide	Methoxychlor	Mirex	Pentachlorophenol	Toxaphene
Maintenance worker	52.8	37.3	37.3	0.745	2.01	9.76	7.04	934	9.76	2.01	0.792	27500	27500	27500	1370	1370	11.5	9.76	2.82	1.39	--	0.704	12.2	--
Off-Site Receptors	46400	33000	33000	654	1780	9420	6040	291000	9420	1780	696	--	--	--	--	--	10300	9420	2460	1230	--	628	628000	--
Sample Location																								
RFS-MAG-DU1	0.01 U	0.017 C	0.01 U	0.0052 U	0.0052 U	0.0052 U	0.0052 U	NA	NA	0.0085	0.0052 U	0.0052 U	0.0052 U	0.0058 CJ	0.012	0.0068 CJ	0.0038 CJ	0.0052 U	NA	0.079 C	0.052 U	NA	NA	0.18 U

Notes:
All values are reported in mg/kg.
Only chemicals that were detected or have screening criteria are listed.
Bold value indicates that result exceeded the Category I criterion.
Screening criteria based on the Final Soil Management Plan, Table C-1, July 18, 2014.

-- Not applicable
BHC Hexachlorocyclohexane
DDD Dichlorodiphenyldichloroethane
DDE Dichlorodiphenyldichloroethene
DDT Dichlorodiphenyltrichloroethane
mg/kg Milligrams per kilogram
NA Not available
C Presence confirmed, but relative percent difference between columns exceeds 40 percent
J Estimated value
U Not detected

Table 5. SVOC Soil Sampling Results

Screening Criteria	1-Methylnaphthalene	2-Methylnaphthalene	4-Methylphenol	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic Acid	bis(2-Ethylhexyl)phthalate	Chrysene	Dibenz(a,h)anthracene	di-n-Butylphthalate	Fluoranthene	Fluorene	Indeno(1,2,3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene
Maintenance worker	*243*	*10100*	*100000*	*100000*	*100000*	*100000*	*5.87*	*0.963*	*5.87*	*75600*	*5.87*	--	*647*	*58.7*	*0.963*	*100000*	*100000*	*100000*	*5.87*	*450*	*100000*	*75600*
Off-Site Receptors	--	--	*823000000*	--	--	--	*11500*	*1150*	*11500*	--	*11500*	--	*1330000*	*115000*	*2670*	--	--	--	*11500*	*3.57*	--	--
Sample Location																						
RFS-MAG-DU1	NA	0.025 J	0.4 U	0.002 J	0.0078	0.0054	0.014	0.016	0.028	0.0088	0.0057	0.63 J	NA	0.023	0.0037 J	NA	0.0026	0.0052 U	0.0056	0.012	0.047*	0.003

Notes:
All values are reported in mg/kg. Values reported are from the 8270C-SIM analysis, except for 2-methylnapthalene, 4-methylphenol, and benzoic acid, which are from the 8270C analysis.
Only chemicals that were detected or have screening criteria are listed.
Screening criteria based on the Final Removal Action Plan, Table 3-1, July 18, 2014.
*Result from analysis 8270C is 0.038 J.

-- Not applicable
mg/kg Milligrams per kilogram
NA Not available
J Estimated value
U Not detected

Table 6. Benzo(a)Pyrene Equivalency Calculations

PAH	RFS-MAG-DU1 Result	Potency Equivalency Factor (EPA 2011)	BAP EQ (RFS-MAG-DU1)
Benzo(a)anthracene	0.014	*0.1*	0.0014
Benzo(b)fluoranthene	0.028	*0.1*	0.0028
Benzo(k)fluoranthene	0.0057	*0.01*	0.000057
Benzo(a)pyrene	0.016	*1*	0.016
Chrysene	0.023	*0.001*	0.000023
Dibenz(a,h)anthracene	0.0037	*1*	0.0037
Indeno(1,2,3-cd)pyrene	0.0056	*0.1*	0.00056
BAP EQ Screening Criterion			***0.4***
Total BAP EQ			**0.025**

Notes:
All values reported in mg/kg.
BAP EQ Benzo(a)pyrene equivalency
EPA U.S. Environmental Protection Agency
mg/kg Milligrams per kilogram
NA Not applicable
PAH Polycyclic aromatic hydrocarbon

Table 7. Aquatic Screening Criteria and Reporting Limits for Groundwater

Analyte Group (Method)/Analyte	Aquatic Screening Criteria: 10 x Ambient Water Quality Criteria [1]	Aquatic Screening Criteria: Marine Aquatic Toxicty Criteria [2]	Laboratory Water Reporting Limit
Metals (6020A/7471A)			
Antimony	43000	--	1
Arsenic	--	36	1
Cadmium	--	9.3	1
Copper	--	3.1	1
Lead	--	8.1	1
Mercury	--	2.1	0.2
Nickel	46000	8.2	1
Selenium	42000	5	1
Silver	--	1.9	1
Thallium	63	--	1
Zinc	260000	81	5
VOCs (EPA 8260B)			
Benzene	710	--	0.5
Carbon tetrachloride	44	--	0.5
Chlorobenzene	210000	--	0.5
Chloroform	4700	--	0.5
1,2-Dichlorobenzene	170000	--	0.5
1,4-Dichlorobenzene	26000	--	0.5
1,2-Dichloroethane	990	--	0.5
1,1-Dichloroethene	32	--	0.5
trans-1,2-Dichloroethene	1400000	--	0.5
1,2-Dichloropropane	390	--	0.5
Ethylbenzene	290000	--	0.5
1,1,2,2-Tetrachloroethane	110	--	0.5
Tetrachloroethene	89	--	0.5
Toluene	2000000	--	0.5
1,1,2-Trichloroethane	420	--	0.5
Trichloroethene	810	--	0.5
Vinyl chloride	5300	--	0.5

Notes:

All values are in µg/L. Only chemicals that have screening criteria are listed in this table.

1 Based on 10 times the surface water AWQC for human consumption of aquatic organisms, with a dilution factor of 5 applied (see note 3). Human health criteria based on consumption of aquatic organisms are from the following sources in order of preference: CTR (EPA 2000) and the NRWQC (EPA 2006). The aquatic screening criteria is based on 10 times those values to allow for dilution and attenuation in the bulk surface water (e.g., tidal surface water in the marsh).

2 Based on the marine aquatic toxicity criteria, with a dilution factor of 5 applied (see note 3). Marine aquatic toxicity criteria are the continuous concentration criteria, where available, from the more stringent of the Basin Plan (RWQCB 2006) or the CTR (U.S. EPA 2000), the NRWQC (EPA 2006b), and the PER (1999).

3 The dilution factor of 5 for groundwater near the BAPB was developed and presented in Appendix I of the Draft Feasibility Study and Remedial Action Plan for Lots 1, 2, and 3 of the neighboring Campus Bay facility (EKI 2008).

µg/L Micrograms per liter
AWQC Ambient water quality criteria
BAPB Biologically active permeable barrier
CTR California Toxics Rule
EPA U.S. Environmental Protection Agency
NRWQC National Recommended Water Quality Criteria
PER Pacific EcoRisk

Table 7. Aquatic Screening Criteria and Reporting Limits for Groundwater

Notes (continued):

RWQCB	San Francisco Bay Regional Water Quality Control Board
VOC	Volatile organic compounds

References:

EKI. 2008. Draft Feasibility study and Remedial Action Plan for Lots 1, 2, and 3, Campus Bay Site, Richmond, California, April 30, 2008.

EPA. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic for the State of California; Rule, Federal Register 40 CAR Part 131, May 2000, available at: http://www.epa.gov/waterscience/standards/ctr/toxic.pdf.

EPA. 2002. National Toxics Rule. 40 CFR Ch I (7-1-02). Section 131.36. U.S. Environmental Protection Agency. 2002.

EPA. 2006a. Code of Federal Regulations. Title 40, Part 131 - Water Quality Standards. U.S. Environmental Protection Agency.

EPA. 2006b. National Recommended Water Quality Criteria. U.S. Environmental Protection Agency, Office of Water, Office of Science and Technology. Available at: http://epa.gov/waterscience/criteria/nrwqc-2006.pdf

PER. 1999. Sediment Quality in Stege Marsh: 1. Ecological Risk Assessment. Pacific EcoRisk.

RWQCB. 2006. Water Quality Control Plan (Basin Plan) for the San Francisco Bay Basin. San Francisco Bay Regional Water Quality Control Board, December.

Table 8. QAPP Reference Locations

Preparation for Field Activities	Reference Section in QAPP [1]
Utility Clearance	Appendix B of FSW, Table 4-2
HASP	Appendix B of FSW, HASP
Analytical Methods	Section 7.2
Analytical Laboratory Selection	Section 7.4
Analytical Requirements	Section 7.3 and Table A-12
Field Sampling	
Chain-of-Custody Requirements	Section 5.4
Soil Sampling Using a Hand Auger	Section 4.1.1.1
Soil Sampling from a Direct-Push Rig (Split and Solid Barrel)	Section 4.1.1.2
Drilling via Direct Push	Section 4.1.3.1
Drilling via Hollow Stem Auger	Section 4.1.3.2
Passive Soil Gas Sampling	Section 4.6.1
Groundwater Sampling from a Well	Section 4.3.2
VOC Encore Sampling	Section 4.1.2.1
Management of Investigation-Derived Waste	Section 4.11
Decontamination	Section 4.10
Field Quality Control Samples	
Equipment Rinsate Samples	Section 4.9 and 3.2.2
Source Water Blank	Section 4.9 and 3.2.2
Temperature Blanks	Section 4.9 and 3.2.2
Trip Blanks	Section 4.9 and 3.2.2
Laboratory Quality Control Samples	
Method Blanks	Section 3.2.2
MS/MSD	Section 3.2.2
Laboratory Control Samples	Section 3.2.2
Surrogate Standards	Section 3.2.2
Field Equipment Testing, Inspection, and Maintenance	
Calibration of Field Equipment	Section 6.1
Maintenance of Field Equipment	Section 11.1

Notes:

1 The QAPP is Appendix A of the FSW (Tetra Tech 2010).

FSW Field Sampling Workplan
HASP Health and Safety Plan
MS/MSD Matrix Spike and Matrix Spike Duplicates
QAPP Quality Assurance Project Plan
VOC Volatile organic compound

Reference:

Tetra Tech. 2010. Phase I Groundwater Field Sampling Workplan, University of California, Berkeley, Richmond Field Station, Richmond, California. June 2.

Table 9. Sample Registry and Rationale

Sampling Location/ ID Number [1,2]	Matrix	Depth (feet bgs)	Analytical Group (Method)	Number of Samples [3]	Rationale
Soil Investigation in the Upland Meadows					
UM01 to UM42 / UM0101 to UM4201 (as indicated by Figure 5)	Soil	0.0-0.5 (as indicated by Figure 6)	Metals (6020A/7471A), PCBs (8082), and PAHs (8270SIM)	42	Gridded soil sampling to assess soils in the Upland Meadows
UM01 to UM42 / UM0102 to UM4202 (as indicated by Figure 5)	Soil	1.5-2.0 (as indicated by Figure 6)	Metals (6020A/7471A), PCBs (8082), PAHs (8270SIM), and VOCs (8260B)	21	Gridded soil sampling to assess soils in the Upland Meadows
UM01, UM03, UM09, UM20, UM28, and UM40/ UM0101, UM0301, UM0901, UM2001, UM2801, and UM4001	Soil	0.0-0.5	Pesticides (8081A)	6	Areas near buildings could have been exposed to pesticides
Carbon Tetrachloride Area Soil Gas Sampling					
SGCT01 to SGCT32 / SGCT01 to SGCT32	Soil Gas	2.0-3.0	VOCs (8260C)	32	Gridded soil gas sampling, centered around piezometer CTP to attempt to identify a carbon tetrachloride source in soil; one background soil gas location
BAPB Area Groundwater Sampling					
ETA01 to ETA03, WSM01 / ETA01GW01 to ETA03GW01, WSM01GW01	Groundwater	TBD in field	Metals (6020A/7470A) and VOCs (8260B)	4	Groundwater samples collected to assess groundwater conditions upgradient and crossgradient of the BAPB

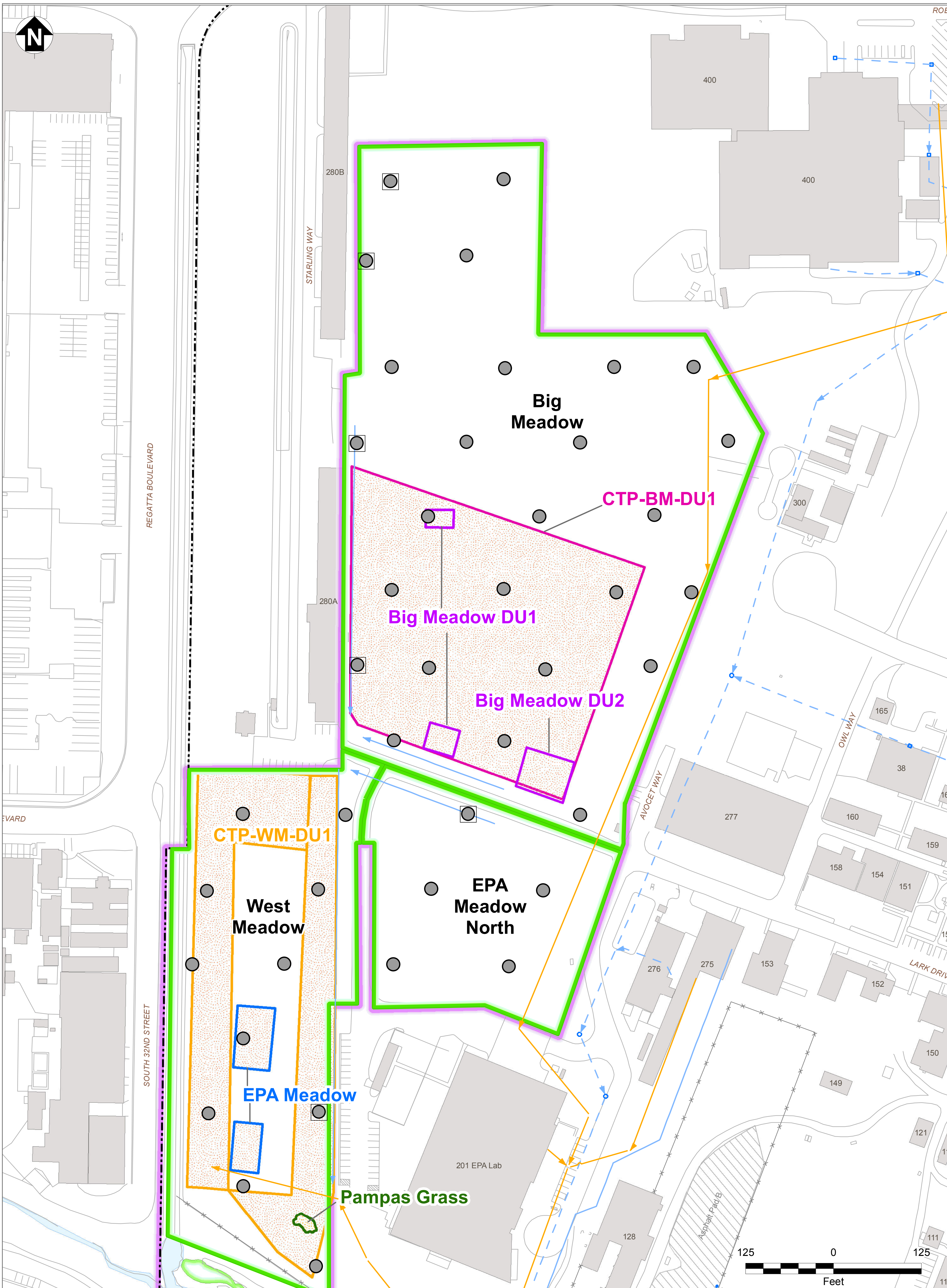
Table 9. Sample Registry and Rationale

Notes:

1 Location IDs are identical to sample IDs except for addition of two numbers in the sample ID indicating separate depths at each location where applicable.
2 Field QC and field duplicate sample locations will be chosen by field personnel based on field conditions. “D1” and “D2” will be added to the sample ID of field duplicate samples, as appropriate.
3 Number of samples do not include field QC samples.

BAPB	Biologically active permeable barrier
bgs	Below ground surface
ID	Identification
QC	Quality control
PAH	Polycyclic aromatic hydrocarbon
PCB	Polychlorinated biphenyl
SVOC	Semivolatile organic compound
TPH-e	Total extractable petroleum hydrocarbons
TPH-p	Total purgeable petroleum hydrocarbons
TBD	To be determined
VOC	Volatile organic compound

APPENDIX A
ISM SAMPLING LOCATIONS IN THE UPLAND MEADOWS



Area of ISM Sampling

Proposed Soil Sampling Locations

Designated Natural Open Space

Existing Buildings

Asphalt/Concrete Pads

Former Richmond Field Station Site Boundary

Roads and Other Landscape Features

Storm Drain Lines:

Open Swale

Underground Culvert

Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:

Existing Sewer Line

Removed Sewer Line

Abandoned Sewer Line

Notes:
Meadow extents shown are the portion of the meadows within the designated Natural Open Space.

TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE A-1
ISM SAMPLING LOCATIONS IN THE UPLAND MEADOWS

Phase IV Field Sampling Plan

6/3/2014 V:\Misc_GIS\Richmond_Field_Station\Projects\Field_Sampling_Workplan\Phase_IV\layouts\ISM_Sampling Upland Meadows_.mxd yashekia.evans

SHADE HOUSE, COASTAL TERRACE PRAIRIE, AND EPA MEADOW RESTORATION PLOTS

TETRA TECH EM INC.

October 11, 2007

Karl Hans
Office of Environment, Health & Safety
University of California, Berkeley
University Hall, 3rd Floor #1150
Berkeley, CA 94720

Subject: Sampling Results for Shade House and Coastal Prairie Surface Soil Samples University of California, Berkeley, Richmond Field Station, Richmond, California

Dear Mr. Hans:

Tetra Tech EM Inc. (Tetra Tech) was contracted by UC Berkeley to conduct sampling activities at Richmond Field Station (RFS), in Richmond, California. The objective of the sampling effort was to characterize surface soils at the Shade House and from areas within the coastal prairie area (two within the Big Meadow and one within the EPA Meadow). Soil samples were collected to evaluate soil conditions at the request of staff of The Watershed Project (TWP) who planted and weeded in surface soils during TWP restoration activities in these areas. This letter provides the rationale for the selected sampling locations, a summary of field sampling protocols, and sample results. Figures presenting the sampling locations are presented at the end of this letter. Complete analytical results are presented in Attachment 1.

Sample Locations

Multi-increment sampling was selected for this project to provide a comprehensive and thorough evaluation of a specific area of exposure, or decision unit. The multi-increment sampling strategy for this project was based on selecting decision units to best represent soil exposure by TWP staff. Decision unit selection was based on interviews conducted with Kari Rodenkirchen and Martha Berthelsen of TWP. Ms. Rodenkirchen was directly involved in all site activities conducted by TWP within the Shade House area. Ms. Berthelsen was directly involved in all site activities conducted by TWP within the Big Meadow and EPA Meadow.

Ms. Rodenkirchen and Ms. Berthelsen provided Tetra Tech with site-specific boundaries and a description of surface soil activities conducted by TWP in the areas. Based on this information, Tetra Tech identified the Shade House Decision Unit, Big Meadow Decision Unit 1, Big Meadow Decision Unit 2, and the EPA Meadow Decision Unit. Decision unit locations are presented on Figures 1, 2, and 3 at the end of this letter. Surface sample depths of 0 to 8 inches below ground surface (bgs) were also based on discussions with Ms. Rodenkirchen and Ms. Berthelsen and are intended to represent exposure to soils during planting.

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Field Sampling Protocols

Surficial soil samples were collected on September 12, 2007. Decision units were identified in the field based on the discussions with TWP staff discussed above. One multi-increment surface soil sample was collected from each of the decision units. The multi-increment soil sample consisted of 50 subsamples, or increment locations, collected from 0 to 8 inches bgs within each decision unit.

The multi-increment sampling technique was used to maximize the goal of obtaining sufficient material over the decision unit to account for both compositional and distributional heterogeneity of any possible contamination. The sampling protocol followed these steps:

1. The field sampler began at a corner of the decision unit and sampled in an orthogonal pattern, moving from north to south to collect subsamples from 50 locations within each decision unit. The location of the subsamples was not critical as long as they were distributed throughout the decision unit. The samples were collected with a disposable trowel. A pick-axe was used to break up the surface soil at areas where the soil was too hard or compact to collect with the trowel. The soil was placed into a new, disposable paper bag. A new paper bag was used for each decision unit and disposed after a single use.

2. The 50 subsamples were mixed in the bag to form one composited, multi-increment sample.

3. The soil from each bag was redistributed into a 1-inch thick uniform layer within a disposable aluminum pan.

4. Fifty incremental subsamples of the soil were randomly collected from across the aluminum pan using a disposable spoon to form the final sample submitted to the laboratory.

One field duplicate was collected at Big Meadow Decision Unit 1. The duplicate was collected consistent with the steps above; however, in the first step, the field sampler began sampling at a different corner of the decision unit. Results of the field duplicate were used as a measure to evaluate the heterogeneity of the coastal prairie soil at RFS.

Following collection, all samples were labeled, wrapped with protective bubble wrap material, placed into sealable plastic bags, and packed into insulated coolers prepared with frozen Blue Ice® to maintain the temperature at or below 4° Celsius. No non-consumable materials were used during the sampling event; therefore, decontamination was not necessary. A copy of the chain-of-custody form is presented in Attachment 1. The sample cooler was delivered to Curtis and Tompkins, Ltd. in Berkeley, California on September 12, 2007.

Sample Results

Soil samples were analyzed for metals; total petroleum hydrocarbons (TPH) as gas, motor oil, and diesel; pesticides; polychlorinated biphenyls (PCBs); and semi-volatile organic compounds (SVOC) using the methods listed below.

- Preparation of Sample: EPA 3520C
- Metals by EPA 6020; Mercury by EPA 7471A
- TPH by EPA 8015Modified and 3630C
- PCB analysis by EPA 8081A
- SVOC analysis by EPA 8270

Sample results are presented below along with California Human Health Screening Levels (CHSSLs) ["Use of California Human Health Screening Levels (CHSSLs) in Evaluation of Contaminated Properties" California Environmental Protection Agency, January 2005]. Where CHSSLs are not available, other screening levels are presented, such as the Federal Region 9 EPA Preliminary Remediation Goals and the California Regional Water Quality Control Board's Environmental Screening Levels.

TPH, SVOC, PESTICIDE, AND PCB RESULTS
REPORTED IN MICROGRAMS PER KILOGRAM (mg/kg)

	TPH (1)			SVOCs (2)	Pesticides (3)		PCBs (4)	
Sample Location	**Gasoline**	**Diesel**	**Motor Oil**	**Fluoranthene**	**4,4'-DDE**	**4,4'-DDT**	**Arochlor 1254**	**Arochlor 1260**
CHSSL Residential	*--*	*--*	*--*	*--*	*1.6*	*1.6*	*0.089*	*0.089*
CHSSL Commercial	*--*	*--*	*--*	*--*	*6.3*	*6.3*	*0.3*	*0.3*
CRWQCB Residential Non Drinking Water	*400*	*500*	*500*	*--*				
CRWQCB Commercial Non Drinking Water	*400*	*500*	*1,000*	*--*				
EPA Region 9 Residential PRG	*--*	*--*	*--*	*2,300*				
EPA Region 9 Commercial PRG	*--*	*--*	*--*	*22,000*				
Shade House	ND	110 110	410 250	ND	ND	ND	0.030	0.01
Big Meadow DU 1	ND	15 20	170 240	ND	ND	ND	0.047	0.016
Big Meadow DU 1 Duplicate	ND	40 35	400 240	ND	ND	ND	0.047	0.015
Big Meadow DU 2	ND	7.1 6.0	96 110	0.18	ND	ND	0.014	0.0079
EPA Meadow	ND	21 9.1	99 84	ND	0.011	0.048	0.024	0.027

Notes:

ND Not detected
1. Bottom result prepared with EPA Method 3630 to minimize organic interference
2. All other SVOCs not detected
3. All other pesticides not detected
4. All other PCBs not detected

METALS RESULTS
REPORTED IN MICROGRAMS PER KILOGRAM (mg/kg)

Sample Location	Metals															
	Antimony	**Arsenic (1)**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Vanadium**	**Zinc**
CHSSL Residential	*30*		*5,200*	*150*	*1.7*	*100,000*	*660*	*3,000*	*150*	*18*	*380*	*1,600*	*380*	*380*	*5*	*530*	*23,000*
CHSSL Commercial	*380*		*63,000*	*1,700*	*7.5*	*100,000*	*3,200*	*38,000*	*3,500*	*180*	*4,800*	*16,000*	*4,800*	*4,800*	*63*	*6,700*	*100,000*
Background		*16*															
Shade House	1.3	15	200	0.5	0.5	53	12	110	44	3.8	1.4	43	ND	ND	ND	46	170
Big Meadow DU 1	0.79	5.6	170	0.45	0.22	34	11	47	41	0.94	0.26	30	0.38	ND	ND	31	67
Big Meadow DU 1 Duplicate	0.71	5.8	160	0.47	0.21	37	11	41	35	0.89	0.15	35	ND	ND	ND	33	71
Big Meadow DU 2	0.49	6.3	140	0.48	ND	43	9.4	20	26	0.36	ND	25	ND	ND	ND	43	42
EPA Meadow	0.74	6.3	250	0.56	0.35	37	26	28	49	0.3	ND	39	0.69	ND	ND	39	84

Notes:

ND Not detected
1. Arsenic screening value based on DTSC-approved ambient level at the adjacent CSV site.

All sample results were either not detected or below the screening levels.

If you have any questions or comments regarding this submittal, please call me at (415) 222-8283.

Sincerely,

Jason Brodersen, P.G.
Project Manager

Enclosure: Figures 1 – 3

Attachment 1: Analytical Results

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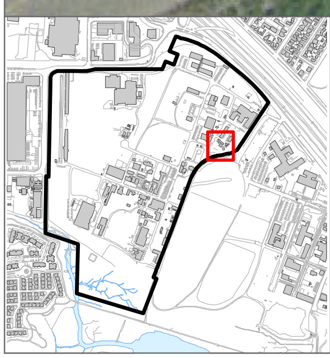


Sampling Boundaries (Approximate)

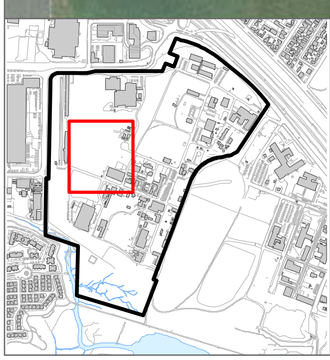
TETRA TECH EM INC.

Richmond Field Station
University of California, Berkeley

FIGURE 1

SHADE HOUSE DECISION UNIT

2007-09-28 V:\Misc_GIS\Richmond_Field_Station\Projects\Coastal_Prairie_Sampling\Shade_House_Decision_Unit.mxd TtEMI-SF Kevin Ernst



Decision Unit 1 Boundary (approximate)
Decision Unit 2 Boundary (approximate)

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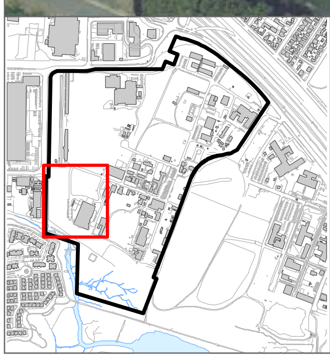
Richmond Field Station
University of California, Berkeley

FIGURE 2

BIG MEADOW COASTAL PRAIRIE
DECISION UNITS 1 AND 2

2007-09-28 V:\Misc_GIS\Richmond_Field_Station\Projects\Coastal_Prairie_Sampling\Big_Meadow_Decision_Units.mxd TtEMI-SF Kevin Ernst



Sampling Boundaries (Approximate)

TETRA TECH EM INC.

Richmond Field Station
University of California, Berkeley

FIGURE 3

EPA MEADOW COASTAL PRAIRIE DECISION UNITS

2007-09-28 V:\Misc_GIS\Richmond_Field_Station\Projects\Coastal_Prairie_Sampling\EPA_Meadow_Decision_Unit.mxd TtEMI-SF Kevin Ernst

PAMPAS GRASS AREA NEAR BUILDING 201

TETRA TECH EM INC.

March 18, 2008

Lynn Nakashima
Project Manager
Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, CA 94710

Subject: Sampling Results for Surface Soil in the Pampas Grass Area near Building 201, University of California, Berkeley, Richmond Field Station, Richmond, California

Dear Ms Nakashima:

Tetra Tech EM Inc. was contracted by the University of California (UC) Berkeley to conduct sampling activities at Richmond Field Station (RFS), in Richmond, California. The objectives of this sampling effort were to characterize surface soil at a pampas grass southwest of Building 201 (currently leased to the U.S. Environmental Protection Agency) for evaluation for worker protection for incidental contact to soil by workers removing the pampas grass, and to determine if any additional characterization is necessary for waste disposal. UC Berkeley is planning on removing this plant as part of the Invasives/Exotic Vegetation Management Program to prevent spread its seeds from spreading into the Western Stege Marsh Restoration Project area.

The attached letter provides the rationale for the selected sampling locations, a summary of field sampling protocols, and sample results. The letter is provided on behalf of UC Berkeley.

If you have any questions or comments regarding this submittal, please call me at (415) 222-8283.

Sincerely,

Jason Brodersen, P.G.
Project Manager

Enclosure: Sampling Results Letter

cc: Greg Haet, Office of Environment, Health & Safety
University of California, Berkeley

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Tel 415.543.4880 Fax 415.543.5480
www.ttemi.com

TETRA TECH EM INC.

March 18, 2008

Greg Haet
EH&S Associate Director, Environmental Protection
Office of Environment, Health & Safety
University of California, Berkeley
University Hall, 3rd Floor #1150
Berkeley, CA 94720

Subject: Sampling Results for Surface Soil in the Pampas Grass Area near Building 201, University of California, Berkeley, Richmond Field Station, Richmond, California

Dear Mr. Haet:

Tetra Tech EM Inc. (Tetra Tech) was contracted by the University of California (UC) Berkeley to conduct sampling activities at Richmond Field Station (RFS), in Richmond, California. The objectives of the sampling effort were to characterize surface soil at a pampas grass area near Building 201 (currently leased to the U.S. Environmental Protection Agency) and to provide information for evaluation of potential incidental contact to soil by workers removing the pampas grass. This letter provides the rationale for the selected sampling locations, a summary of field sampling protocols, and sample results. A figure presenting the sampling locations is presented at the end of this letter. Complete analytical results are presented in Attachment 1.

Sample Locations

Tetra Tech collected a composite sample from surface and near surface soils within the pampas grass area adjacent to Building 201 which is planned to be removed. The pampas grass area is approximately 25 feet by 40 feet and is shown on Figure 1. Surface soil samples were collected near the pampas grass roots from 0 to 1 foot below ground surface at 15 locations. The sample density is sufficient to represent soil exposure given the relative small size of the area.

Field Sampling Protocol

Surface soil samples were collected on January 23, 2008. The samples collected from the 15 locations described above were combined into one composite sample. The composite sample was placed in a clean glass jar provided by Curtis & Tompkins, Ltd. laboratory. The sample jar was properly labeled, packed in cushioning material and placed in a sample cooler. An extra jar was also filled to ensure sufficient quantity was provided to the laboratory for analysis. The sample was maintained at the standard temperature of 4° Celsius or below. The sample cooler was delivered to Curtis and Tompkins, Ltd. in Berkeley, California on January 24, 2008. A copy of the chain-of-custody form is included in Attachment 1.

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Sample Results

The soil sample was analyzed for the following:

Analyte	Analytical Method
Metals	EPA 6010B
Mercury	EPA 7471A
Semivolatile organic compounds (SVOC)	EPA 8270C
Total petroleum hydrocarbons (TPH)	EPA 8015B
Pesticides	EPA 8081A
Polychlorinated biphenyls (PCB)	EPA 608

Sample results are presented in the attached tables along with California Human Health Screening Levels (CHHSL). Where CHHSLs are not available, other screening levels are presented, such as the EPA Region 9 Preliminary Remediation Goals (PRG) and the California Regional Water Quality Control Board's Environmental Screening Levels (ESL). The references are provided below.

California Environmental Protection Agency. 2005. "Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties." January.

California Regional Water Quality Board San Francisco Bay Region. 2007. "Screening For Environmental Concerns at Sites with Contaminated Soil and Groundwater, Interim Final." November.

EPA. 2004. "EPA Region 9 Preliminary Remediation Goals (PRG) Table." December 28. Available Online at: http://www.epa.gov/region9/waste/sfund/prg/index.html

All analytes were reported at concentrations less than the laboratory reporting limits or less than their respective screening levels.

If you have any questions or comments regarding this submittal, please call me at (415) 222-8283.

Sincerely,

Jason Brodersen, P.G.
Project Manager

Enclosure: Figure 1

Attachment 1: Analytical Results

ANALYTICAL RESULTS FOR TPH, SVOC, PESTICIDES, AND PCB
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

Sample Location	TPH			SVOCs	Pesticides *(2)*	PCBs					
	Gasoline	Diesel	Motor Oil	*(1)*	4,4'-DDT	Aroclor-1016	Aroclor-1221	Aroclor-1232	Aroclor-1242	Aroclor-1254	Aroclor-1260
CHHSL Residential	--	--	--	--	*1.6*	*0.089*	*0.089*	*0.089*	*0.089*	*0.089*	*0.089*
CHHSL Commercial	--	--	--	--	*6.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*	*0.3*
CRWQCB Residential Non Drinking Water	*400*	*500*	*500*	--	--						
CRWQCB Commercial Non Drinking Water	*400*	*500*	*1,000*	--	--						
EPA Region 9 Residential PRG	--	--	--	--	--						
EPA Region 9 Commercial PRG	--	--	--	--	--						
Pampas Grass/Building 201 Sample	ND (1.2)	24 Y	200	ND *(3)*	0.018 J	ND (0.015)	ND (0.029)	ND (0.015)	ND (0.015)	0.072	0.029

Notes:

1. No SVOCs were detected
2. All other pesticides were not detected
3. See Attachment 1 for all reporting limits

-- Screening level not presented if CHHSL is available or the analyte was not detected
ND Not detected (reporting limit)
Y Sample exhibits chromatographic pattern which does not resemble standard
J Estimated Value

ANALYTICAL RESULTS FOR METALS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

Sample Location	Metals																
	Antimony	**Arsenic (1)**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Copper**	**Lead**	**Mercury**	**Molybdenum**	**Nickel**	**Selenium**	**Silver**	**Thallium**	**Vanadium**	**Zinc**
CHHSL Residential	*30*		*5,200*	*150*	*1.7*	*100,000*	*660*	*3,000*	*150*	*18*	*380*	*1,600*	*380*	*380*	*5*	*530*	*23,000*
CHHSL Commercial	*380*		*63,000*	*1,700*	*7.5*	*100,000*	*3,200*	*38,000*	*3,500*	*180*	*4,800*	*16,000*	*4,800*	*4,800*	*63*	*6,700*	*100,000*
Background		*16*															
Pampas Grass Building 201	ND	7.8	190	0.49	0.82	45	14	230	54	1.5	0.63	38	ND	0.48	ND	39	200
Laboratory Reporting Limit	*0.61*	*0.30*	*0.30*	*0.12*	*0.30*	*0.30*	*0.30*	*0.30*	*0.30*	*0.050*	*0.30*	*0.30*	*0.61*	*0.30*	*0.61*	*0.30*	*1.2*

Notes:

1. Arsenic screening value based on DTSC-approved ambient concentration developed for the adjacent Campus Bay site.

ND Not detected

COASTAL TERRACE PRAIRIE MEADOWS

March 4, 2013

Greg Haet
EH&S Associate Director, Environmental Protection
Office of Environment, Health & Safety
University of California, Berkeley
University Hall, 3rd Floor #1150
Berkeley, CA 94720

Subject: Sampling Results for Soil Samples Collected for the CTP Meadow Restoration Project University of California, Berkeley, Richmond Field Station, Richmond, California

Dear Mr. Haet:

Tetra Tech, Inc. (Tetra Tech) was contracted by the University of California (UC) Berkeley to conduct sampling activities at Richmond Field Station (RFS), in Richmond, California. The objective of the sampling effort was to characterize near-surface soil in the areas in the Coastal Terrace Prairie (CTP) Meadows, to evaluate soil conditions that research students from UC Berkeley could be exposed to while performing brief restoration activities within the area. This letter provides the rationale for the selected sampling locations, a summary of field sampling protocols, and sample results. A figure presenting the sampling locations is enclosed at the end of this letter. Complete analytical results are presented in Attachments 1 and 2.

Sample Locations

Incremental sampling methodology was selected for this project to provide a comprehensive and thorough evaluation of chemical concentrations in a specific area of potential exposure, or decision unit. The incremental sampling strategy for this project was based on selecting two decision units to best represent potential exposure.

UC Berkeley provided Tetra Tech with site-specific plans for the areas to be restored, which consisted of one area in the Big Meadow and one in the West Meadow. Restoration activities may include disturbance of surface soils down to approximately 6 to 8 inches below ground surface to remove invasive plants and cultivate new native plants.

Two decision units were selected to best represent possible worker exposure conditions. Decision Unit CTP-BM-DU1 represents the restoration area within the Big Meadow; Decision Unit CTP-WM-DU1 represents the restoration area within the West Meadow. Based on the assumption of soil disturbance, surface sample depths of 0 to 6 inches below ground surface (bgs) were collected throughout the decision units.

Field Sampling Protocols

Soil samples were collected on February 2 and February 6, 2012. The decision unit boundaries were identified in the field based on the rationale presented in the previous section; one incremental soil sample was collected from each of the decision units. Each incremental soil sample was composed of subsamples from 50 increment locations.

Incremental sampling methodology was used to maximize the goal of obtaining sufficient material over the decision unit to account for both compositional and distributional heterogeneity of any possible contamination. The sampling protocol followed these steps for the decision units:

1. The field sampler began at a corner of the surface decision unit and sampled in random pattern, beginning in one corner to collect subsamples from 50 locations within the decision unit. The location of the subsamples was not critical as long as they were distributed throughout the decision unit. Samples were collected from the surface using a shovel. For each decision unit, the soil was placed into a stainless steel bowl. The steel bowl was decontaminated between each decision unit using Alconox and de-ionized water.

2. The subsamples were thoroughly mixed in the bowl to form one composited, multi-increment sample from each decision unit.

3. The soil from the bowl was then redistributed into a 1-inch thick uniform layer (approximately 16 by 24 inches) onto a plastic bag.

4. The soil described in Step 3 was subsequently divided again into 50 subsamples using a disposable spoon. This sample was placed in the sample containers provided by the laboratory to form the final sample that was submitted to the analytical laboratory for the analyses listed below.

Following collection from Decision Units CTP-BM-DU1 and CTP-WM-DU1, the sample jars were labeled, wrapped with protective bubble wrap material, placed into a sealable plastic bags, and packed into an insulated cooler. These samples were taken directly from the field to Curtis and Tompkins Laboratory in Berkeley, CA on February 2 and 6, 2012. A copy of the chain-of-custody forms are presented in Attachment 1.

Analyses Summary, Screening Criteria, and Sample Results

Soil samples were analyzed for metals; total petroleum hydrocarbons (TPH) motor oil and diesel; pesticides; polychlorinated biphenyls (PCB); and semi-volatile organic compounds (SVOC) using the methods listed below.

- Metals by EPA 6020; Mercury by EPA 7471A
- TPH-Extractables by EPA 8015B Modified
- Pesticides by EPA 8081A
- PCB analysis by EPA 8082
- SVOC analysis by EPA 8270C

Sample results are presented below along with California Human Health Screening Levels (CHHSL) [“Use of California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties” California Environmental Protection Agency, January 2005, updated in 2010] and EPA Region 9 RSLs. For TPH, the California Regional Water Quality Control Board Residential and Commercial non-drinking water standards are included. For SVOC and VOC results the U.S. Environmental Protection Agency Regional Screening Levels (RSL) are included.

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In addition, the California EPA benzo(a)pyrene potency equivalence factors (PEF) for SVOCs detected are included. These factors come from the Office of Environmental Health Hazard Assessment's 'Air Toxics Hot Spots Program Risk Assessment Guidelines Part II: Technical Support Document for Describing Available Cancer Potency Factors' (2002). Benzo(a)pyrene is the primary representative for SVOCs. The PEFs were used to calculate the equivalent concentrations of the SVOCs with equivalency factors in terms of benzo(a)pyrene and the totals were screened against the CHHSLs and modified RSL for benzo(a)pyrene, as well as two ambient values established in DTSC's 'Use of the Northern and Southern California Polynuclear Aromatic Hydrocarbon (PAH) Studies in the Manufactured Gas Plant Site Cleanup Process' (2009): the mean benzo(a)pyrene equivalent value and the 95^{th} upper confidence limit on the mean benzo(a)pyrene equivalent values from the Northern California ambient dataset.

All analytes were detected in the CTP Meadow Decision Units at concentrations below the corresponding screening criteria.

Conclusions

Based on the screen against the CHHSL, the soil in all decision units is safe for the restoration workers in the CTP Meadows.

If you have any questions or comments regarding this submittal, please call me at (510) 302-6283.

Sincerely,

Jason Brodersen, P.G.
Project Manager

Enclosure: Figure 1, Tables 1 through 5
Attachment 1: Analytical Results for CTP-WM-DU1
Attachment 2: Analytical Results for CTP-BM-DU1

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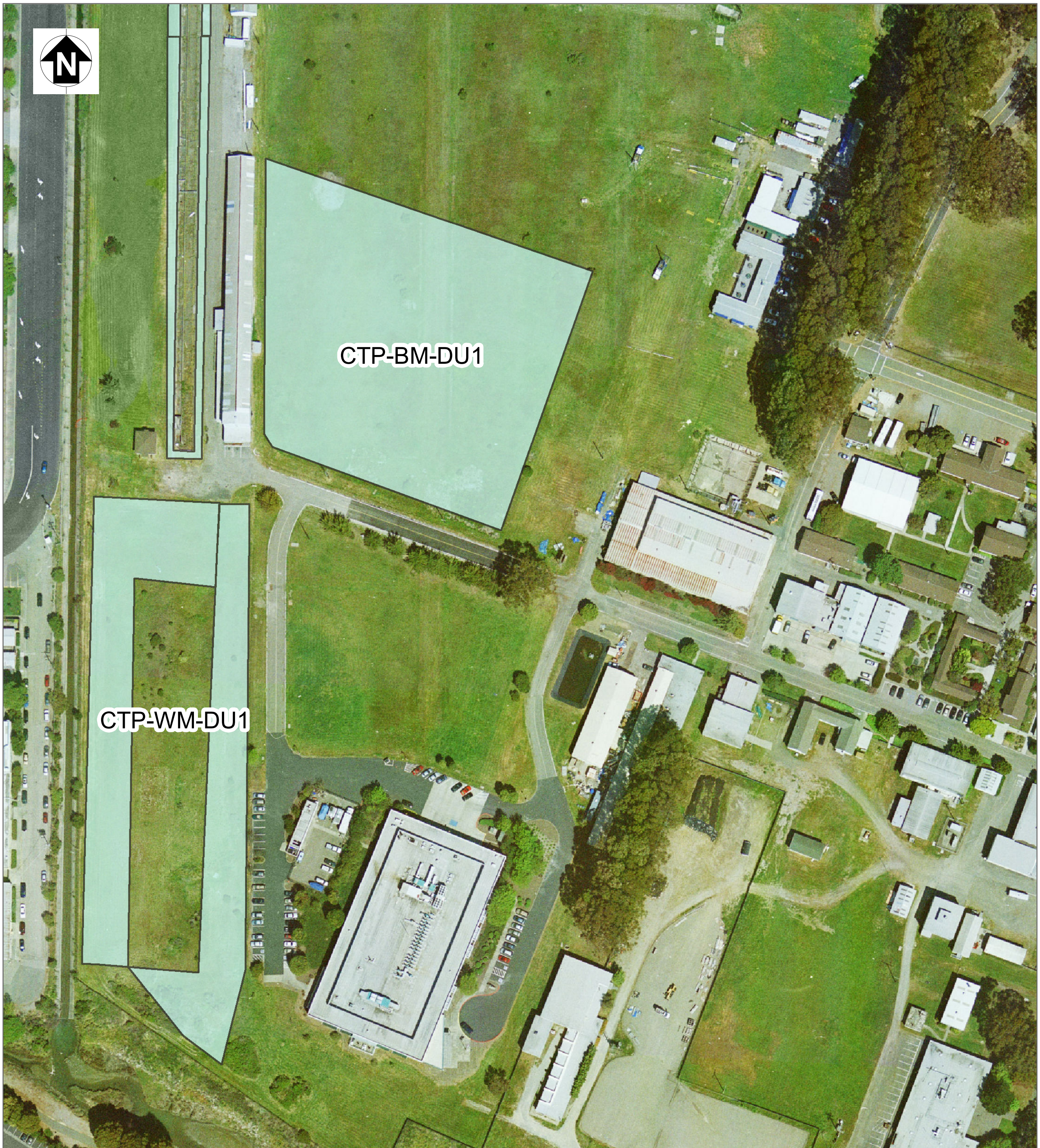
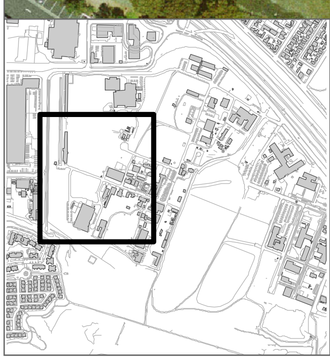




TETRA TECH EM INC.

Richmond Field Station
University of California, Berkeley

CTP MEADOWS ISM
SAMPLING LOCATIONS

2012-03-02 v:\misc_gis\richmond_field_station\projects\miscel\CTP_Meadows_ISM.mxd TtEMI-OAK CF

TABLE 1.
METALS SOIL SAMPLING RESULTS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

Sample Location	Metals																								
	Aluminum	**Antimony**	**Arsenic (1)**	**Barium**	**Beryllium**	**Cadmium**	**Calcium**	**Chromium**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Magnesium**	**Manganese**	**Mercury**	**Molybdenum**	**Nickel**	**Potassium**	**Selenium**	**Silver**	**Sodium**	**Thallium**	**Vanadium**	**Zinc**
CHHSL Residential	*NA*	*30*		*5,200*	*16*	*1.7*	*NA*	*100,000*	*660*	*3,000*	*NA*	*80*	*NA*	*NA*	*18*	*380*	*1,600*	*NA*	*380*	*380*	*NA*	*5.0*	*530*	*23,000*
CHHSL Commercial	*NA*	*380*		*63,000*	*190*	*7.5*	*NA*	*100,000*	*3,200*	*38,000*	*NA*	*320*	*NA*	*NA*	*180*	*4,800*	*16,000*	*NA*	*4800*	*4,800*	*NA*	*63*	*6,700*	*100,000*
Background			*16*																					
CTP-BM-DU1	9700	0.31	5.1	140	0.62	0.2 J	2900	35	7.6	24	12000	29	2100	470	0.42	0.38	29	680	0.24 J	0.061 J	100	0.1 J	32	49
CTP-WM-DU1	14000	0.51	8.3	150	0.5	0.82	4800	42	11	60	20000	37	3200	520	0.21	0.49	40	1000	0.28 J	0.3 J	130	0.18 J	36	190

Notes:
CHSSL California Human Health Screening Level
J Estimated value
U Not detected

TABLE 2.
DETECTED PCB AND TPH SOIL SAMPLING RESULTS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

	PCBs							TPH	
	PCB-1016	**PCB-1221**	**PCB-1232**	**PCB-1242**	**PCB-1248**	**PCB-1254**	**PCB-1260**	**Diesel C10-C24**	**Motor Oil C24-C36**
CHHSL Residential *CHHSL Commercial*	*0.089* *0.30*	*0.089* *0.30*	*0.089* *0.30*	*0.089* *0.30*	*0.089* *0.30*	*0.089* *0.30*	*0.089* *0.30*		
RWQCB Residential Land Use RSLs								*100*	*500*
CTP-BM-DU1	0.012 U	0.024 U	0.012 U	0.012 U	0.012 U	0.020	0.012 U	9.3 Y	95
CTP-WM-DU1	0.012 U	0.023 U	0.012 U	0.012 U	0.012 U	0.014	0.0099 J	5.5 Y	63

Notes:

CHSSL	California Human Health Screening Level
J	Estimated value
RSL	Regional Screening Level
RSQCB	Regional Water Quality Control Board
U	Not detected
Y	Sample exhibits chromatographic pattern which does not resemble strata

TABLE 3.
PESTICIDE SAMPLING RESULTS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

	Pesticides																			
	4-4'-DDD	**4-4'-DDE**	**4-4'-DDT**	**Aldrin**	**alpha-BHC**	**alpha-Chlordane**	**beta-BHC**	**delta-BHC**	**Dieldrin**	**Endosulfan I**	**Endosulfan II**	**Endosulfan sulfate**	**Endrin**	**Endrin aldehyde**	**gamma-BHC**	**gamma-Chlordane**	**Heptachlor**	**Heptachlor epoxide**	**Methoxychlor**	**Toxaphene**
Screening Value (mg/kg)	*2 (2)*	*1.4 (2)*	*1.6 (1)*	*0.029 (2)*	*0.077 (2)*	*0.43 (1)*	*0.27 (2)*	*0.30 (2)*	*0.030 (2)*	*370 (2)*	*370 (2)*	*370 (2)*	*14 (2)*	*-- (3)*	*0.52 (2)*	*0.43 (1)*	*0.111 (2)*	*0.053 (2)*	*310 (2)*	*0.44 (2)*
CTP-BM-DU1	0.004 U	0.0051	0.00533	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.004 U	0.0021 U	0.004 U	0.004 U	0.004 U	0.004 U	0.0021 U	0.0021 U	0.0021 U	0.0021 U	0.021 U	0.073 U
CTP-WM-DU1	0.00093 J	0.0028 J	0.0029 J	0.0017 U	0.0017 U	0.00039 CJ	0.0017 U	0.0017 U	0.0033 U	0.0017 U	0.0033 U	0.0033 U	0.0033 U	0.0033 U	0.0017 U	0.0017 U	0.0017 U	0.00061 CJ	0.017 U	0.060 U

Notes:

CHSSL	California Human Health Screening Level
EPA	U.S. Environmental Protection Agency
J	Estimated value
NA	Not available
RSL	Regional Screening Level
U	Not detected
(1)	CHHSL value
(2)	EPA RSL value
(3)	No CHHSL or RSL available.

TABLE 4.
SVOC SOIL SAMPLING RESULTS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

	1,2,4-Trichlorobenzene	1,2-Dichlorobenzene	1,3-Dichlorobenzene	1,4-Dichlorobenzene	2,4,5-Trichlrophenol	2,4,6-Trichlrophenol	2,4-Dichlorophenol	2,4-Dimethylphenol	2,4-Dinitrophenol	2,6-Dinitrotoluene	2,4-Dinitrotoluene	2-Chloronaphthalene	2-Chlorophenol	2-Methylnaphthalene	2-Methylphenol	2-Nitroaniline	2-Nitrophenol	3,3'-Dichlorobenzidine	3-Nitroaniline	4,6-Dintro-2-methylphenol	4-Bromophenyl phenyl ether	4-Chloro-3-methylphenol	4-Chloroaniline
Screening Value (mg/kg)	*220 (2)*	*1,900 (2)*	*-- (3)*	*2.4 (2)*	*6,100 (2)*	*6.9 (4)*	*180 (2)*	*1,200 (2)*	*120 (2)*	*61 (2)*	*1.6 (2)*	*6,300 (2)*	*390 (2)*	*-- (3)*	*-- (3)*	*610 (2)*	*-- (3)*	*1.1 (2)*	*-- (3)*	*-- (3)*	*-- (3)*	*-- (3)*	*2.4 (2)*
CTP-BM-DU1	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	0.81 U	1.6 U	0.81 U	0.81 U	0.81 U	0.81 U	0.16 U	0.81 U	1.6 U	1.6 U	1.6 U	1.6 U	1.6 U	0.81 U	0.81 U	0.81 U
CTP-WM-DU1	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.83 U	0.41 U	0.41 U	0.41 U	0.41 U	0.083 U	0.41 U	0.83 U	0.83 U	0.83 U	0.83 U	0.83 U	0.41 U	0.41 U	0.41 U

	4-Chlorophenyl phenyl ether	4-Methylphenol	4-Nitroaniline	4-Nitrophenol	Acenaphthene	Acenaphthylene	Anthracene	Azobenzene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzoic acid	Benzyl alcohol	Bis(2-chloroethoxy)methane	Bis(2-chloroethyl)ether	Bis(2-chloroisopropyl)ether	Bis(2-ethylhexyl)phthalate	Butyl benzyl phthalate	Chrysene	Dibenz(a,h)anthracene
Screening Value (mg/kg)	*-- (3)*	*-- (3)*	*24 (2)*	*-- (3)*	*3,400 (2)*	*-- (3)*	*17,000 (2)*	*5.1(2)*	*0.15 (2)*	*0.038 (1)*	*0.15 (2)*	*-- (3)*	*0.38 (4)*	*2.4E+05 (2)*	*6,100 (2)*	*180 (2)*	*0.21 (2)*	*-- (3)*	*35 (2)*	*260 (2)*	*3.8 (4)*	*0.015 (2)*
CTP-BM-DU1	0.81 U	0.81 U	1.6 U	1.6 U	0.016 U	0.16 U	0.16 U	0.81 U	0.16 U	0.16 U	0.16 U	0.16 U	0.16 U	4.0 U	0.81 U	0.81 U	0.81 U	0.81 U	0.057 J	0.81 U	0.16 U	0.16 U
CTP-WM-DU1	0.41 U	0.41 U	0.83 U	0.83 U	0.083 U	0.083 U	0.083 U	0.41 U	0.083 U	0.0081 J	0.012 J	0.083 U	0.083 U	2.1 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.41 U	0.011 J	0.083 U

TABLE 4. (continued)
SVOC SOIL SAMPLING RESULTS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

	Dibenzofuran	Diethyl phthalate	Dimethyl phthalate	Di-n-butyl phthalate	Di-n-octyl phthalate	Fluoranthene	Fluorene	Hexachlorobenzene	Hexachlorobutadiene	Hexachlorocyclopentadiene	Hexachloroethane	Indeno(1,2,3-cd)pyrene	Isophorone	Naphthalene	Nitrobenzene	N-Nitrosodimethylamine	N-Nitroso-di-n-propylamine	N-Nitrosodiphenylamine	Pentachlorophenol	Phenanthrene	Phenol	Pyrene
Screening Value (mg/kg)	*-- (3)*	*49,000 (2)*	*-- (3)*	*-- (3)*	*-- (3)*	*2,300 (2)*	*2,300 (2)*	*.030 (2)*	*6.2 (2)*	*370 (2)*	*35 (2)*	*0.15 (2)*	*510 (2)*	*3.6 (2)*	*4.8 (2)*	*0.002 (2)*	*0.069 (2)*	*99 (2)*	*0.89 (2)*	*-- (3)*	*18,000 (2)*	*1,700 (2)*
CTP-BM-DU1	0.81 U	0.81 U	0.81 U	0.025 J	0.81 U	0.16 U	0.16 U	0.81 U	0.81 U	1.6 U	0.81 U	0.16 U	0.81 U	0.16 U	0.81 U	0.81 U	0.81 U	0.81 U	1.6 U	0.16 U	0.81 U	0.16 U
CTP-WM-DU1	0.41 U	0.41 U	0.41 U	0.02 J	0.41 U	0.083 U	0.083 U	0.41 U	0.41 U	0.83 U	0.41 U	0.083 J	0.41 U	0.083 U	0.41 U	0.41 U	0.41 U	0.41 U	0.83 U	0.083 U	0.41 U	0.01 J

Notes:
CHSSL California Human Health Screening Level
DTSC California Department of Toxic Substances Control
EPA U.S. Environmental Protection Agency
J Estimated value
NA Not available
RSL Regional Screening Level
U Not detected
(1) CHHSL value
(2) EPA RSL value
(3) No CHHSL or RSL available
(4) DTSC's Human Health Risk Assessment, Note Number 3 (May 6, 2009)

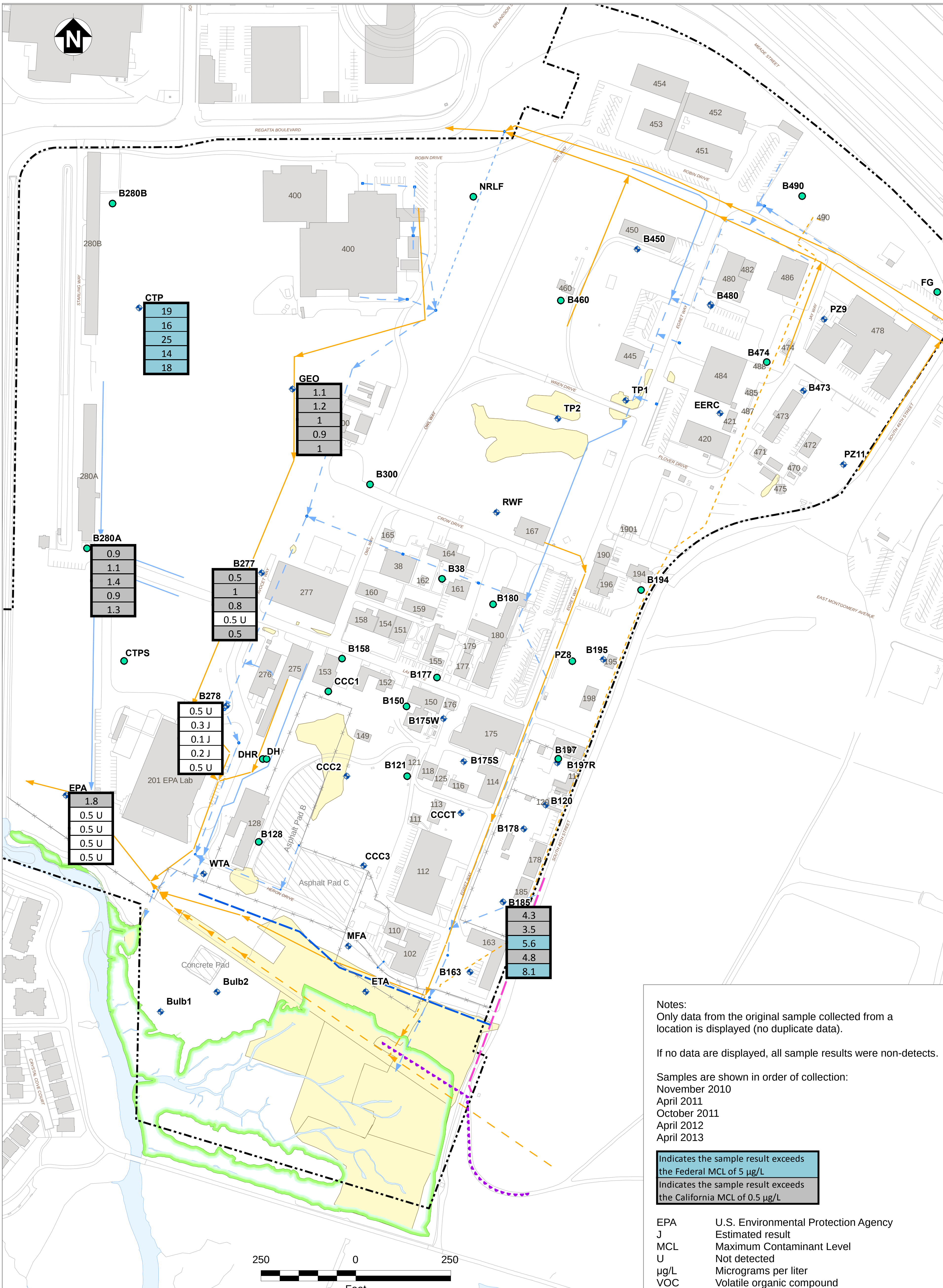
TABLE 5.
BAP EQUIVANCY CALCULATIONS
REPORTED IN MILLIGRAMS PER KILOGRAM (mg/kg)

PAH	CTP-BM-DU1 (mg/kg)	CTP-WM-DU1 (mg/kg)	Potency Equivalency Factor		CTP-BM-DU1		CTP-WM-DU1	
			EPA (2011)	CAL/EPA (1994,2003), DTSC (2011)	BAP-EQ-EPA	BAP-EQ-CalEPA	BAP-EQ-EPA	BAP-EQ-CalEPA
Benzo(a)anthracene	< 0.16	< 0.083	0.1	0.1	NA	NA	NA	NA
Benzo(b)fluoranthene	< 0.16	0.012	0.1	0.1	NA	NA	0.0012	0.0012
Benzo(k)fluoranthene	< 0.16	< 0.083	0.01	0.1	NA	NA	NA	NA
Benzo(a)pyrene	< 0.16	0.0081	1	1	NA	NA	0.0081	0.0081
Chrysene	< 0.16	0.011	0.001	0.01	NA	NA	0.000011	0.00011
Dibenz(a,h)anthracene	< 0.16	< 0.083	1	0.34	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	< 0.16	0.083	0.1	0.1	NA	NA	0.0083	0.0083
Total B(a)P Equivalent					**NA**	**NA**	**0.02**	**0.02**

Notes:

<	Not detected
B(a)P	Benzo(a)pyrene
Cal/EPA	California Environmental Protection Agency
DTSC	California Department of Toxic Substances Control
EPA	U.S. Environmental Protection Agency
NA	Not applicable
RSL	Regional Screening Level

APPENDIX B
CARBON TETRACHLORIDE GROUNDWATER CONCENTRATIONS



Notes:
Only data from the original sample collected from a location is displayed (no duplicate data).

If no data are displayed, all sample results were non-detects.

Samples are shown in order of collection:
November 2010
April 2011
October 2011
April 2012
April 2013

Indicates the sample result exceeds the Federal MCL of 5 µg/L
Indicates the sample result exceeds the California MCL of 0.5 µg/L

EPA	U.S. Environmental Protection Agency
J	Estimated result
MCL	Maximum Contaminant Level
U	Not detected
µg/L	Micrograms per liter
VOC	Volatile organic compound

- Groundwater Sampling Locations
- Shallow Piezometers Not Sampled for VOCs in April 2013
- Existing Buildings
- Asphalt/Concrete Pads
- Remediated Areas
- Surface Water
- Marsh Boundary
- Former Richmond Field Station Site Boundary
- Roads and Other Landscape Features
- Fenceline
- Biologically Active Permeable Barrier Wall
- Former Seawall (Approximate)
- Slurry Wall

Storm Drain Lines:
- Open Swale
- Underground Culvert
- Underground Culvert, Abandoned (Grouted at Manholes)

Sanitary Sewer Lines:
- Existing Sewer Line
- Removed Sewer Line
- Abandoned Sewer Line

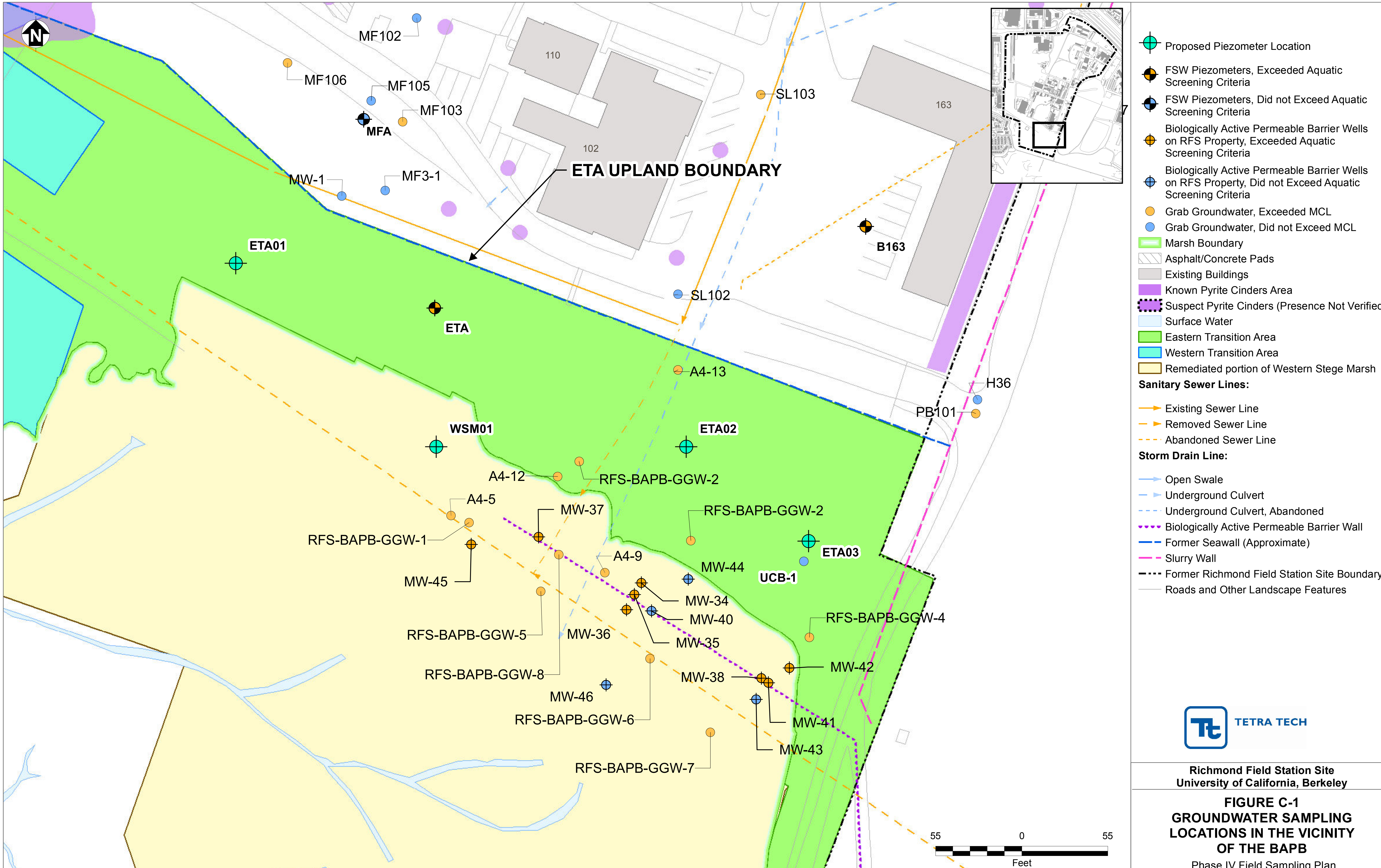
TETRA TECH

Richmond Field Station Site
University of California, Berkeley

FIGURE B-1
CARBON TETRACHLORIDE GROUNDWATER CONCENTRATIONS

Phase IV Field Sampling Plan

APPENDIX C
BAPB AREA GROUNDWATER SAMPLES



Richmond Field Station Site
University of California, Berkeley

FIGURE C-1
GROUNDWATER SAMPLING LOCATIONS IN THE VICINITY OF THE BAPB
Phase IV Field Sampling Plan

9/14/2014 V:\Misc_GIS\Richmond_Field_Station\Projects\Field_Sampling_Workplan\Phase_IV\layouts\Groundwater Sampling BAPB.mxd - yashekia.evans

APPENDIX D
RESPONSE TO COMMENTS ON THE DRAFT FSP AND DTSC APPROVAL LETTER

Department of Toxic Substances Control

Matthew Rodriquez
Secretary for
Environmental Protection

Miriam Barcellona Ingenito
Acting Director
700 Heinz Avenue
Berkeley, California 94710-2721

Edmund G. Brown Jr.
Governor

September 25, 2014

Mr. Greg Haet
EH&S Associate Director, Environmental Protection
Office of Environment, Health & Safety
University of California, Berkeley
University Hall, 3rd Floor, #1150
Berkeley, California 94720

Dear Mr. Haet:

The Department of Toxic Substances Control (DTSC) received the September 9, 2014 Response to Comments and the September 19, 2014, revised *Draft Phase IV Field Sampling Plan* (Sampling Plan) for the University of California, Berkeley, Richmond Bay Campus, Former Richmond Field Station Site, located in Richmond, California. The Sampling Plan was prepared by Tetra Tech, Inc. on behalf of the University of California, Berkeley (UC).

The scope of the Sampling Plan is based on data gaps identified in the current conditions report. Proposed work includes:

- soil sampling in the Upland Meadows;
- soil gas sampling in the Big Meadow;
- placement of additional piezometers along the border of the Eastern Transition Area and Western Stege Marsh; and,
- exploratory excavation and radiological screening investigation in the Bulb area within the Western Transition Area.

Attachment 1of the Sampling Plan, Radiological Sampling Plan, will be provided at a later date at which time DTSC will review and provide comments on all aspects of the Bulb area investigation. DTSC has reviewed the revised Sampling Plan for the other three proposed activities and the Response to Comments and found that DTSC comments 1 through 17 have been adequately addressed. With respect to comments provided by DTSC's Human and Ecological Risk Office, Ecological Risk Assessment Section (ERAS), please find enclosed a memorandum evaluating the specific responses, which require minor modification to the final Sampling Plan. The Sampling plan is approved with the modifications included in ERAS' memorandum.

Please provide the revised Sampling Plan within 15 days of the date of this letter incorporating the modification requested by ERAS.

If you have any questions, please contact Lynn Nakashima at lynn.nakashima@dtsc.ca.gov or (510) 540-3839.

Sincerely,

Lynn Nakashima

Lynn Nakashima, Project Manager
Senior Hazardous Substances Scientist
Brownfields and Environmental
Restoration Program
Berkeley Office - Cleanup Operations

Mark Vest

Mark Vest, P.G.
Senior Engineering Geologist
Brownfields and Environmental
Restoration Program
Sacramento Office - Geologic Services

Enclosure

cc: Karl Hans
University of California, Berkeley
Environmental Health & Safety
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Berkeley, California 94720

Jason Brodersen
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1999 Harrison Street, Suite 500
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Kimi Klein, Ph.D.
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Matt Rodriquez,
Secretary for
Environmental Protection

Department of Toxic Substances Control

Miriam Barcellona Ingenito
Acting Director
8800 Cal Center Drive
Sacramento, California 95826-3200

Edmund G Brown,
Governor

MEMORANDUM

TO: Lynn Nakashima
Senior Environmental Scientist
Brownfields and Environmental Restoration
Department of Toxic Substances Control
700 Heinz Avenue, Suite 200
Berkeley, CA 94710

FROM: J. Michael Eichelberger, Ph.D.
Staff Toxicologist
Ecological Risk Assessment Section (ERAS)
Human and Ecological Risk Office (HERO)
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 95826

DATE: September 23, 2014

SUBJECT: RESPONSE TO COMMENTS TO THE 'DRAFT PHASE IV FIELD SAMPLING PLAN UNIVERSITY OF CALIFORNIA, BERKELEY RICHMOND BAY CAMPUS FORMER RICHMOND FIELD STATION SITE RICHMOND, CALIFORNIA'

PCA: 11018 Site Code: 201605-00

BACKGROUND

At the request of the DTSC project manager, ERAS is providing review and comment on the aforementioned report in the subject line above. Under order from the Department of Toxic Substances Control (docket number IS/E-RAO 06/07-004), the University of California has been conducting phased investigations and cleanup of the subject property located 1301 South 46th Street in Richmond, California. The proposed Phase IV investigation presents a sampling strategy for four areas: 1) Big Meadow, EPA Meadow North, and West Meadow; 2) The Magnetic Anomaly; 3) the Carbon Tetrachloride Area; and, 4) the Biologically Active Permeable Barrier (BAPB). Original ERAS comments are presented in plain text, the University of California Richmond Field

Station (UCRFS) responses are in '*italics*" and ERAS corresponding return comments are in '**bold**' font.

DOCUMENT REVIEWED

ERAS reviewed "Response to Comments to the 'Draft Phase IV Field Sampling Plan University of California, Berkeley Richmond Bay Campus Former Richmond Field Station Site Richmond, California' prepared by Tetra Tech, Inc., (Oakland, California) and dated June 3, 2014. ERAS received the report for review via an Envirostor work request dated June 4, 2014.

SCOPE OF REVIEW

The report was reviewed for scientific content related to ecological risk assessment. Grammatical or typographical errors that do not affect the interpretation of the text have not been noted.

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GENERAL COMMENT

ERAS largely believes the report adequately describes a reasonable sampling strategy for sampling the Meadows, the Carbon Tetrachloride Area, the Magnetic Anomaly of the Bulb in the Western Transition Area, and Groundwater upgradient and west of the BARB. However, the report should be strengthened and clarified by addressing the following Specific Comments listed below.

UCRFS Response: NA

ERAS Response: NA

SPECIFIC COMMENTS

1. Pdf page 10 of 90, Section 1.2 Investigation Purpose, BAPRB Area Groundwater. The report indicates that DTSC had requested "*additional grab groundwater samples from locations upgradient, downgradient, and to the west of the BAPB to assess the distribution of dissolved metals and VOCs I groundwater*". The Phase IV investigation proposes placement of four piezometers located upgradient and crossgradient from the BARB. Please explain why no piezometers are proposed downgradient of the BARB. Downgradient samples were requested by DTSC.

   UCRFS Response: Piezometers MW-43, MW-45 and MW-46, installed by Terraphase on behalf of Zeneca, were installed in 2013 downgradient of the BARB: this information has been added to the text in Section 1.2.

   ERAS Response: Comment accepted.

2. Pdf page 12 of 90 Section 2.1.1, Upland Meadows: Big Meadow, EPA Meadow North, and West Meadow, first paragraph. If known, please describe the nature of the small mammal studies conducted by the university in the Meadows.

   UCRFS Response: Text will be amended to include any small mammal studies identified by UC. If specific references cannot be identified, the text regarding studies will be deleted.

   ERAS Response: Comment accepted.

3. Pdf page 15 of 90, Section 2.2.4, BAPB Area Groundwater Characterization. Please provide a table of the Ambient Water Quality Criteria Continuous Criterion Concentrations that will be used for screening as a guideline for the DQO Reporting Limits.

   UCRFS Response: The document has been amended to include a table presenting the relevant screening criteria. Note that chemical concentrations in groundwater will be compared to the aquatic screening criteria consistent with the adjacent Former Zeneca Site, as stated in the DQO section.

   ERAS Response: ERAS defers to the Geological Services Unit regarding the applicability of the Zeneca (Campus Bay) 5X dilution factor for UCRFS groundwater. Please reference Table 7 'Aquatic Screening Criteria and Reporting Limits for Groundwater' in Section 2.2.4.

4. Pdf page 18 of 90, Section 3.2.1, DQOs for Soil in the Upland Meadows, Step 6: Specify Performance or Acceptance Criteria. Please provide a table with the soil ecological screening levels for each Chemical of Concern to be used for the guidance of DQO Reporting Limits.

   UCRFS Response: The document has been amended to include a table presenting the proposed ecological screening levels. Standard laboratory reporting protocols consistent with EPA SW-846 will be followed for chemicals for which ecological screening levels are not available.

   ERAS Response: Comment accepted. Please note there is low confidence in the Oak Ridge National Laboratory (ORNL) plant and invertebrate mercury screening levels. Plant screening levels, in general, are suspect. ORNL states in their own screening level document, '*If chemical concentrations reported in field soils that support vigorous and diverse plant communities exceed one or more of the benchmarks presented in this report or if a benchmark is exceeded by background soil concentrations, it is generally safe to assume that the benchmark is a poor measure of risk to the plant community at that site.*' ERAS believes protection of the sensitive Coastal Prairie is the most significant biological resource under the current investigation. Potential exceedance of the plant

mercury screening level of 0.3 mg/kg should not be viewed as a mandate for removal actions that may require removal of habitat. If the vegetation is healthy and judged to be functioning normally, the mercury exceedance should not be viewed as deleteriously affecting the vegetation. In this scenario, removal would cause more harm than benefit.

Very little data is available for evaluation of earthworm mercury toxicity, and the ORNL screening level based on a reproductive endpoint for $HgCl_2$, does not show a reliable measure of toxicity; there was no reduction in the number of juveniles produced at the lowest dose. Screening based on the ORNL invertebrate screening level will have a high degree of uncertainty.

No mercury screening levels are available for either birds or mammals. ERAS back-calculated $HgCl_2$ no-effect based screening levels for the Robin and the Ornate Shrew based on ORNL No Observable Adverse Effect Level (NOAEL) chronic Toxicity Reference Values (TRVs - Japanese Quail, 0.45 mg/kg^{-}day; Mink, 1.01 mg/kg^{-}day). ERAS assumed an area use factor of one and a conservative bioaccumulation factor of one. Ingestion rates were estimated from Nagy (2001) and incidental soil ingestion rate from US EPA (1993). The mercury soil screening level for the Robin is 30.5 mg/kg and that for the Ornate Shrew is 38.5 mg/kg. These values can be used for screening purposes protective of higher trophic levels at the 'Site'.

Please note that screening levels are based on inorganic mercury, since little to no detectable organic mercury is expected in upland soils of the Coastal Prairie, where its formation is not favorable. Also, mercury has very high affinity for sulfur, either as a geological form or as part of a sulfhydryl group in organic matter where sulfhydryl groups as Cysteine are common. Mercury sulfides have very low solubility's and corresponding bioavailability. Therefore, the estimation of 100 percent bioavailability in calculation of screening levels most likely a conservative estimation; the actual bioavailability is most likely lower.

5. Pdf page 19 of 90, Section DQOs for Soil in the Upland Meadows, Step 6: Specify Performance or Acceptance Criteria. ERAS, is not familiar with taking triplicates to establish a margin of error for a sample dataset. In this case, what is the margin of error measuring? Please provide the methodology.

   UCRFS Response: Please see response to DTSC Comment 6(a) regarding use of triplicate samples.

   ERAS Response: Comment accepted.

6. Pdf page 20 of 90, Section 3.2.2, DQOs for the Magnetic Anomaly Investigation, Step 5: Develop the Decision Rules. The report indicates that radiological

screening levels will be submitted prior to the final draft of the Field Sampling Plan. Will ecological screening levels be provided, if so what is the source.

UCRFS Response: Radiological ecological screening levels will not be identified for the exploratory excavation. If radiation is found to be present during the excavation, then ecological screening levels will be developed in support of future investigations, if appropriate.

ERAS Response: Comment accepted.

7. Pdf page 38 of 90, Figure 3 Phase IV Sampling Areas. What does the carbon tetrachloride 'background' sample represent? In ERAS' view there is no background for carbon tetrachloride.

   UCRFS Response: Please see response to DTSC Comment 8(b) regarding background samples for carbon tetrachloride.

   ERAS Response: Comment accepted.

8. Pdf page 55 of 90, Table Titled TPH, SCOC, Pesticide, and PCB Results Reported in Micrograms per Kilogram (mg/kg). Results are presented for the coastal prairie but screening was conducted only against CHHSL's and not ecological screening levels. Organochlorine pesticides are reported as non-detect, results are presented in mg/kg but reporting limits are unknown. The Eco-SSL mammalian screening level is 0.021mg/kg. Insufficient information is presented in the table to provide guidance for Phase IV sampling.

   UCRFS Response: The proposed sampling includes consideration of areas where pesticides are most likely to be present: near buildings and within ditches. If pesticides are found to be present in this subset of samples, UC may propose additional sampling based on the data review.

   ERAS Response: Comment accepted.

<u>CONCLUSIONS</u>

The report needs to be revised to address the comments above. Tables should be inserted in the report that lists the ecological screening levels for each media being sampled. The report is not complete without inclusion of the radiological sampling plan for the BULB.

UCRFS Response: NA

ERAS Response: Please note ERAS responses to Specific Comment 4 and incorporate the bird and mammalian screening levels in Table 1.

REFERENCES

Nagy, K.A. 1991. Food requirements of wild animals: predicitive equations for free-living mammals, reptiles, and birds. Nutri. Abs. Revs. Ser. B 71(10): 1R-12R.

US EPA. 1993. Wildlife Exposure Handbook. EPA/600/R-93/187a.

Reviewed by: Brian Faulkner, Ph.D.
Senior Toxicologist

Cc: James M. Polisini Ph.D.
Supervising Toxicologist (HERO)

Michael Anderson Ph.D.
Supervising Toxicologist
California Fish and Wildlife

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
LN 1	Section 1	1	Please amend to indicate that ground water conditions will be investigated in the vicinity and to the west of the BAPB (Biologically Active Permeable Barrier).	Text has been revised to clarify that groundwater conditions will be investigated in the vicinity and to the west of the BAPB.
LN 2	Section 1.1	2	The third paragraph of this section references the Final RAW. This reference will need to be revised after the RAW has been finalized,	Text has been updated to reference the Final RAW, dated July 18, 2014. The UC 2014 reference has also been updated to reference the final LRDP.
LN 3	Section 1.2	3	Include in this section that site-wide ground water monitoring has been conducted on an annual basis since 2012.	Text has been amended to state the groundwater has been conducted on annual basis since 2012.
LN 4	Section 2.2.4	4	Include in the second paragraph that the Regional Water Quality Control Board approved the backfill that was used in 2002 and 2004.	Text has been amended to clarify Regional Water Quality Control Board approval of the backfill material.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
LN 5	Section 3.1	5	When referring to the work proposed at the Bulb (text, table of contents, figures), please consistently refer to it as an "exploratory excavation". Also, clarify that the source of the anomaly may or may not be removed from the area, pending identification of the anomaly or reference Section 3.3.2.	Text and figures have been updated to refer to the work as an exploratory excavation, and that the source of the anomaly may or may not be removed from the area, pending identification of the anomaly. UC and its radiological consultant are currently preparing the radiological excavation work plan portion for the exploratory excavation. UC proposes to provide complete details regarding the exploratory excavation to DTSC as an addendum to this FSP and is requesting approval of the other three sampling activities identified in this FSP in advance of the exploratory excavation, which will enable UC to proceed with the other activities prior to approval of the exploratory excavation activities. This FSP continues to provide the background and purpose of the exploratory excavation, and defers the investigation details to an upcoming addendum. DTSC approval of this FSP will apply solely to the three activities presented in the FSP, excluding the exploratory excavation. DTSC approval of the exploratory excavation activities is dependent on the review and approval of the forthcoming addendum. UC collected a soil sample for analysis on July 24, 2014 to help determine potential air sampling parameters during exploratory excavation activities. The FSP has been updated to include the soil sample results. The sample results will be incorporated into the air monitoring plan, to be provided within the exploratory excavation addendum.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
LN 6	Section 3.2.1	6	a. Step 6, third item, and Section 3.2.3, Step 6: Please provide a reference that describes the statistics discussed and their relevance to the investigation and the proposed sampling scheme. To estimate exposure point concentrations, DTSC typically calculates a 95% upper confidence limit of the mean. If few analytical results are available the maximum observed concentration is used as an estimate. b. Step 7: Explain why it is expected that VOCs would be detectable in the samples collected from 0-0.5 feet below ground surface, or delete the VOC analysis from this sample depth.	a. The collection of field replicate samples is to help identify precision and representativeness of the sample results. According to the Uniform Federal Policy for Quality Assurance Project Plans; Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs (EPA-505-B-04-900A, March 2005, Final), "overall project precision is measured by collecting data from co-located field duplicate (or replicate) samples." (Section 2.6.2.1 Precision) Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. Field duplicate precision checks will help indicate potential spatial variability (Section 5.2.3.1.3 Representativeness) The evaluation of precision and representativeness is independent from the use of exposure point concentrations. b. Text has been amended to clarify that VOCs will be analyzed in soil samples collected from the 1.5 to 2 foot interval only.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
LN 7	Section 3.2.2	7	a. Steps 1 and 6: Include that the California Department of Public Health- Radiologic Health Branch will be involved in the review of the Radiological Sampling Plan to be included as Attachment 1. b. Step 3: Include whether surface scans for radioactivity have been conducted within the Bulb Area at other than the two piezometer locations. c. Page 15, Step 5, first item: State that chemical analytical data will also be screened against commercial screening criteria.	a. Text has been revised to clarify that the California Department of Public Health – Radiologic Health Branch will be provided with the Radiological Sampling Plan for review. b. Surface scans were conducted throughout approximately half of the Bulb during the 2004 DTSC magnetometer survey (see Figure 7 and Appendix B). Text has been revised to clarify the extent of the 2004 surface scan, and will also describe the surface scan for radioactivity that was conducted by the UC Berkeley Radiologic Health Office at the magnetic anomaly on July 24, 2014. The revised document also includes a summary memorandum describing the 2014 survey and results. c. Text regarding human health screening criteria has been moved from the fourth bullet to the first bullet. Text has been revised to clarify that data will be compared with the lesser of the applicable human health screening criteria – the maintenance worker and the inhalation pathway for the off-site receptor, as presented Table 1.
LN 8	Section 3.2.3	8	a. Step 1: Add within the problem section that the investigation needs to be conducted in a manner that minimizes disruption to the Big Meadow.	a. Text has been amended to state that the investigation will be conducted in a manner that minimizes any disruption to the Big Meadow at the site.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
			b. Step 4: Explain why a background sample is needed for the soil gas sample. While ambient (outdoor) air samples are collected during indoor air sampling events, typically a background sample Is not collected during In situ soil gas investigations. Two trip blanks should be collected and analyzed. One trip blank should accompany the passive samplers to the field and then analyzed. The second trip blank should accompany the samplers from the field to the laboratory and then analyzed. c. Step 6: Identify which naturally-occurring organic constituents may be present in soil	b. The intent of the background sample was to identify potential natural occurring organic constituents, which have been identified in previous grassland samples during total hydrocarbon analysis as Tentatively Identified Compounds. Since the target analyte for this investigation is specifically carbon tetrachloride, text regarding a background sample has been removed. Text has been amended to include the trip blanks identified in the DTSC comment. c. Text regarding a background sample has been removed per the previous comment. The following text from Step 6 has also been removed: "While not anticipated, it is possible that naturally-occurring organic constituents in soil could manifest as low level volatile organic detections, and therefore false positive results."
LN 9	Section 3.2.4	9	a. Step 1: Identify the land use for the areas described in this section. b. Step 6 and 7: The depths of piezometers should not be automatically limited to 15 feet bgs, but should be based on the subsurface materials encountered and the ground water zone intended to be monitored. In this investigation, the screen lengths and depths should be carefully restricted to intercept only the shallow water-bearing zone. The target sample intervals should be based on the general depths of the two water-bearing zones as determined by other investigations, the depth .of the BAPB, the avoidance of cinder intervals as proposed in the Sampling Plan, and the other information inputs identified in the DQOs.	a. Text has been revised to clarify that the land uses in the investigation area are both Research, Education, and Support, and Natural Open Space. b. Text has been revised to clarify that the depths of piezometers and screened intervals will be identified based on all current BAPB data available and observations made during the field investigation. The sample interval will be targeted at the shallow water-bearing zone while incorporating avoidance of cinder intervals.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
LN 10	Section 3.3	10	As the potential exists for different types of contamination to be encountered in the Bulb investigation, specific decontamination and waste management practices need to be included in the Sampling Plan for DTSC review and approval. If the information will be included within Attachment 1, this should be stated.	Text has been amended to clarify that the details regarding all exploratory excavations will be included in the FSP addendum.
LN 11	Section 3.3.1	11	Include a reference to the Coastal Terrace Prairie Management Plan and state that that activities occurring in the Upland Meadows area will adhere to its requirements.	Text has been revised to include a reference to the grasslands management plan identified in the Final Environmental Impact Report.
LN 12	Section 3.3.2	12	a. Page 20: In addition to obtaining a permit from the San Francisco Bay Conservation and Development Commission, contact California Department of Fish and Wildlife and the US Fish and Wildlife Service to determine if either agency will require a permit has other requirements associated with the sampling activities, such as soil stockpiling.	a. Text has been revised to clarify that the California Department of Fish and Wildlife and the US Fish and Wildlife Service have been contacted regarding any permit applications or notifications. Text includes a summary of the information requested by these agencies.
			b. Page 21, Exploratory Excavation Procedures: State the anticipated dimensions of the soil stockpile and how any potential run-off will be dealt with.	b. Text has been revised to present the range of soil stockpiles to be generated, since the boundaries of the excavation are solely estimated. Soil management and run-off alternatives will be described in the FSP addendum.
			c. Page 23, Dust Control Measures: State how long the soil stockpiles will be present at the site. If the stockpiles will be present longer than one day, state how the stockpiles will be managed.	c. Stockpile management will be described in the FSP addendum.
LN 13	Section 3.3.3	13	Clarify in the text whether the samplers will be impacted by rain or whether the samplers can be deployed if adverse weather conditions are expected.	Although the samplers are not affected by rain or other weather conditions, sampling activities will not be conducted if wet or rainy conditions are present, consistent with the protection of grasslands stated in DTSC Comment 8. This has been clarified in the text.

UC Berkeley Ref. No.	**Page / Sect No.**	**DTSC Comment No.**	**DTSC Comment**	**UC Berkeley Response**
LN 14	Section 3.3.4	14	a. As mentioned above, the length of the well screens should be based on the types of subsurface materials encountered and work performed by others in the local area. Use similar screen lengths as were used by previous investigators. The proposal to adjust screen intervals downward to avoid cinders would result in some wells monitoring deeper intervals than other wells. Have alternate lengths of screen materials available on site and construct wells to monitor the same intervals or parts of the same intervals. If that doesn't work, move the boring.	a. Text has been amended to clarify that piezometer well screen length will be installed consistent with the methodologies used to construct the current groundwater monitoring wells in the investigation area. The specific actions identified in the DTSC comment have been included in the revised text.
			b. Identify the type of drill rig and measures that will be used to minimize potential damage to the local area.	b. Text has been revised to clarify that the drilling equipment will be selected to minimize damage to the investigation area.
LN 15	Section 3.3.5	15	a. The analytical methods that will be used to analyze samples for radioactivity need to be included on Table 1.	a. Analytical methods regarding radioisotope screening will be presented in the FSP addendum.
			b. This section needs to state that a health and safety plan will be prepared for the field activities. In addition, a copy of the plan needs to be provided to DTSC prior to the start of fieldwork.	b. Text has been amended to state that health and safety plans for all field activities will be provided to DTSC.
			c. Include the identification of the laboratories that will be used to analyze samples as per Section 7.4 of the QAPP.	c. Proposed analytical laboratories are provided in the updated text, and will be presented in the FSP addendum for any radiological sampling if merited.
LN 16	Figure 3, Phase IV Sampling Areas	16	Please explain the term "Open Piezometer." This designation is included in the legend.	The legend on Figure 3 has been changed to "Existing piezometer"
LN 17	Figure D-1, Groundwater Sampling Locations in the Vicinity of the BAPB	17	Either delete or add the meaning of footnote 1 (BAPB Barrier Wells on RFS Property. Exceeded Aquatic Screening Criteria[1]).	Footnote 1 has been deleted from Figure D-1.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
			Phases I through III of previous field sampling efforts investigated site-wide groundwater, mercury in the mercury fulminate area, polychlorinated biphenyls (PCBs) at former transformer locations and the corporation yard, carbon tetrachloride in groundwater underlying the natural open space, and other small remaining areas of contamination. Phase IV field sampling will include: soil investigation of the meadows constituting the natural open space; investigation of the magnetic anomaly previously identified in the "bulb" of the transition habitat; an attempt to locate the source of the carbon tetrachloride detected in groundwater; and, further characterization of contaminants in groundwater up gradient and cross gradient to the biologically active permeable barrier (BAPB). The HERO reviewed the field sampling work plan for Phase IV, focusing on the adequacy of the proposed data to support a potential human health risk evaluation. The Ecological Risk Assessment Section (ERAS) will submit a separate memorandum reviewing this work plan for its adequacy to support a potential ecological health risk evaluation. The HERO has the following **Specific Comments** on the Work Plan.	NA
KK 1	Page 4 Section 1.2	1	The text describes the natural open space that will be subjected to soil sampling. Please add the approximate size of this are in acres to the description.	Text has been revised to clarify the approximate sizes of the investigation areas.
KK 2	Page 4 Section 1.2	2	This section describes the carbon tetrachloride area. Since carbon tetrachloride has been detected in groundwater, provide the depth to groundwater in this description.	Approximate depths to groundwater have been included in the revised text.
KK 3	Page 12 Section 3.2.1	3	A) The text of this section states that soil samples at 0 to 2 feet below ground surface (bgs) will be sampled on an approximately 125-foot grid. Also provide the approximate grid for the 0 to 0.5 feet bgs soil samples.	A) Text has been revised to clarify that the 0 to 0.5 feet bgs soil sample locations are placed on a 125-foot square grid, and that the 1.5 to 2.0 feet bgs samples will be collected at half of the 0 to 0.5 feet bgs sample locations, resulting in a location spacing of a 125 x 250-foot rectangular grid.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
KK 3 (cont'd)	Page 12 Section 3.2.1	3 (cont'd)	B) The text states that, if chemicals are detected in these surface soil samples, samples will be taken to a depth of 10 feet bgs for future evaluation of exposure by construction workers. If the upland meadows have been designated as protected natural open spaces, sampling to 10 feet bgs would not be necessary, and sampling from 0 to 6 feet bgs to address exposure by burrowing animals and plants is sufficient.	Future maintenance workers may be exposed to soils to 10 feet bgs when performing maintenance work on underground utilities. The text has been revised to clarify that samples may be taken to a depth of 10 feet bgs for future evaluation of exposure by maintenance workers.
KK 4	Page 12 Section 3.2.1	4	The soil data will be compared to commercial soil screening levels and ecological soil screening levels. Add text providing a rationale for comparing the concentrations of contaminants in soil to commercial screening levels since the upland meadows will remain protected natural open space. If the intent is protection of groundskeepers and maintenance workers, this should be so stated.	Per the response to comment KK 3, maintenance workers may potentially be exposed to chemicals as deep at 10 feet bgs. In addition, off-site receptors may be exposed to chemicals via the inhalation pathway. Section 3.2.1 has been updated to state that soil data will be compared to maintenance worker and off-site inhalation screening criteria, and will present the rationale for the comparison. These criteria have also been specified in a new Table 1.
KK 5	Page 14 Section 3.2.2	5	Contaminant concentrations in soil in this area will be compared only to ecological screening criteria. These concentrations should also be compared to the appropriate human health screening criteria, as discussed in the specific comment above.	See response to comment KK 4.
KK 6	Page 16 Section 3.2.3	6	Shallow soil gas sampling, using passive soil gas samplers, is proposed for the soil overlying the groundwater where carbon tetrachloride has been detected. A) Provide the depth to groundwater in this problem statement.	A) While the primary purpose of the passive soil gas sampling investigation is to help identify if there is a source of carbon tetrachloride related to previous spills or disposal in the investigation area, the soil gas samplers may also detect carbon tetrachloride off-gassing from groundwater. Therefore, the depth to groundwater has been included in the problem statement. Based on data evaluation, UC will recommend whether detections of carbon tetrachloride can be attributed to possible soil sources or to off-gassing from groundwater.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
			B) The depth of the placement of the soil gas samplers should be related to the depth to groundwater. It should be shown that the deployment depth of the soil gas samplers is deep enough so the samplers will not be affected by barometric conditions at the surface.	B) Please see response to A) above. The text has been revised to clarify that the proposed passive soil gas depths are consistent with AGI recommended depths for near surface sampling, and will not be affected by barometric conditions at the surface.
KK 7	Page 16 Section 3.2.3	7	According to the text, concentrations of carbon tetrachloride will be obtained from the sampler. It should be stated that these mass value measurements cannot be converted to soil gas concentrations and, therefore, are not useable in a health risk evaluation.	Text has been revised to clarify that results from the passive soil gas samples are not intended for use in a human health or ecological risk evaluation.
KK 8	Page 17 Section 3.2.3	8	If carbon tetrachloride is identified in the passive soil samplers, active soil gas sampling should be performed in order to obtain data that can be used in a health risk assessment.	Text has been amended to include that active soil gas sampling may be considered in the following investigation or evaluation.
KK 9	Page 18 Section 3.2.4	9	One of the goals of this study is to determine if legacy contamination at the site is contributing to the elevated contaminant concentrations in groundwater in the area of the BAPB. The text of this section should be revised to include the approach proposed for comparing concentrations of contaminants in groundwater to contaminant soil and sediment concentrations.	The purpose of this investigation is to better characterized groundwater in the vicinity of the BAPB. The evaluation of the groundwater concentrations and potential migration to the marsh will be conducted under as a part of the Phase V FSP scope.
KK 10	Page 18 Section 3.2.4 and, Figure 9	10	Please provide the approximate groundwater flow direction in the vicinity of the BAPB in the text, and add the flow direction to the figure.	The flow direction in the vicinity of the BAPB is likely to the southwest, although there are not enough data points that have been measured at the same time to confirm the assumption. The following text has been added to the second bullet in Step 1: "The approximate groundwater flow direction in the vicinity of the BAPB is to the southwest." Figure 9 was not updated because there are not sufficient data points to confirm the flow direction in the area. The current flow direction lines indicate the assumed flow direction with question marks.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
KK 11	Page 21 Section 3.3.2	11	A University of California Berkeley Radiation Safety Office-approved health physics consultant will be present during all exploratory excavation activities. The presence of a DTSC-approved health physics consultant should be considered as well, depending on the circumstances and results of the initial radiological survey.	Text has been revised to indicate that in addition to the California Department of Public Health review, UC will receive any additional DTSC approvals required. This information will be provided in the FSP addendum for the magnetic anomaly excavation activities.
KK 12	Page 23 Section 3.3.2	12	Dust control measures are specified in this section. However, odor control measures should also be specified, as such measures may be necessary in this area of the site near the marsh.	During previous work in West Stege Marsh sediments, there have not been issues with odors. UC does not expect to encounter odor issues.
	Conclusion		This is a well-written draft work plan. However, the HERO has identified deficiencies as described in the specific comments above that must be addressed before the HERO can recommend the approval of this work plan.	NA

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
			ERAS largely believes the report adequately describes a reasonable sampling strategy for sampling the Meadows, the Carbon Tetrachloride Area, the Magnetic Anomaly of the Bulb in the Western Transition Area, and Groundwater upgradient and west of the BARB. However, the report should be strengthened and clarified by addressing the following **Specific Comments** listed below.	NA
ME 1	Pdf page 10 of 90, Section 1.2	1	The report indicates that DTSC had requested *"additional grab groundwater samples from locations upgradient, downgradient, and to the west of the BAPB to assess the distribution of dissolved metals and VOCs I groundwater"*. The Phase IV investigation proposes placement of four piezometers located upgradient and crossgradient from the BABP. Please explain why no piezometers are proposed downgradient of the BABP. Downgradient samples were requested by DTSC.	Piezometers MW-43, MW-45, and MW-46, installed by Terraphase on behalf of Zeneca, were installed in 2013 downgradient of the BAPB; this information has been added to the text in Section 1.2.
ME 2	PDF Page 12 of 90 Section 2.1.1	2	Big Meadow, EPA Meadow North, and West Meadow, first paragraph. If known, please describe the nature of the small mammal studies conducted by the university in the Meadows.	Text will be amended to include any small mammal studies identified by UC. If specific references cannot be identified, the text regarding studies will be deleted.
ME 3	PDF Page 15 of 90 Section 2.2.4	3	Please provide a table of the Ambient Water Quality Criteria Continuous Criterion Concentrations that will be used for screening as a guideline for the DQO Reporting Limits.	The document has been amended to include a table presenting the relevant screening criteria. Note that chemical concentrations in groundwater will be compared to the aquatic screening criteria consistent with the adjacent Former Zeneca Site, as stated in the DQO section.
ME 4	PDF page 18 of 90 Section 3.2.1	4	Please provide a table with the soil ecological screening levels for each Chemical of Concern to be used for the guidance of DQO Reporting Limits.	The document has been amended to include a table presenting the proposed ecological screening levels. Standard laboratory reporting protocols consistent with EPA SW-846 will be followed for chemicals for which ecological screening levels are not available.

UC Berkeley Ref. No.	Page / Sect No.	DTSC Comment No.	DTSC Comment	UC Berkeley Response
ME 5	PDF page 19 of 90 Section DQOs for Soil in the Upland Meadows, Step 6: Specify Performance or Acceptance Criteria	5	ERAS, is not familiar with taking triplicates to establish a margin of error for a sample dataset. In this case, what is the margin of error measuring? Please provide the methodology.	Please see response to DTSC Comment 6(a) regarding use of triplicate samples.
ME 6	PDF page 20 of 90 Section 3.2.2	6	The report indicates that radiological screening levels will be submitted prior to the final draft of the Field Sampling Plan. Will ecological screening levels be provided, if so what is the source.	Radiological ecological screening levels will not be identified for the exploratory excavation. If radiation is found to be present during the excavation, then ecological screening levels will be developed in support of future investigations, if appropriate.
ME 7	PDF page 38 of 90 Figure 3	7	What does the carbon tetrachloride 'background' sample represent? In ERAS' view there is no background for carbon tetrachloride.	Please see response to DTSC Comment 8(b) regarding background samples for carbon tetrachloride.
ME 8	PDF page 55 of 90 Table Titled TPH**,** SCOC, Pesticide, and PCB Results Reported in Micrograms per Kilogram (mg/kg).	8	Results are presented for the coastal prairie but screening was conducted only against CHHSL's and not ecological screening levels. Organochlorine pesticides are reported as non-detect, results are presented in mg/kg but reporting limits are unknown. The Eco-SSL mammalian screening level is 0.021mg/kg. Insufficient information is presented in the table to provide guidance for Phase IV sampling.	The proposed sampling includes consideration of areas where pesticides are most likely to be present: near buildings and within ditches. If pesticides are found to be present in this subset of samples, UC may propose additional sampling based on the data review.
	Conclusion		The report needs to be revised to address the comments above. Tables should be inserted in the report that lists the ecological screening levels for each media being sampled. The report is not complete without inclusion of the radiological sampling plan for the BULB.	NA

ATTACHMENT 1
DTSC MAGNETOMETER SURVEY

MEMORANDUM

TO: Lynn Nakashima, Senior Hazardous Substances Scientist
Northern California – Coastal Cleanup Operations Branch
Department of Toxic Substances Control
700 Heinz Avenue
Berkeley, CA 94710

FROM: Michael O. Finch, PG
Geologic Services Unit
Department of Toxic Substances Control
8800 Cal Center Drive
Sacramento, CA 95826

DATE: December 15, 2006

SUBJECT: MAGNETOMETER SURVEY AT UNIVERSITY OF CALIFORNIA, RICHMOND FIELD STATION, RICHMOND.

The Geologic Services Unit (GSU) of the Department of Toxic Substances Control (DTSC) was requested to provide a magnetometer survey at the University of California Richmond Field Station (Site) in an area commonly referred to as the "Bulb" to locate possible buried steel drums. The result of this survey follows.

Mark Vest and Michael Finch of the GSU arrived at the Site the morning of November 14, 2006, and established four grid systems: three 6 feet by 10 feet, and one 12 feet by 10 feet, to cover 36,000 square feet around the surface impoundment in the Bulb area as shown on the attached figure. Heavy vegetation prevented taking measurements at every location on the grids. A Geometrics G-856 magnetometer was used to conduct the survey. A magnetometer measures the earth's magnetic field strength at one point in space and time. The nearby presence of ferrous metals disrupts the magnetic field and produces a magnetic anomaly. A background reading of 49,300 +- 100 gamma was measured for this general location away from any obvious metal objects and is considered typical for this location in California. Magnetic soils were not noted at the Site, and significant scattered metallic debris was not observed that could interfere with the survey. These conditions can allow for detection of large ferrous bodies to depths of more than 20 feet below grade.

The completed survey showed a strong anomaly centered 170 feet south-southwest of the impoundment as shown in red on the attachment. This anomaly exhibits an approximate 900 gamma above background and covers roughly 20 by 36 feet. The anomaly shows the classic "bull's eye" pattern and has the expected negative anomaly associated with large ferrous bodies. The depth of the ferrous body remains uncertain, however, if large enough (say the size of an automobile) it could be buried 20 feet below grade. Given the location of the Site next to San Francisco Bay and low surface elevation (less than 5 feet above sea level) a depth of 20 feet would be under more than 15 feet of water. A mass of five or so 55 gallon steel drums buried 5 to 10 feet below grade could give a similar magnetic anomaly. The GSU marked the anomaly in the field with a discarded skateboard.

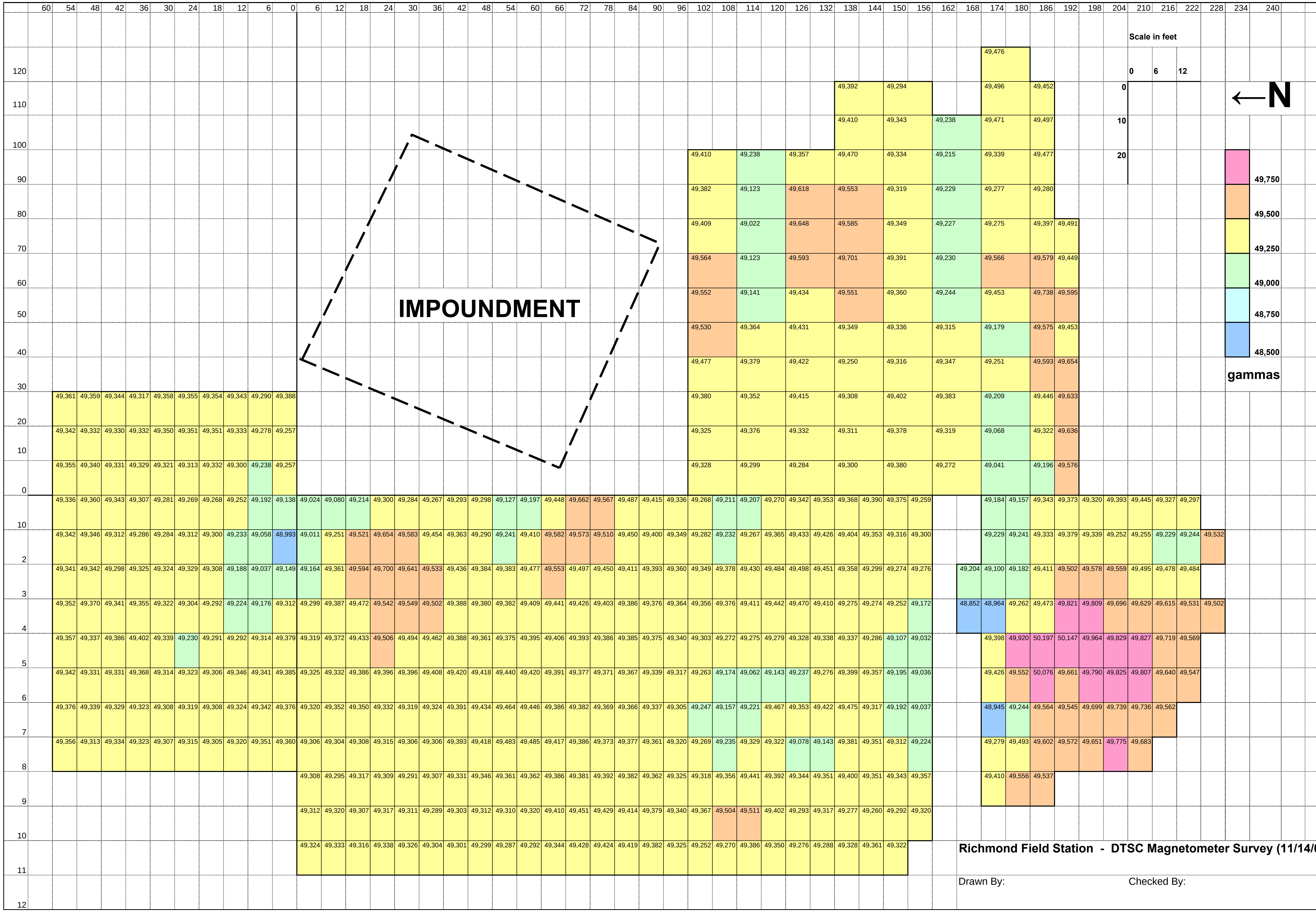
No other strong anomalies were found in the grids and other elevated magnetometer readings are assumed to be caused by rebar or other debris seen at the Site. The northeastern side of the surface impoundment was briefly scanned for anomalies, but no readings above background were noted.

The GSU concludes that some kind of large ferrous body is buried 170 feet south of the Site impoundment at an unknown depth. The GSU recommends that this anomaly be excavated for further investigation. A hand-held metal detector may assist the excavation crew during this process.

If you have any further questions please telephone me at (916) 255-3583 or E-mail at mfinch@dtsc.ca.gov.

Attachment

cc: Mark Vest



Prepared by DTSC 2/5/2007

ATTACHMENT 2
RFS BULB INVESTIGATION, 2014 RADIATION SURVEY

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

OFFICE OF ENVIRONMENT, HEALTH AND SAFETY
317 UNIVERSITY HALL
BERKELEY, CALIFORNIA 94720-1150

August 5, 2014

Karl Hans
EH&S, UC Berkeley
317 University Hall, MC 1150
Berkeley, CA 94704

RE: Richmond Field Station Bulb Investigation

Dear Karl:

On Thursday, July 24, I performed a radiation survey to assist with soil sampling at the Richmond Field Station (RFS) Bulb, located in the southern portion of the Western Transition Area. The sampling was conducted with contractors from Tetra Tech, Inc, Jason Brodersen, Cynthia Breene, and Mark Dufy. A magnetic anomaly was identified at the RFS Bulb site during a November 2006 magnetometer survey. The soil sampling, and associated radiation survey, was performed to provide a preliminary evaluation of soil conditions in fill material above the original bay mud surface in advance of excavation of the magnetic anomaly location planned in 2014. Radiation safety was requested to perform the radiation survey because the magnetic anomaly is thought to potentially include uranium ore material buried in waste drums.

The radiation survey was performed using a Canberra InSpector 1000 (S/N 02084500) with a 1.5”x1.5” LaBr IPROL-1 probe (S/N 04074637). LaBr probes are used to detect gamma rays from 30 keV to 3.0 MeV. The high resolution is excellent for nuclide identification while retaining a high efficiency.

Using a hand-auger sampling device, the field team advanced 8 boreholes into the soil from the surface down to the original bay mud. Only 4 of the penetrations actually made it down to the original bay mud layer, as there was often resistance at about 18-24” below the surface in the anomaly area. This appeared to be buried concrete, which could be construction waste or other debris.

For each boring, the LaBr probe was lowered down the hole to monitor for increasing levels of radioactivity which might indicate buried radioactive material. The average background reading at the surface was approximately 10 µrem/hr. When the LaBr probe was lowered below the surface, there was an increase to approximately 13-15 µrem/hr on the probe. This is likely due to the increased geometry of detecting naturally occurring activity in the ground or concrete. An exposed piece of concrete pipe was surveyed with no elevated level of exposure.

No readings over twice background (20 µrem/hr) were detected. However, it was not possible to evaluate radiation levels beneath the concrete. I recommend that if there is any attempt to remove the concrete to further investigate the anomaly, a member of the Radiation Safety team must be present to monitor for radioactive materials. If there is no plan to go below the resistance level, there is no evidence of radioactive materials present.

Sincerely,

Dan Hibbing
Health Physicist, Radiation Safety

Document location: N:\Buidings & D&D\RFS\BULB Investigation\RFS Bulb Investigation 25Jul14.docx

ATTACHMENT 3
GUIDELINES FOR SOIL GAS AND SUB-SLAB SAMPLING USING THE AGI UNIVERSAL SAMPLER

AMPLIFIED GEOCHEMICAL IMAGING, LLC

Guidelines for Soil Gas and Sub-Slab Sampling Using the AGI Universal Sampler

NOTE: If you have any questions regarding installation and retrieval, please call:
Jay Hodny, Jim Whetzel or Dayna Cobb
(302) 266-2428

GENERAL

Always obtain utility clearance before any subsurface sampling.

Soil Gas & Sub-slab Soil Gas

For soil gas sampling, the AGI Universal Samplers can be placed on the surface under a cover or installed to any depth, in uncased or cased holes, and can include vertical profiling. The installation hole is sealed effectively against air infiltration with natural cork which is impermeable to gases and liquids. The prescribed practice is to place the passive sampler (i.e., the adsorbent) at the desired sampling depth. Generally, for soil gas sampling, depths of three feet or more are favored to minimize the effects of surface and near-surface variables (e.g., soil temperature, barometric pressure, air pollution, natural organic content) on the soil gas signal of interest.

Similarly, subslab soil gas can be collected by placing the module at the slab/soil interface, at depth beneath the slab, or both, in permanent or temporary installation holes. The installation hole is advanced through the slab, and sealed with the cork after module insertion. Alternatively, exterior subslab sampling can be achieved by advancing the installation hole at an angle to reach beneath the slab from the outside of the structure.

For soil gas and subslab soil gas sampling, the installation is flush with the surface with no sampling equipment remaining on the surface. Site activities (e.g., dry cleaner, refinery, aircraft runway operations, etc.) can continue uninterrupted.

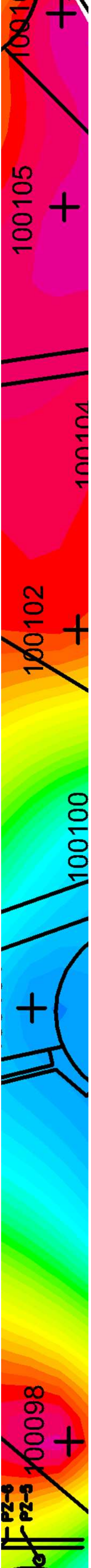
Site activities which may disturb the natural soil gas migration should not be conducted during the time when the AGI Samplers are in the subsurface. Such activities include, but are not limited to, installation/operation of soil vapor extraction systems, drilling (e.g., air-rotary), excavation, air sparging, etc.

The following items are provided by AGI:

- cardboard shipping container(s), partitioned box(es) containing individually numbered AGI Samplers - (DO NOT DISCARD SHIPPING CONTAINER OR PARTITIONED BOXES),
- insertion rod (please return after use; bundle sections together with a rubber band do not use tape),
- corks with screw eyes,
- string,
- Chain of Custody and Installation/Retrieval Log
- custody seals

STORAGE

AGI Samplers are carefully cleaned, sealed, and stored after manufacturing. They must remain sealed in their vials in the shipping boxes until deployment and after retrieval. **DO NOT** store near potential sources of organic vapors such as petroleum fuels and exhaust, solvents, adhesives, paints, etc.



AMPLIFIED GEOCHEMICAL IMAGING, LLC

Guidelines for Soil Gas and Sub-Slab Sampling Using the AGI Universal Sampler

REQUIRED TOOLS/SUPPLIES

A narrow diameter hole (approximately 1/2 to 1-inch; 2.5cm) is drilled or driven to the desired sampling depth. Simple hand tools such as a slam bar or rotary hammer drill are used to create the installation hole in soil. A hammer drill or similar coring tool is required to advance the hole through a slab. Direct-push or auger-type tools are usually needed for deeper installations.

Additional tools (to be supplied by the customer) required for installation may include:

- equipment to lay out and mark sample locations (scaled map, measuring tapes, pin flags, GPS unit);
- disposable gloves and equipment decontamination supplies
- slide hammer/tile probe (slam bar) or electric rotary hammer drill (AC power outlet or portable generator and extension cords) with carbide-tipped bits or augers (1/2 to 1-inch; 2.5cm diameter, three feet; 1 meter or more, in length).
- Optional: concrete patching material

If sample locations need to be hidden to prevent damage/loss by vandalism or animals, push the cork farther into the hole, place a metal washer or nut on top of the cork, and cover with soil and sod. Use a metal detector to locate modules for retrieval.

Natural cork is impermeable to gases and liquids, providing an effective seal against infiltration of ambient air. For additional security, a thin layer of concrete patching material can be applied over the cork.

The following vendors supply installation hole drilling equipment. The information is provided as a courtesy and does not represent any endorsement of these products or suppliers:

Item	Supplier	Phone No.
* Slide Hammer/Tile Probes	Forestry Supplies	(800) 647-5368
* Carbide Drill Bits (36" long)	1. Kerfoot Technologies, Inc. 2. the Blade Runner	1. (508) 539-3002 2. (610) 444-6708
* Rotary Hammer Drill	SKILL-BOSCH Power Tools	(800) 334-5730

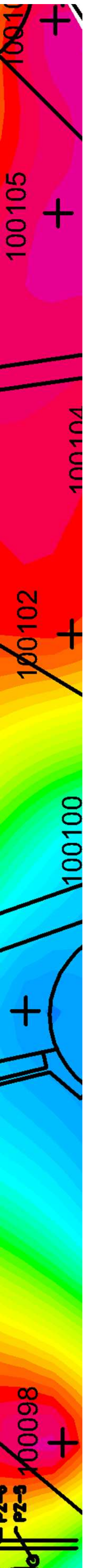
* Art's Manufacturing Supply (dba AMS) has all these items (800) 635-7330

TRIP BLANKS

An additional number (specified) of AGI Samplers are included as trip blanks. The customer selects which modules to be used/treated as trip blanks, and notes this on the Chain of Custody and Installation/Retrieval Log. These modules remain unopened, travel to and from the site during installation and retrieval, while in storage away from AGI's facility, and in transit to/from AGI's facility.

SAMPLER INSTALLATION

- The sample grid can be laid out beforehand (recommended) or during the module installation. Do not use spray paint or similar materials to mark locations, or drill through locations marked with spray paint.
- To facilitate the installation of the modules, it is recommended that the string and corks be prepared prior to going to the field. As an example, for a three foot installation, cut a piece of the supplied string to a length of approximately 7.0 feet or 2.25 meters. Tie the ends of the string together using a non-slip knot (square knot is suggested, Figure 1). Pass the looped string through the eyelet in the cork and pull it back through itself. Wrap the remainder of the string around the cork and secure the string/cork combination with a rubber band. The cork and cord are now ready to attach to the module after the installation hole is created.



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SAMPLER RETRIEVAL

- Following the sampler exposure period identify and check each location in the field using the site map.
- Remove the cork with a penknife, screwdriver or corkscrew. Grasp the cord and pull the sampler from the ground; **verify the sampler ID number**. Wipe excess dirt or water on the surface of the sampler. Cut off and discard the cork and cord. Place the entire sampler into its labeled jar and secure the lid.
- **Use caution when screwing down the lid on the sample jars. Clean any soil/debris from the threads of the jar and lid, and make sure no part of the sampler is pinched between the jar and lid. Be sure the seal is tight. Over-tightening may cause breakage.**
- **Affix a custody seal to the side of the jar and jar lid. Do not cover the barcode with the seal.**
- Place the jar in the supplied partitioned box.
- Complete the sampler retrieval date/time on the Installation/Retrieval log.

PACKAGING FOR RETURN

- Place boxes with samplers back into outer shipping container using appropriate packing materials to protect fragile contents.
- **Do not** use Styrofoam "peanuts" as packing material. Bubble packing is acceptable.
- Label box to indicate fragile contents.
- There is no need to return the shipment in coolers with ice.
- **Return the AGI Samplers, insertion rod and paperwork (preferably by overnight courier) to**:

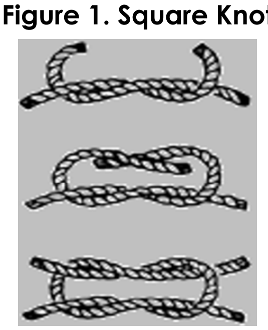
AGI Laboratory
210 Executive Drive, Suite 1
Newark, DE 19702-3335
302-266-2428
Phone: (410) 392-7600
Attn: NOTIFY LAB IMMEDIATELY UPON DELIVERY!!

IMPORTANT: Samples should not be shipped for weekend or holiday delivery.

Square knot instructions (Figure 1)

1. *Take an end of the string in each hand.*
2. *Pass the left-hand string over the right-hand string and wrap it around the right-hand string.*
3. *Take the string end that is now in your right hand, place it over the string end in your left hand and wrap it around that string.*
4. *Pull the string carefully to tighten the knot.*

Figure 1. Square Knot



AMPLIFIED GEOCHEMICAL IMAGING, LLC

Guidelines for Soil Gas and Sub-Slab Sampling Using the AGI Universal Sampler

Soil Gas and Sub-slab Soil Gas Sampling

Slide hammer

Rotary hammer drill

Initial insertion

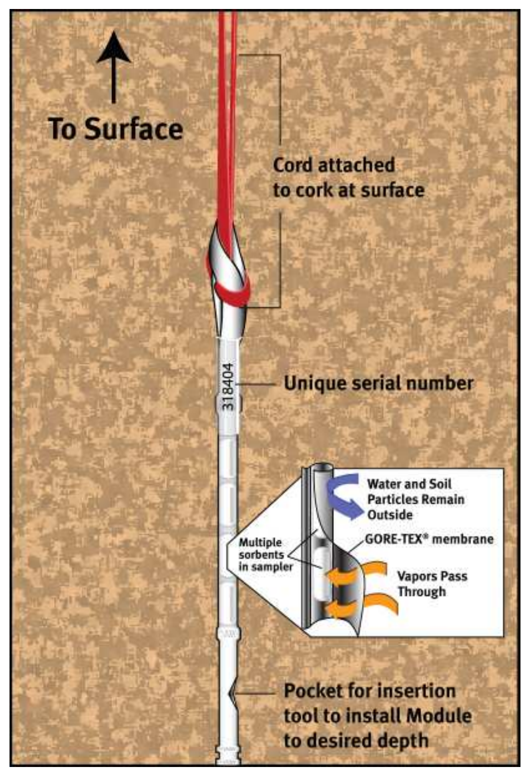
After insertion, impermeable cork sealed

Initial insertion into permanent sampling port.

Angle beneath slab.

Rotary hammer drill

Note: Dry cleaner operations continue, no obstructions on surface after installation.



GORE-TEX® membrane allows for unimpeded migration of soil gas to adsorbent, while protecting the adsorbent from liquid water and soil.

www.agisureys.net

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