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# UNDERGROUND FUEL STORAGE TANK-RELATED CORRECTIVE ACTION REPORT

## 2836 UNION STREET
## OAKLAND, CALIFORNIA

*Prepared for:*

**LARRY WADLER**
**2525 MANDELA PARKWAY**
**OAKLAND, CA 94607**

**December 2006**

STELLAR
ENVIRONMENTAL SOLUTIONS, INC.
GEOSCIENCE & ENGINEERING CONSULTING

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**December 1, 2006**

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December 1, 2006

Mr. Barney Chan
Hazardous Materials Specialist
Alameda County Environmental Health Care Services Agency
Department of Environmental Health – Local Oversight Program
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Subject: Underground Fuel Storage Tank-Related Corrective Action Report
2836 Union Street, Oakland, California – RO#2905

Dear Mr. Chan:

On behalf of the property owner and "Responsible Party" (Mr. Lawrence Wadler), Stellar Environmental Solutions, Inc. (SES) is submitting this Corrective Action Report related to petroleum contamination from a former underground fuel storage tank. This work follows initial site characterization activities (in August and October 2005 and April 2006); the reports of those activities were provided to Alameda County Environmental Health (in both hard copy and electronic upload to the ftp system) and to the State Water Resources Control Board's GeoTracker system.

The corrective action completed was effective in removing the majority of residual soil, which could be easily identified except where it occurred beneath the building footprint. Significant groundwater contamination was also recovered through purging the excavation area of contaminated groundwater. However, available data indicate remaining contamination that exceeds Regional Water Quality Control Board Environmental Screening Levels. In our professional opinion, the recent installation of the ten monitoring wells to conduct quarterly groundwater monitoring is the appropriate action to further evaluate the magnitude and stability of the contaminant plume over time, and to determine whether additional corrective action might be warranted and if site closure criteria can be met.

I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report are true and correct to the best of my knowledge. If you have any questions regarding this report, please contact us at (510) 644-3123.

Sincerely,

Henry Pietropaoli, R.G., R.E.A.
Project Manager

Richard S. Makdisi, R.G., R.E.A.
Principal

REGISTERED GEOLOGIST
RICHARD S. MAKDISI
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# EXECUTIVE SUMMARY

## SUMMARY AND FINDINGS

This work follows a preliminary site investigation in August 2005 and additional site characterization investigations in October 2005 and April 2006.

One 10,000-gallon gasoline underground fuel storage tank (UFST) was installed in the late 1970s. The UFST operated under Alameda County Environmental Health permit (permit No. STID 4065) until it's removal in 1998. Site soil and groundwater have been contaminated by gasoline and associated aromatic hydrocarbons. Soil analytical results show that soil contamination began at a depth of approximately 6 to 7 feet, and did not extend deeper than approximately 11 feet.

The corrective action completed was effective in removing the majority of the residual soil, which could be easily identified. Residual contaminated soil remaining on site is mainly beneath the building footprint (not possible to access). Significant groundwater contamination was also recovered through purging contaminated groundwater from the excavation area. However, according to the available data, the remaining contamination exceeds Regional Water Quality Control Board Environmental Screening Levels. In our professional opinion, the recent installation of the ten monitoring wells to conduct quarterly groundwater monitoring is the appropriate action to further evaluate the magnitude and stability of the contaminant plume over time, and to determine whether additional corrective action might be warranted or if site closure criteria can be met.

During this investigation, 397.6 tons of contaminated soil was removed from the vicinity of the former UFST and disposed of at a permitted non-hazardous landfill. The resultant excavation comprised an approximately 900-square foot area. It is estimated that 30 to 40 cubic yards of contaminated material, containing total petroleum hydrocarbons as gasoline at an estimated 1,000+ milligrams per kilogram, still resides beneath the building on site. Thus, approximately 90 percent of the contaminated soil was remediated.

During this investigation, 900 gallons of contaminated groundwater was initially pumped from the open excavation and found to contain high levels of dissolved hydrocarbons. As a result of this apparent good contaminant mass capture, another 4,200 gallons of contaminated groundwater was pumped from the backfilled excavation via the temporary dewatering point and sent to a non-hazardous wastewater recycling facility. Pre-pumping and post-pumping excavation groundwater sample analytical results show that significant mass removal was accomplished by excavation dewatering.

Groundwater in the immediate vicinity of the former UFST occurs at a depth of less than 10 feet, and appears under at least semi-confining conditions, rising from approximately 20 feet below ground surface to as high as 6 feet below grade, such that groundwater is in contact with residual contaminated soil. The groundwater contaminant plume has not been fully delineated, but appears to have an elliptical configuration with the long axis trending east to west-northwest.

The extent of the contaminant plume is determined by the mass of residual soil contamination, hydrogeologic characteristics, and the ability of natural degradation mechanisms to reduce contaminant mass. Groundwater contamination will continue to migrate downgradient from the source area, primarily by advection.

While this corrective action removed the great majority of hydrocarbon contaminant mass, shallow groundwater will likely continue to be impacted by the remaining residual soil contamination by adsorption from soil into groundwater. However, it should result in significant reduction in the hydrocarbon dissolved fraction concentrations. The dissolved phase hydrocarbon contamination in the groundwater does not appear to be adsorbing onto downgradient soils.

Local groundwater flow direction is generally to the west (toward San Francisco Bay and following local topography) in this area of west Oakland. Based on the configuration of the groundwater contaminant plume, it appears that local groundwater flow direction in the recent past was to the west-northwest. However, as seen in the October 2006 groundwater elevation map, the present direction is southwest toward the hydrologic void created by dewatering of the excavation. The flow direction will likely turn west-northwest once hydrogeologic conditions equilibrate.

## RECOMMENDATIONS

- We recommend following up with Alameda County Environmental Health following its receipt of this report, to discuss the requirements to move the site toward regulatory closure. We further recommend that the Alameda County Environmental Health-requested work be implemented, and that all future technical reports be provided to the appropriate regulatory agencies, including electronic uploads to Alameda County Environmental Health’s ftp system and the State Water Board’s GeoTracker system.

- Excavation groundwater sample analytical results show that significant mass removal is accomplished by excavation dewatering. Additional excavation dewatering should be continued, followed by collection of post-pumping groundwater samples to evaluate the effectiveness of the pumping.
- Groundwater monitoring should be continued. All of the groundwater monitoring wells should be re-sampled as soon as possible, using micro-purging method, to evaluate the effect of dewatering and to obtain samples from the wells that were purged dry after well development and could not be sampled. Obtaining samples from all of the wells should illuminate the degree of hydraulic conductivity between the shallow and deep water-bearing zones. The groundwater flow direction as it is affected by the excavation should be evaluated in future monitoring events.
- The site should be evaluated for potential remediation by soil vapor extraction should natural attenuation fail to demonstrate a stable or reducing plume.

# 1.0 INTRODUCTION

## PROJECT DESCRIPTION

Stellar Environmental Solutions, Inc. (SES) was contracted by Mr. Lawrence Wadler (property owner) to conduct corrective actions related to soil and groundwater contamination at 2836 Union Street in Oakland, California. This work follows a preliminary site investigation in August 2005 and additional site characterization investigations in October 2005 and April 2006. Both investigations revealed subsurface contamination from a former 10,000-gallon underground fuel storage tank (UFST).

Figure 1 shows the site location. Figure 2 is a site plan showing the locations of the borings, monitoring wells, and corrective action excavations for this and previous investigations. Appendix A contains photographic documentation of investigation activities. Appendix B contains analytical data from previous investigations.

## SUBJECT PROPERTY DESCRIPTION AND HISTORY

The approximately 7,200-square foot rectangular subject property is developed with one approximately 1,500-square foot two-story building. A narrow driveway borders the building to the north, and the rear of the property is undeveloped (paved). Adjacent uses include:

- A residence (to the north);
- A paved parking area (to the east);
- A residence (to the south); and
- A sidewalk, then Union Street, then an auto body repair facility (to the west).

The property operated as an express courier facility (Modern Mail Services, Inc.) between 1951 and 2003. The UFST had been operating under a current Alameda County Environmental Health permit (permit No. STID 4065) until it was removed in 1998. The tank closure report was submitted to the Oakland Fire Department (Golden Gate Tank Removal, 1998).

## Figure 1
## Site Location Map

## Figure 2
## Site Plan

### November 2005 Initial Site Characterization

The November 2005 investigation included the advancing of four exploratory boreholes and the collection of soil and grab-groundwater samples for laboratory analysis. It was determined that gasoline and related aromatic hydrocarbons were present at elevated levels in both soil and groundwater; soil contamination apparently was limited to the area near the former dispenser. The investigation was summarized in a technical report (SES, 2005b) and, based on the findings, SES recommended that a corrective action investigation be conducted; this was proposed in our December 22, 2005 technical workplan (SES, 2005c).

### April 2006 Characterization

The April 2006 investigation involved the advancing of nine exploratory boreholes and the collection of soil and grab-groundwater samples for analysis to determine the areal and vertical extent of both soil and groundwater contamination. Site data indicated the presence of petroleum hydrocarbons in soil and groundwater that warranted groundwater monitoring well installation and quarterly monitoring. It was also determined that it would be both cost-effective and feasible to remove the remaining (accessible) contaminated soils by excavation, as an interim corrective action. The investigation is summarized in a technical report (SES, 2006b).

## REGULATORY STATUS

Alameda County Environmental Health has assigned the site to its fuel leak case system (RO#2901) and a case officer has been assigned. The case has been assigned No. T0600105641 in the State Water Resources Control Board's GeoTracker system. Electronic uploads of required data/reports will be submitted to both of these agencies.

## PURPOSE AND SCOPE OF THIS INVESTIGATION

The objectives of the current phase of work are:

1. Implement the recommendations of the April 2006 investigation;
2. Remove by excavation residual UFST contaminated soil mass that is contributing to degradation of groundwater;
3. Document residual contaminant concentrations, primarily those extending beneath the site building;
4. Begin groundwater monitoring and sampling;
5. Pump groundwater from the excavation to remove contaminant mass in groundwater; and

6. Collect pre-pumping and post-pumping groundwater samples to evaluate the effectiveness of pit pumping as a means of contaminant mass removal.

## PROJECT PARTICIPANTS

The following personnel, firms, and regulatory agencies were involved in the work for this investigation:

- **Mr. Lawrence Wadler –** Subject Property Owner
- **Stellar Environmental Solutions, Inc. –** Environmental consultant and prime contractor for the project
- **Alameda County Department of Environmental Health –** Workplan concurrence, permitting, and inspections (Appendix C)
- **City of Oakland –** Encroachment permitting (Appendix C)
- **Bay Area Air Quality Management District** – Notification in accordance with Regulation 8 Rule 40 as it pertains to contaminated soil excavation (Appendix C)
- **Speelman Excavation Services –** Soil excavation, contaminated soil removal, and backfilling (SES subcontractor)
- **A&E Asphalt –** Final completion of excavation (SES subcontractor)
- **Virgil Chavez Land Surveying –** GeoTracker-certified monitoring well survey (SES subcontractor)
- **Resonance Sonic International –** Drilling and monitoring well construction (SES subcontractor)
- **Evergreen Environmental Services –** Contaminated water removal and recycling (SES subcontractor)
- **Allied Waste –** Landfill (contaminated soil profile package prepared by SES)
- **Blaine Tech Services –** Groundwater monitoring and development (SES subcontractor)
- **Curtis & Tompkins, Ltd. –** Environmental sample analyses (SES subcontractor)
- **MacCampbell Analytical Laboratory –** Environmental sample analyses (SES subcontractor)
- **Department of Water Resources** – Submittal of Monitoring Well Completion Reports (prepared by SES)

# 2.0 PHYSICAL SETTING

## TOPOGRAPHY AND DRAINAGE

The mean elevation of the property is approximately 18 feet above mean sea level (amsl), and the general topographic gradient in the site vicinity is slight and to the west-southwest (toward San Francisco Bay). The site itself has no discernible slope. The nearest downgradient (to the west) permanent surface water body is the Airport Channel of San Leandro Bay (which is connected to San Francisco Bay), approximately 2 miles west of the subject property. According to the commercially available database, the site is not located within a flood zone or wetland.

## LITHOLOGY AND HYDROGEOLOGY

Shallow site lithology has been determined in this and previous investigations by the visual method of the Unified Soils Classification System (USCS) using continuous core soil samples. Appendix D contains borehole geologic logs from this investigation.

Figures 3 and 4 depict geologic cross-sections of the site (approximately parallel to and perpendicular to the inferred groundwater flow direction), with borehole data projected into the cross-sections. The cross-sections incorporate data collected during this and prior investigations necessary to illustrate the contaminated soil and associated groundwater plume.

The predominant soil type in all site boreholes was silty clay, generally firm and plastic. Several of the boreholes had no obvious sand or gravel units, although minor amounts of sand and gravel were occasionally present in the overall clay matrix with the occurrence of groundwater coincident in units with higher sandy-gravel than clay content. Local heterogeneities in shallow lithology and groundwater levels are typical of the alluvial deposits in this area.

In deeper boreholes drilled during installation of MW-2B, MW-3B, MW-4B, and BH-14, silty-clayey-sandy gravel at depths of approximately 20 to 22 feet below ground surface (bgs) was encountered. Groundwater quickly (within 5 minutes) rose to approximately 5 to 6 feet bgs in those boreholes, indicating confined or semi-confined conditions.

In borings advanced during installation of MW-1B, MW-2B, MW-5B, and BH-14, a thin sand and/or gravel unit was encountered at depths of approximately 6 to 13 feet but as deep as 18 feet

## Figure 3
## Geologic Cross-Section A-A’

## Figure 4
## Geologic Cross-Section B-B’

in MW-2B. The lateral extent of this unit to the south of BH-14 is undefined, and it was not encountered in borings advanced during installation of MW-3B or MW-4B to the north and west, respectively. This sandy-gravel had a heavy fuel odor, and was also observed during the excavation to extend beneath the building. The unit was saturated and appears to represent the limited perched groundwater unit identified in the April 2006 investigation. Groundwater in this shallow unit could be perched or the result of an upward gradient from the confining pressure exerted by the 20- to 22-foot-deep groundwater zone. Groundwater moves very slowly in the shallow unit relative to the deeper zone, as demonstrated during subsequent sampling during which only one of the five shallow zone wells and four of the five deep well recharged quickly enough to provide a sample for analysis.

Local groundwater flow direction is generally to the west (toward San Francisco Bay and following local topography) in this area of west Oakland.

# 3.0 SEPTEMBER 2006 WELL INSTALLATIONS

This section summarizes the installation of ten monitoring wells, installed as five "nested well pairs" designed to monitor the apparent shallow and deeper water-bearing zones, to differentiate vertical contaminate zones in groundwater. The shallow well of each nested pair extended approximately 13 feet bgs, and the deeper well was placed at approximately 25 feet bgs. Additionally, one boring (BH-14) was advanced on the southern side of the property to define to the southern lateral extent of lithologic units and the contaminant plume.

**PRE-FIELD WORK PERMITTING AND CLEARANCES**

- Obtain workplan concurrence from Alameda County Environmental Health.
- Obtain borehole drilling and monitoring well permit from Alameda County Public Works Agency.
- Obtain Encroachment and Excavation Permit from the City of Oakland, required for the wells drilled in Union Street.
- Visit site to mark drilling locations, then notify Underground Service Alert (USA Ticket #343966).

**INSTALLATION OF MONITORING WELLS**

On September 25 and 26, 2006, Resonance Sonic International (CA C-57 License #802334), under the direction of SES, installed ten groundwater monitoring wells in the area surrounding the subsequent excavation activity. Four of the wells were located offsite in neighboring properties and six wells were located onsite. The borings for the deep well were advanced with a 3.25-inch outside diameter sampling barrel and drive rods using a GeoProbe™ truck-mounted direct-push drilling rig. Continuous soil samples were collected for geologic logging. Soil samples were also collected for laboratory analysis based on lithologic location and/or PID measurement.

Boring logs and monitoring well construction details can be found in Appendix D. Table 1 summarizes the monitoring well construction and elevation survey data. Department of Water Resources (DWR) Well Completion Reports are found in Appendix E.

## Table 1
## Monitoring Well Construction and Groundwater Elevation Data
## 2836 Union Street, Oakland, California

| Well | Well Depth Below TOC | Rim Elevation | TOC Elevation | Groundwater Elevation (10/5/06) | Groundwater Elevation (10/30/06) |
|---|---|---|---|---|---|
| MW-1A | 12.59 | 12.52 | 12.25 | dry | 0.49 |
| MW-1B | 22.52 | 12.48 | 12.05 | 4.56 | 4.54 |
| MW-2A | 12.69 | 13.06 | 12.82 | 4.87 | 4.97 |
| MW-2B | 24.59 | 13.16 | 12.96 | 5.06 | 4.88 |
| MW-3A | 13.06 | 11.76 | 11.59 | dry | 2.02 |
| MW-3B | 25.06 | 12.10 | 11.95 | 4.61 | 4.49 |
| MW-4A | 12.28 | 11.25 | 11.02 | 1.28 | 2.52 |
| MW-4B | 24.32 | 11.25 | 11.04 | 4.41 | 4.44 |
| MW-5A | 12.58 | 12.56 | 12.42 | 2.82 | 1.94 |
| MW-5B | 25.39 | 12.57 | 12.38 | 3.31 | 4.00 |

Notes:

TOC = top of casing

Wells are 1-inch diameter.

All elevations are in feet above mean sea level.

Water was first encountered in MW-2B at approximately 9.5 feet bgs. No water was encountered during drilling in the shallow borings or in deeper boring MW-5B. Water in all other remaining bores was encountered between 17 and 22 feet bgs. A minor amount of groundwater infiltrated the deeper borings during well construction; however, none of the borings experienced conditions that hampered construction of the wells. Soil cuttings were containerized in one 55-gallon drum onsite and later disposed of along with contaminated soil from the following excavation activity.

Following the removal of core samples, a 3.25-inch outside diameter drive rods were advanced with a sacrificial tip to the complete depth of the borehole. The well was constructed in accordance with specifications documented in the SES May 2006 workplan submitted to Alameda County Environmental Health. The well installed is a “pre-packed” GeoProbe™ well—i.e., a pre-constructed annular filter pack and bentonite seal assembled in the field. This technique has the advantage of generating less soil cuttings and less well development/purge water. This well installation technique was approved by Alameda County Environmental Health.

The monitoring well emplacement procedure involved the following steps:

- 2-inch continuous core sampling rods were withdrawn after sampling.
- The pre-packed well was emplaced inside the outer casing; supplemental sand was added to fill the annular space around the pre-packed screens and to provide an approximately ½-foot to 1-foot cover over the top of the well screens.
- A 2-foot layer of Bentonite chips was added on top of the sand and hydrated.
- Portland cement grout slurry was brought to near ground surface, and the well box was installed in concrete.

The following are key well construction specifications:

- Well screen and filter pack ("pre-packed"): 1.5-inch outside diameter stainless steel mesh, enclosing #20/40 sand, wrapped around 0.75-inch inside diameter (0.010-inch slotted) Schedule 40 PVC screen. In each of the nested well pairs, a 6-foot-long screen extending from approximately 19 to 25 feet bgs was installed in the deep well, and a 3-foot-long screen extending from approximately 10 to 13 feet bgs was installed in the shallow well.
- Well riser: 0.75-inch inside diameter Schedule 40 PVC.
- Pollution seal: 2-foot-thick layer of bentonite chips (hydrated), overlain by Portland cement grout slurry to 1 foot deep, overlain by rapid-set concrete (from 1 foot to surface). In accordance with Alameda County Environmental Health requirements, the diameter of the uppermost portion of the seal (upper 1 foot) was approximately 10 inches.
- Surface completion: Christy-type flush-mount steel box (6-inch-diameter) inside an 8-inch-diameter hole cut in the asphalt/concrete.

## DECONTAMINATION PROCEDURES AND BORE ABANDONMENT

All downhole equipment used for borehole drilling and sampling was decontaminated before each bore location and between sampling depths. All surfaces of the sampling equipment and materials were washed with water until all visible dirt, grime, and grease was rinsed from the equipment.

The one boring (BH-14) that was not converted to a monitoring well was abandoned by the following method: the bore was filled with grout mixture of 95 percent cement and 5 percent bentonite, and was emplaced using a tremie pipe, from the bottom of the borehole to ground surface.

## WELL DEVELOPMENT AND SAMPLING

Groundwater monitoring well development, water level measurements, purging, and sampling were conducted on October 5, 2006, by Blaine Tech Services under the supervision of SES personnel.

The wells were developed by surging with a ¾-inch-diameter plunger, and then purging (pumping out groundwater) with a peristaltic pump (by Blaine Tech Services Inc.). During the development process, the well was pumped dry several times in an attempt to purge the requisite ten casing volumes to set the annular sand pack, and to reduce the potential for fine-grained native materials to infiltrate the sand pack. Approximately 5.5 gallons of well development and sampling purge water was generated and containerized onsite. The purge water was profiled and disposed of later, along with water removed from the excavation (discussed in more detail in Section 4.0).

After development, the wells were sampled. Only one of the five shallow zone wells and four of the five deep well recharged fast enough (within 8 hours) to collect a sample for analysis.

The groundwater quality parameters of temperature, pH, conductivity, and turbidity were field-measured during well development using daily-calibrated instruments. After development, a groundwater sample was collected.

The samples were placed in an ice chest with ice at approximately 4°C and transported to the analytical laboratory under chain-of-custody the same day. Laboratory analysis was conducted by Curtis and Tompkins, Ltd. (of Berkeley, California), an analytical laboratory certified by the State of California Environmental Laboratory Accreditation Program (ELAP).

Groundwater monitoring field notes and well development records are contained in Appendix F. Appendix G outlines SES's standard sampling protocol for groundwater. Groundwater monitoring elevation data are summarized in Table 1. Groundwater analytical results are discussed later in Section 5.0.

## WELL SURVEY

On October 30, 2006, the survey company, Virgil Chavez Land Surveying, under contract to SES, completed the well elevation survey to State of California GeoTracker standards. The elevations at the north side of the top of PVC casing and the ground surface at the rim of the well box were surveyed. Groundwater elevation data collected from wells are summarized in Table 1, including depth to water in feet and groundwater elevations in feet above mean sea level (amsl). The certified survey report is contained in Appendix H.

## GROUNDWATER FLOW DIRECTION

Figure 5 is a groundwater elevation map, based on the October 5, 2006 groundwater elevation measurements. The flow direction is indicated to be to the south, toward the excavation. Based on regional flow patterns (toward San Francisco Bay) and the configuration of the groundwater contaminant plume, discussed in the next section, this apparent flow direction is thought to be locally influenced by the soil excavation and associated dewatering, which proceeded the groundwater measurements. The flow direction will likely return to the west-northwest once hydrogeologic conditions equilibrate.

# Figure 5
# Groundwater Elevation Map

# 4.0 OCTOBER 2006 CONTAMINATED SOIL REMOVAL

This section summarizes the removal of residual hydrocarbon-contaminated soil associated with the former UFST. Excavation activities were conducted during weekday hours from 8:00 a.m. to 5:00 p.m., as required by local ordinance to minimize disturbance to the surrounding neighborhood. Figure 2 is a site plan showing the location of the former UFST and area of excavation. Figure 3 presents the excavation sampling locations with analytical results. The soil excavation sample analytical results are discussed in a subsequent section. Photographic documentation of the corrective action is presented in Appendix A.

## PRE-FIELD WORK PLANNING

Prior to excavation activities, SES conducted the following planning activities:

- Updated the site-specific Health and Safety Plan to include the excavation activities;
- Notified Underground Service Alert to inform any potential underground utility providers to mark the location of their utilities;
- Notified the Bay Area Air Quality Management District (Regulation 8 Rule 40) of contaminated soil excavation (a copy of that notification is included in Appendix C);
- Notified residents in surrounding properties; and
- Coordinated with Alameda County Environmental Health for the final monitoring well sanitary seal inspection.

## SOIL EXCAVATION AND REMOVAL

Excavation activities began October 3, 2006 with the removal of overlying concrete and asphalt. Soil removal progressed from west to east and then south using a 710D backhoe to a depth of 10.5 to 11.5 feet bgs. Soil removed from the excavation was periodically screened with a photoionization detector (PID), which provided a qualitative evaluation of contamination to determine whether additional excavation was necessary and where excavation confirmation soil samples should be collected. The soil contamination during the September 2006 excavation was fairly easily identified by its odor, blue-green color, and PID readings, and in some places its correlation with a sandy gravelly lense. Soil analytical results from borings BH-02, BH-05, BH-06, and BH-08 (collected during the April 2006 investigation) that fell within the limits of the excavation were also used as a guide in conjunction with the PID to determine the excavation depth. In general, during this investigation, it appears that a PID measurement below approximately 100 parts per million by volume of air (ppmv) correlated to a laboratory finding of non-detect to very low concentrations of total petroleum hydrocarbons as gasoline (TPHg). PID measurements associated with boring and excavation samples are shown on Table 2. An exclusion zone around the excavation was created, and no Level 4 Health and Safety standards were exceeded.

Lesser evidence of contamination existed in the north, west, and east walls. PID readings diminished dramatically to undetectable with the PID from 11 to 11.5 feet bgs.

Significant contamination was noted in the southwestern area of the excavation where the contamination extended beneath the building on site and was inaccessible for removal. It is estimated that 30 to 40 cubic yards of contaminated material, represented by soil samples W1, W6, and MW-5B, still resides beneath the building and is contained primarily in a shallow (8- to 10-foot-bgs) sandy-gravel unit. This unit was revealed during excavation to be a saturated perched groundwater layer within a generally ubiquitous clay, and was observed to have fully drained into the excavation pit. The water was subsequently pumped out, and depth to groundwater at the end of the day in the excavation was approximately 11 feet bgs.

An in-place former concrete oil/water separator sump was removed from the southeastern area of the excavation. This sump measured 4 feet long, 2 feet wide, and 3 feet deep, and was filled with thick oily material that was placed in the contaminated soil pile. The highest PID readings (1,518 ppmv) obtained during the CAP were obtained at a depth of 2 feet below the sump.

On the western-most side of the excavation, we encountered the apparent former UFST excavation—an approximately 4-foot wide by 6-foot deep area of sandy-gravel fill material. There were no significant PID readings (less than or equal to 4.6 ppmv) measured in this sand backfill or on any area of the westernmost wall.

Petroleum-laden groundwater within a clayey sand-gravel unit encountered from 6 to 10 feet bgs infiltrated the excavation from the southern wall of the excavation. Significant quantities of groundwater did not appear to infiltrate from other walls or upward from the excavation floor.

Approximately 397.6 tons of excavated soil was temporarily stockpiled on the adjacent parcel to the east (owned by the subject property owner), and was segregated into one inferred non-contaminated stockpile (upper soils) and two inferred contaminated stockpiles (lower soils). The stockpiles were completely covered with plastic sheeting to minimize volatile emissions and to protect them from rainfall.

The final excavation was 11 to 11.5 feet deep, within predominantly medium-stiff clay. As shown on Figure 3, the L-shaped excavation measured approximately 36 feet long in the east-west dimension (approximately 14 feet wide on the west side), and approximately 33 feet long in the north-south dimension on the eastern wall (and 16 feet wide) constituting an approximately 900-square foot area. The excavation walls were vertical in most areas, with very little sloughing.

## EXCAVATION CONFIRMATION SOIL SAMPLING

Six excavation wall and two excavation floor confirmation samples were collected during and following the removal of contaminated soil (locations shown on Figure 3). These samples were collected with the teeth of the backhoe; a trowel was then used to collect an aliquot of soil from the backhoe bucket for PID screening and for subsequent analysis by the analytical laboratory. The following samples were collected:

- **W1 and W6 (6 feet bgs**) were collected from the south and west walls of the excavation below the edge of the building from low-permeability clay, directly above the aforementioned saturated sandy gravel. These samples are representative of inaccessible highly soil contaminated material extending beneath the building.
- **W2, W3, W4, and W5** were excavation sidewall samples collected at a depth of 6 feet, the zone of apparent maximum soil contamination in those locations. Location W3 could not be excavated further due to northern property boundary constraints.
- **Excavation floor samples** (F1 and F2) were collected at 11 and 11.5 feet, respectively, at the base of the excavation to document the lower extent of contamination.

All samples were placed in glass jars with Teflon-lined lids, labeled, placed on ice, and submitted to the analytical laboratory under chain-of-custody.

## PROFILING AND DISPOSAL OF STOCKPILED SOIL

A 4-point composite sample was collected from the soil stockpiles, in new glass jars. The samples were analyzed for potential contaminants of concern (volatile and extractable-range hydrocarbons; benzene, toluene, ethylbenzene and total xylenes [BTEX]; and total lead). On behalf of the property owner, we prepared and submitted to Allied Waste a waste profile package summarizing the analytical results. The landfill profile package is included in Appendix I.

The stockpile samples had detectable hydrocarbon contamination; therefore, none of the soil was deemed suitable for backfilling. On October 6 and 13, 2006, 397.6 tons of contaminated soil and soil and debris from previous investigations was transported offsite by Speelman Excavation and disposed of at Allied Waste's Keller Canyon Landfill in Pittsburg, California. Transport manifests of soil offsite removal are included in Appendix I.

## GROUNDWATER PUMPING

Approximately 900 gallons of groundwater was pumped from the excavation on October 5 and 6, 2006 as a corrective action measure (to remove contaminant mass). A pre-pumping and a post-pumping groundwater sample was collected for laboratory analysis. The pumped water was stored onsite in two 500-gallon plastic tanks, along with purge water from monitoring well development and sampling. A composite sample for disposal purposes was collected from the two tanks on October 13, 2006, prior to removal and disposal of the water by Evergreen Environmental Services on October 30, 2006. On November 3, 2006, an additional 4,200 gallons was purged from the excavation. A sample of the tank water for disposal purposes was collected the same day.

Analytical results of purged groundwater are presented in Table 2 and discussed in Section 6. Appendix I contains an offsite transport documentation. Appendix J contains the certified analytical laboratory reports for the excavation groundwater and wastewater profiling and chain-of-custody records.

## ESTMATED CONTAMINANT MASS REMOVAL

### Contamination Removed during Soil Excavation

Approximately 400 tons or 600 CY of contaminated soil was removed from the site, with an average TPHg concentration of 840 milligrams per kilogram (mg/kg). This represent 6.6 pounds of gasoline

### Contamination Removed During Dewatering

A total of 900 gallons of TPHg contaminated groundwater was removed from the site, with an average concentration of 35,000 micrograms per liter (µg/L), and an additional 4,200 gallons of groundwater containing 5,200 µg/L of TPHg was removed. This represents approximately 0.4 pounds of gasoline.

## BACKFILLING, DEWATERING POINT AND SITE RESTORATION

Backfilling was conducted on October 6, 2006, immediately following removal of contaminated groundwater. Drain rock (81.5 tons) was emplaced in the base of the excavation to a height approximately 5 to 6 feet below grade (to bridge infiltrating groundwater). A temporary 4-inch PVC pipe perforated with drill holes from 6 to11 feet bgs was installed in the backfill. This pipe can be used in the future as a dewatering point and/or for soil-vapor extraction (SVE). The remainder of the excavation was backfilled with 271.83 tons of predominant sand-size Class 2 A/B clean imported fill from a depth of 5 to 6 feet bgs up to 3 feet bgs; 26.23 tons of predominant silt/clay-size Class 2 A/B clean imported fill was used from 3 feet to 4 inches bgs. Class 2 A/B possesses a low permeability designed to act as a cap to prevent air circuiting from the surface if SVE or bioventing is implemented. The excavation was backfilled in approximately 1-foot lifts, and each lift was compacted with a whacker-type compacter mounted on the excavator. The excavation was resurfaced to existing grade with asphalt by A&E Asphalt on October 26, 2006.

# 5.0 REGULATORY CONSIDERATIONS, ANALYTICAL RESULTS, AND DISCUSSION OF FINDINGS

## REGULATORY CONSIDERATIONS AND SCREENING LEVELS

The Regional Water Quality Control Board (Water Board) has established Environmental Screening Levels (ESLs) for evaluating the likelihood of environmental impact. ESLs are conservative screening-level criteria for soil and groundwater, designed to be generally protective of both drinking water resources and aquatic environments; they incorporate both environmental and human health risk considerations. ESLs are not cleanup criteria (i.e., health-based numerical values or disposal-based values). Rather, they are used as a preliminary guide in determining whether additional remediation and/or investigation may be warranted. Exceedance of ESLs suggests that additional investigation and/or remediation is warranted.

Different ESLs are published for commercial/industrial vs. residential land use, for sites where groundwater is a potential drinking water resource vs. is not a drinking water resource, and the type of receiving water body. A Water Board-published map of the East Bay shows areas where groundwater is, and is not, a potential drinking water resource.

In our professional opinion, the appropriate ESLs for the subject site are based on:

- Residential land use (due to the residence adjoining the property) and commercial/ industrial (for the subject property itself). Note that, for both soil and groundwater contaminants, all ESLs for site contaminants are the same for both residential and commercial/industrial land use.
- Groundwater is a potential drinking water resource. In our professional opinion, the appropriate ESLs for the subject site are *commercial/industrial land use* and *groundwater is a potential drinking water resource.* This is based on both the property zoning status (commercial/industrial) and the designation of this area of Oakland as "Zone A – Significant Drinking Water Resource (Water Board, 1999).
- The receiving body for groundwater discharge is an estuary (San Francisco Bay).

The State of California has also promulgated drinking water standards (Maximum Contaminant Levels [MCLs]) for some of the site contaminants. Drinking water standards may also be utilized by regulatory agencies to evaluate the potential risk associated with groundwater contamination. For the site contaminants, MCLs are generally the same as the ESLs (except that there is no MCL for gasoline).

Once ESLs or drinking water standards are exceeded, the need for and type of additional investigative and corrective actions are generally driven by the potential risk associated with the contamination. Minimum regulatory criteria generally applied to fuel leak cases in groundwater include:

- The contaminant source has been removed, including reasonably accessible contaminated soils that pose a long-term impact to groundwater.
- The extent of residual contamination has been fully characterized, to obtain sufficient lithologic and hydrogeologic understanding (generally referred to as a Site Conceptual Model).
- Groundwater wells have been installed and are monitored periodically to evaluate groundwater contaminant concentrations and hydrochemical trends.
- The stability of the contaminant plume has been evaluated to determine whether it is moving or increasing in concentration.
- A determination has been made as to whether the residual contamination poses an unacceptable risk to sensitive receptors.

As stated above, ESLs are used as a preliminary guide in determining whether additional remediation or other action is warranted. Exceedance of ESLs may warrant additional actions, such as monitoring plume stability to demonstrate no risk to sensitive receptors in the case of sites where drinking water is not threatened.

## ANALYTICAL METHODS

The initial site characterization documented contamination by the following LUFT-related constituents: gasoline; BTEX; and methyl *tertiary*-butyl ether (MTBE). In addition, several other contaminants were analyzed (as required by Alameda County Environmental Health)—ethanol; fuel oxygenates (*tertiary*-butyl alcohol [TBA], di-isopropyl ether [DIPE], ethyl *tertiary*-butyl ether [ETBE], and *tertiary*-amyl methyl ether [TAME]); and lead scavengers (1,2-dichloroethane [EDC] and 1,2-dibromoethane [EDB]).

Soil and groundwater samples were analyzed using the following methods for:

- Total extractable hydrocarbons – gasoline-range (TEHg), by EPA Method 8015B
- BTEX and MTBE, by EPA Method 8260

- Total volatile hydrocarbons (TVH) – gasoline range, by EPA Method 8015M
- Total lead, by EPA Method 6010 (in accordance with landfill requirement)
- Ethanol, by EPA Method 8260 (in accordance with Alameda County Environmental Health requirement)
- TBA, DIPE, ETBE, and TAME, by EPA Method 8260B (in accordance with Alameda County Environmental Health requirement)
- EDC and EDB, by EPA Method 8260B (in accordance with Alameda County Environmental Health requirement)

In addition, the stockpiled soil sample was analyzed for total lead, as required for landfill disposal profiling.

All investigation soil and groundwater samples were analyzed by either McCampbell Analytical, Inc., (Pittsburg, California) or Curtis & Tompkins, Ltd. (Berkeley, California). Both labs maintain current ELAP certifications for all the analytical methods utilized in this investigation.

Appendix J contains the certified analytical laboratory reports and chain-of-custody records for the corrective action phase (excavation confirmation soil, excavation groundwater, and stockpiled soil).

## ANALYTICAL RESULTS AND DISTRIBUTION OF CONTAMINANTS

Tables 2 and 3 summarize the soil and groundwater analytical results, respectively. Table 4 presents the oxygenates and lead scavengers tested for in both soil and groundwater. The certified laboratory reports and chain-of-custody records are presented in Appendix J.

### Excavation and Boring Soil Sample Analytical Results

The excavation immediately revealed visual contamination within the first 5 feet of digging and the volatilization of gasoline was pronounced. Consistent PID readings above 100 ppmv were found when discolored (by hydrocarbons) soil was tested. The soil was removed from the excavation and stockpiled. Stockpile samples, excavation confirmation samples, and bore samples all show the primary soil contaminant as gasoline, with lesser quantities of BTEX and MTBE. Soil collected during installation of MW-1B (10 feet), MW-2B (17 feet), MW-1B (15 feet) and MW-5B (8.5 feet) and excavation wall samples (W1 and W6 [both 6 feet deep]) contained concentrations above their respective ESLs for all contaminants detected. MTBE was detected above the ESL in MW-2B (17 feet), MW-5B (15 feet), and BH-14 (15 feet). Excavation

# Table 2
# Soil Sample Analytical Results – September/October 2006
# 2836 Union Street, Oakland, California

| **Sample ID** | **PID (ppmv)** | **Sample Depth (feet)** | **TVHg** | **Benzene** | **Toluene** | **Ethylbenzene** | **Total Xylenes** | **MTBE** | **Total Lead** |
|---|---|---|---|---|---|---|---|---|---|
| **Borehole Soil Samples** | | | | | | | | | |
| MW 2B-12 | 4.8 | 12-12.5 | *<0.96* | *< 4.8* | *< 4.8* | *< 4.8* | *< 4.8* | *< 4.8* | *NA* |
| MW 2B-17 | 1.3 | 17-17.5 | *<0.91* | *<4.5* | *<4.5* | *<4.5* | *<4.5* | **4.9** | *NA* |
| MW 2B-24 | 0.1 | 23-24 | *<0.98* | *< 4.9* | *< 4.9* | *< 4.9* | *< 4.9* | *< 4.9* | *NA* |
| MW 1B-10 | 0 | 10-10.5 | **790** | *<130* | *<130* | **1,100** | **130** | *<130* | *NA* |
| MW 1B-15 | 0 | 15-15.5 | *<0.88* | *< 4.4* | *< 4.4* | *< 4.4* | *< 4.4* | **31** | *NA* |
| MW 1B-23 | 0 | 23-23.5 | *<0.88* | *< 4.4* | *< 4.4* | *< 4.4* | *< 4.4* | *< 4.4* | *NA* |
| MW 3B-19 | 0 | 19-19.5 | *< 1.0* | *< 5.0* | *< 5.0* | *< 5.0* | *< 5.0* | *< 5.0* | *NA* |
| BH 14-8.5 | 0 | 8.5-9 | *<0.93* | *<4.6* | *<4.6* | *<4.6* | *<4.6* | *<4.6* | *NA* |
| BH 14-15 | 0 | 15-15.5 | *<0.91* | *<4.5* | *<4.5* | *<4.5* | *<4.5* | **17** | *NA* |
| BH 14-19.5 | 0 | 19-19.5 | *<0.94* | *<4.7* | *<4.7* | *<4.7* | *<4.7* | *<4.7* | *NA* |
| BH 14-24.5 | 0 | 24.5-25 | *< 0.86* | *< 4.3* | *< 4.3* | *< 4.3* | *< 4.3* | *< 4.3* | *NA* |
| MW 4B-17 | 0 | 17-17.5 | *<0.93* | *<4.6* | *<4.6* | *<4.6* | *<4.6* | *<4.6* | *NA* |
| MW 5B-8.5 | 24 | 8.5-9 | **930** | *<130* | *<130* | **640** | *<130* | *<130* | *NA* |
| MW 5B-15 | 0.4 | 15-15.5 | *<0.94* | *<4.7* | *<4.7* | *<4.7* | *<4.7* | **7.2** | *NA* |
| MW 5B-21.5 | 3.2 | 21.5-22 | *<0.94* | *<4.7* | *<4.7* | *<4.7* | *<4.7* | *<4.7* | *NA* |
| MW 5B-24 | 5.2 | 24.24.5 | *<0.89* | *< 4.5* | *< 4.5* | *< 4.5* | *< 4.5* | *< 4.5* | *NA* |

**Table 2** ***continued***

| Sample ID | PID (ppmv) | Sample Depth (feet) | TVHg | Benzene | Toluene | Ethylbenzene | Total Xylenes | MTBE | Total Lead |
|---|---|---|---|---|---|---|---|---|---|
| **Excavation Wall Samples** | | | | | | | | | |
| W1 | 250 | 6 | **1,100** | **2.6** | **44** | **34** | **200** | *<10* | *<10* |
| W2 | 45 | 6 | 1.5 | *< 0.005* | < 0.0091 | < 0.012 | 0.038 | *< 0.005* | *NA* |
| W3 | 120 | 6 | **270** | *<0.10* | 0.36 | **7.4** | 0.93 | *<1.0* | *<1.0* |
| W4 | 30 | 7 | *<1.0* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *NA* |
| W5 | 36 | 6 | <1.1 | *<5.3* | *<5.3* | *<5.3* | *<5.3* | *NA* | *NA* |
| W6 | 1518 | 6 | **1,700** | *<250* | *<250* | **17,000** | **35,400** | *NA* | *NA* |
| **Excavation Floor Samples** | | | | | | | | | |
| F1 | 6 | 11 | *<1.0* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *NA* |
| F2 | 14 | 11.5 | *<1.0* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *< 0.005* | *NA* |
| **Stockpile Comp** | | | **840** | *<250* | *<250* | **5000** | **14,800** | *NA* | 13 |
| **Soil ESLs** | | | *100* | *0.04* | *2.0* | *3.0* | *1.5* | *0.023* | *50* $^{(a)}$ |

Notes:

ESLs = Water Board Environmental Screening Levels for residential or commercial/industrial sites where groundwater is a potential drinking water resource.
MTBE = methyl *tertiary*-butyl ether
NA = not analyzed for this constituent
PID = photoionization detector (readings in ppmv)
ppmv = parts per million by volume air
TVHg = total volatile hydrocarbons as gasoline.

Samples in **bold-face type** exceed the ESL criterion.
All concentrations are in milligrams per kilogram (mg/kg).

# Table 3
# September-October 2006 Groundwater Sample Analytical Results
## 2836 Union Street, Oakland, California

| Sample | TVHg | Benzene | Toluene | Ethylbenzene | Total Xylenes | MTBE |
|---|---|---|---|---|---|---|
| **Monitoring Wells** | | | | | | |
| MW-1A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-1B | **350** | *<1.3* | *<1.3* | *<1.3* | *<1.3* | 2.7 |
| MW-2A | 80 | *<0.5* | *<0.5* | *<0.5* | *<0.5* | *<0.5* |
| MW-2B | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-3A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-3B | **1,900** | *<10* | *<10* | *<10* | *<10* | *<10* |
| MW-4A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-4B | **1,100** | *<2.5* | *<2.5* | *<2.5* | *<2.5* | *<2.5* |
| MW-5A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-5B | **13,000** | **9.6** | 0.6 | 21 | 1.9 | **37** |
| **Excavation Dewatering (a)** | | | | | | |
| EGW-1 (onset of pumping) | **21,000** | **140** | **370** | **1,100** | **1,970** | **110** |
| EGW-2 (920 gallons removed) | **49,000** | **310** | **930** | **1,700** | **4,500** | *NA* |
| EGW-3 (4200 gallons removed) | **5,200** | **110** | **75** | **240** | **470** | *NA* |
| **Groundwater ESLs** | 100 / 500 | 1.0 / 46 | 40 / 130 | 30 / 290 | 13 / 13 | 5.0 / 1,800 |
| **MCLs** | 100 | 1.0 | 40 | 30 | 20 | 5.0 |

Notes:

[a] Sample collected from temporary excavation dewatering point.

ESLs = Water Board Environmental Screening Levels for residential or commercial/industrial sites where groundwater is a potential drinking water resource.

MCLs = Maximum Contaminant Levels

MTBE = methyl *tertiary*-butyl ether

NA = not analyzed for this constituent

NS = not sampled

TVHg = total volatile hydrocarbons as gasoline

Samples in **bold-face type** exceed the ESL criterion.

All concentrations are in micrograms per liter (µg/L).

# Table 4
# September and October 2006 Soil and Groundwater Sample Analytical Results
# Lead Scavengers, Fuel Oxygenates and Ethanol
# 2836 Union Street, Oakland, California

| Sample I.D. | EDC | EDB | ETBE | DIPE | TAME | TBA | Ethanol |
|---|---|---|---|---|---|---|---|
| **Soil Analyses (mg/kg)** | | | | | | | |
| MW 2B-12 | <4.8 | <4.8 | <4.8 | <4.8 | <4.8 | <96 | <960 |
| MW 2B-17 | <4.5 | <4.5 | <4.5 | <4.5 | <4.5 | <91 | <910 |
| MW 2B-24 | <4.9 | <4.9 | <4.9 | <4.9 | <4.9 | <98 | <980 |
| MW 1B-10 | <130 | <130 | <130 | <130 | <130 | <2,500 | <25,000 |
| MW 1B-15 | <4.4 | <4.4 | <4.4 | <4.4 | <4.4 | <88 | <880 |
| MW 1B-23 | <4.4 | <4.4 | <4.4 | <4.4 | <4.4 | <88 | <880 |
| MW 3B-19 | <5.0 | <5.0 | <5.0 | <5.0 | <5.0 | <100 | <1,000 |
| BH 14-8.5 | <4.6 | <4.6 | <4.6 | <4.6 | <4.6 | <93 | <930 |
| BH 14-15 | <4.5 | <4.5 | <4.5 | <4.5 | <4.5 | <91 | <910 |
| BH 14-19.5 | <4.7 | <4.7 | <4.7 | <4.7 | <4.7 | <94 | <940 |
| BH 14-24.5 | <4.3 | <4.3 | <4.3 | <4.3 | <4.3 | <86 | <860 |
| MW 4B-17 | <4.6 | <4.6 | <4.6 | <4.6 | <4.6 | <93 | <930 |
| MW 5B-8.5 | <130 | <130 | <130 | <130 | <130 | <2,500 | <25,000 |
| MW 5B-15 | <4.7 | <4.7 | <4.7 | <4.7 | <4.7 | <94 | <940 |
| MW 5B-21.5 | <4.7 | <4.7 | <4.7 | <4.7 | <4.7 | <94 | <940 |
| MW 5B-24 | <4.5 | <4.5 | <4.5 | <4.5 | <4.5 | <89 | <890 |
| W1 | <2.0 | <2.0 | <2.0 | <2.0 | <2.0 | <20 | <100 |
| W2 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.05 | <0.25 |
| W3 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | < 0.10 | <1.0 | <5.0 |
| W4 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.05 | <0.25 |
| F1 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.005 | < 0.05 | <0.25 |
| **Water Board Environmental Screening Levels** | | | | | | | |
| **Soil ESLs** | 0.0045 | 0.00033 | NLP | NLP | NLP | NLP | 450 |

## Table 2 *continued*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Groundwater analyses (ug/L)** | | | | | | | |
| MW-1A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-1B | 3.1 | *<1.3* | *<1.3* | *<1.3* | *<1.3* | <25 | <2,500 |
| MW-2A | *<0.5* | *< 0.5* | *< 0.5* | *< 0.5* | *<0.5* | *<10* | *<1,000* |
| MW-2B | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-3A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-3B | *<10* | *<10* | *<10* | *<10* | *<10* | *<200* | *<20,000* |
| MW-4A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-4B | *<2.5* | *< 0.5* | *< 1* | *< 1* | *<2.5* | *< 50* | *<5,000* |
| MW-5A | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* | *NS* |
| MW-5B | *<0.5* | *<0.5* | *<0.5* | *<0.5* | 1.5 | *< 10* | *<1,000* |
| **Water Board Environmental Screening Levels** | | | | | | | |
| **Groundwater ESLs** | 0.05 | 0.005 | NLP | NLP | NLP | NLP | 50,000 |

<u>Notes</u>:

ESLs = Water Board Environmental Screening Levels for residential or commercial/industrial sites where groundwater is a potential drinking water resource.
NLP = no level published

DIPE = isopropyl ether
EDB = ethylene dibromide (1,2-dibromoethane)
EDC = ethylene dichloride (1,2-dichloroethane).
ETBE = ethyl *tertiary*-butyl ether
TAME = *tertiary*-amyl methyl ether
TBA = *tertiary*-butyl alcohol

mg/kg = milligrams per kilogram
µg/L = micrograms per liter

wall sample W3 contained TPHg and ethylbenzene above their respective ESLs, along with trace amounts of toluene and total xylenes. Western excavation wall sample W2 contained trace amounts of TPHg (1.5 mg/kg) and total xylenes 0.012 mg/kg).

### Residual Soil Contamination

An estimated 90 percent of the contaminated soil was removed; the remaining 10 percent was predominantly located beneath the existing building foundations. Residual TPHg soil contamination (790 to 270 mg/kg) above regulatory ESLs exists to the north, but was inaccessible for removal over the property line. To the south-southwest (underneath the onsite building), an estimated 30 to 40 cubic yards of contaminated soil remains. Maximum residual soil contamination exists from 6 to probably 10.5 feet bgs in this area; it is represented by excavation wall samples W1 (6 feet bgs) and W6 (6 feet bgs), with 1,100 to 1700 mg/kg of TPHg, respectively, and soil sample 5B (8.5 feet bgs) with 930 mg/kg. This volume estimate assumes attenuation of the southern extent of contaminated soil mass approximately halfway between MW-5B and BH-14.

Figure 6 shows the excavation confirmation sample results. Eight soil samples were collected as base of excavation or sidewall samples to confirm that accessible contaminated soil was removed. The two samples that showed relatively elevated residual concentrations after the soil excavation remedy were located in the two northern and eastern excavation walls immediately adjacent to the building. These data, along with the soil sample data from wells MW5a and MW5b inside the building, indicate the residual soil contamination is beneath the building. The remaining confirmation soil samples were all at concentrations of 270 mg/kg or less. The base of excavation samples, where it was critical to remove as much of the contamination as possible given the proximity to groundwater, were at trace level of 1.5 mg/kg or less.

### Groundwater Analytical Results

TVHg was detected above its ESL in all monitoring wells where it was analyzed, except in MW-2A. Benzene and MTBE were detected above their ESLs in well MW-5B, the well with the highest contaminant concentration. BTEX, MTBE, and TAME were also detected in onsite well MW-5B. MTBE and 1,2-DCA were detected in onsite well MW-1B.

Excavation water samples were collected at a dewatering point directly downgradient of the former UFST location, the area of highest residual soil contamination beneath the building. All contaminant concentrations were higher in the dewatering samples than in groundwater

# Figure 6
# Excavation Confirmation Sample Analytical Results

monitoring well samples. It is possible that groundwater contaminant concentrations in the developed groundwater monitoring wells are lower than the excavation water samples, due to the filtering capacity of the well pack material.

There was a significant reduction in TPHg concentrations between the groundwater pre-pumping samples (21,000 and 49,000 µg/L) and final post-pumping sample (5,200 µg/L). This suggests that pumping may be successful in reducing contaminant mass in groundwater. Post-pumping groundwater contaminant concentrations still exceed ESL criteria for all compounds analyzed.

Figure 7 shows an isoconcentration contour map of TPHg concentration in groundwater based on the October monitoring well analytical results. The plume geometry strongly indicates a west by northwest migrational pattern, which is in line with general groundwater flow direction in this area. However, this flow pattern is contradicted by the hydrologic data, shown in Figure 5.

### Groundwater Contaminant Plume

These data shows a dissolved plume of TPHg that originates from the former UFST excavation and extends in an elliptical configuration westward across the western portion of the property and then offsite to the west under Union Street. The plume appears to be, at minimum, 60 feet long by 100 feet wide. The lateral limits of the plume upgradient to the east are fairly well constrained by monitoring wells MW-1B and MW-2B, respectively. The northern, southern, and western limits are less defined. The concentrations in groundwater shown in downgradient wells MW-3B and MW-4B show attenuation with distance from the source area; however, the distal extent of the plume has not been fully defined. The limits of the plume are generally determined by the mass of contamination in both soil and groundwater, hydrogeologic characteristics, and the ability of natural degradation processes to control the plume migration.

The resultant contaminant plume has migrated to the west, downgradient of the former UFST. Migration of the dissolved phase hydrocarbon contamination in groundwater does not appear to have caused additional soil contamination by adsorption onto downgradient soils within the capillary fringe zone to the west of the former UFST, as indicated by soil samples collected during installation of the downgradient wells.

## CONTAMINANT TRANSPORT OF CONCEPTUAL MODEL

The site conceptual model suggests that the onsite soil and groundwater contamination originated from leaks from the gasoline UFST and/or associated piping. The highest concentration of contamination was located around the pump dispenser rather then the in-ground UFST, suggesting leakage from that area.

## Figure 7
## TVH-gasoline Plume – October 5, 2006

The leaking gasoline petroleum product migrated down through clay–rich soil and initially accumulated in a upper “perched” zone of a thin sand-rich layer found inconsistently between a depth of 6 and 8 feet bgs (see cross sectional Figures 3 and 4). From this accumulation point, the contamination worked its way slowly down through the clay-rich soil underlying the perched zone, with a significant fraction of the hydrocarbons adsorbing onto the vadose zone soil, eventually reaching the perennial groundwater table and a gravel-sand rich horizon found at depths of 18 to 20 feet bgs. The gasoline phase contamination shows a relatively significant BTEX fraction, but only trace to minor concentrations of MTBE. Fuel oxygenates were also initially analyzed for, but not found except in trace concentrations.

The fuel contamination migrated downward from the source(s) in the UFST area, likely in inverted cone geometry downward through the laterally uniform clay stratigraphy until it reached the discontinuous sandy perched layer where it would travel laterally. The excavation showed a visually distinctive zone of soil contamination to a depth of about 10 feet bgs (see Appendix A). No vertical preferential pathways based on lithology were noted in the excavation of nearby well logs, but the contamination clearly migrated down to the deeper water-bearing zone at a depth of 18 feet and greater.

Numerous field and laboratory studies have concluded that the subsurface behavior of petroleum hydrocarbons is significantly impacted by their high capacity to undergo biodegradation (Lawrence Livermore National Laboratory, 1995 A variety of naturally-occurring microorganisms utilize petroleum hydrocarbons as a carbon (food) source. Biodegradation of hydrocarbons can occur under anaerobic conditions, but is more highly favored in aerobic conditions.

Biodegradation should be enhanced following the excavation and groundwater purging remedy, as aerobic conditions have been introduced by the removal of the clay-rich contaminated soil and replacement with permeable backfill material. Most hydrocarbon plume conceptual models show biodegradation of petroleum hydrocarbons in groundwater as having a significant role in creating a stable plume, minimizing groundwater plume configuration and concentrations over time (Lawrence Livermore National Laboratory, 1995).

In general, natural attenuation of petroleum in groundwater is very likely occurring unless petroleum concentrations are sufficient to overwhelm the biodegradation process (i.e., in the high concentration area of the plume). In these areas, biodegradation progresses until one of the process-limiting factors (usually oxygen) is depleted to the point at which biodegradation is not supported.

## PROJECTED FUTURE TRENDS AND REMEDIAL OPTIONS

### Projected Future Trends

The gasoline hydrocarbon plumes, flowing the recent soil removal action, remain stable or diminish over the long term, now that the main source of contaminated backfill has been remediated. However, in the short term, the residual gasoline and BTEX in the soil can release more gasoline to the groundwater, particularly during the winter recharge months when the groundwater table could rise to desorb the residual hydrocarbon beneath the building.

### Potential Remedial Action

Now that the main source area soil has been remediated by excavation, the remaining potential gasoline contaminant has diminished potential to migrate to groundwater. The main residual concern is that the contaminant mass beneath the building will continue to feed the plume.

At this point, SES recommends monitoring of natural attenuation and plume stability following the soil and purge water remediation, with one additional purging of the excavation groundwater in the excavation backfill area. Depending on the outcome of future quarterly monitoring, additional remediation such as vapor extraction could be considered.

## GROUNDWATER IMPACTS AND BENEFICIAL USES

How much groundwater contamination impacts the current and projected beneficial use of the groundwater? In general, impacts of contamination on the environment by petroleum products are evaluated on a case-by-case basis by the regulators, with consideration given to Water Board ESLs. There appears to be no identified groundwater impacts of concern in the current case, although the area is considered to be a sensitive groundwater recharge area that should be protected.

## IMPACTS OF RESIDUAL CONTAMINATION ON BENEFICIAL USES

There are no known immediate impacts to the groundwater that affect current beneficial use, although the area of immediate site area is within the “Zone A” designation by Water Board “East Bay Plain Groundwater Basin Beneficial Use Evaluation Report” (Water Board, 1999). The Zone A designation calls the groundwater a “significant drinking water resource.”

The nearest surface water body is San Francisco Bay, located approximately 4,000 feet west by northwest of the site. Groundwater in the immediate vicinity of the site is not likely to be a potential drinking water source given its shallow depth and turbidity.

The primary source (UFSTs) and secondary source (contaminated soil) have been remediated to the extent that was practical. While a pod of contaminated soil estimated at about 50 cubic yards remains at the site, it is located beneath the building and cannot be directly accessed without structurally compromising the existing building. Remediating the residual soil would require the application of an in-situ method, such as vapor extraction.

The property owner has no plans to utilize site groundwater for any purpose, and assuming approval for site development is achieved, the former source area would remain paved to prevent any infiltrating precipitation from providing a migrational mechanism for the hydrocarbons still entrained in the soil.

# 6.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

## SUMMARY AND CONCLUSIONS

- This work follows a preliminary site investigation in August 2005 and additional site characterization investigations in October 2005 and April 2006.
- One 10,000-gallon gasoline UFST was installed in the late 1970s. The UFST operated under Alameda County Environmental Health permit (Permit No. STID 4065) until its removal in 1998.
- Site soil and groundwater has been contaminated by gasoline and associated aromatic hydrocarbons. Soil analytical results show that soil contamination began at a depth of approximately 6 to 7 feet, and did not extend deeper than approximately 11 feet.
- During this investigation, 397.6 tons of contaminated soil was removed from the vicinity of the former UFST and disposed of at a permitted non-hazardous landfill. The resultant excavation constituted an approximately 900-square foot area.
- It is estimated that between 30 and 40 cubic yards of contaminated material containing TPHg at present concentrations (estimated at about 1,200 mg/kg) still exists beneath the building on site.
- During this investigation, 900 gallons of contaminated groundwater was pumped from the open excavation, and 4,200 gallons was pumped from the backfilled excavation via the temporary dewatering point and sent to a non-hazardous wastewater recycling facility. Pre-pumping and post-pumping excavation groundwater sample analytical results show that significant mass removal was accomplished by excavation dewatering.
- Groundwater in the immediate vicinity of the former UFST occurs at a depth of less than 10 feet, and appears under at least semi-confining conditions, rising from approximately 20 feet bgs to as high as 6 feet below grade, such that groundwater is in contact with residual contaminated soil. The groundwater contaminate plume has not been fully delineated, but appears to be in elliptical configuration with its long axis trending east by west-northwest.
- The extent of the contaminant plume is determined by the mass of residual soil contamination, hydrogeologic characteristics, and the ability of natural degradation

mechanisms to reduce contaminant mass. Groundwater contamination will continue to migrate downgradient from the source area, primarily by advection.

- While this corrective action removed a substantial mass of contamination, shallow groundwater will likely continue to be impacted by the remaining residual soil contamination by desorption from soil into groundwater. The dissolved phase hydrocarbon contamination in the groundwater does not appear to be adsorbing onto downgradient soils.
- Local groundwater flow direction is generally to the west (toward San Francisco Bay and following local topography) in this area of west Oakland. Based on the configuration of the groundwater contaminant plume, it appears that local groundwater flow direction in the recent past was to the west-northwest; however, as seen in the October 2006 groundwater elevation map, the present direction is southwest toward the hydrologic void created by dewatering the excavation. The flow direction will likely turn west-northwest once hydrogeologic conditions equilibrate.

## RECOMMENDATIONS

- We recommend following up with Alameda County Environmental Health after its receipt of this report, to discuss the requirements to move the site toward regulatory closure. We further recommend that the work requested by Alameda County Environmental Health work be implemented, and that all future technical reports be provided to the appropriate regulatory agencies, including electronic uploads to Alameda County Environmental Health's ftp system and the State Water Resources Control Board's GeoTracker system.
- Excavation groundwater sample analytical results show that significant mass removal is accomplished by excavation dewatering. Additional excavation dewatering should be continued, followed by the collection of post-pumping groundwater samples to evaluate the effectiveness of the pumping.
- Groundwater monitoring should be continued. All of the groundwater monitoring wells should be re-sampled, using micro-purging method, as soon as possible to evaluate the effect of excavation dewatering and to obtain samples from wells that were purged dry after well development and could not be sampled. Obtaining samples from all of the wells should illuminate the degree of hydraulic conductivity between the shallow and deeper water-bearing zones. The groundwater flow direction, as it is affected by the excavation, should be evaluated in future monitoring events.
- The site should be evaluated for potential remediation by soil vapor extraction should natural attenuation fail to demonstrate a stable or reducing plume.

# 7.0 LIMITATIONS

This report has been prepared for the exclusive use of Mr. Lawrence Wadler (subject property owner), the regulatory agencies, and their authorized assigns and/or representatives. No reliance on this report shall be made by anyone other than those for whom it was prepared.

The findings and conclusions presented in this report are based solely on the findings of the investigations discussed herein. This report has been prepared in accordance with generally accepted methodologies and standards of practice of the area. The personnel performing this assessment are qualified to perform such investigations and have accurately reported the information available, but cannot attest to the validity of that information. No warranty, expressed or implied, is made as to the findings, conclusions, and recommendations included in the report.

# 8.0 REFERENCES

Alameda County Environmental Health, 2006. Letter approving technical workplan for corrective action investigation at 2836 Union Street, Oakland, California. March 20.

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# APPENDIX A

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## Photodocumentation

# APPENDIX B

# Previous Analytical Results and Plume Maps

# APPENDIX C

# Regulatory Notifications and Permits

# APPENDIX D

## Boring Logs and Monitoring Well Construction Specifications

# APPENDIX E

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# Department of Water Resources
# Well Completion Report

# APPENDIX F

# Groundwater Monitoring and Sampling Field Report

# APPENDIX G

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# SES Groundwater Standard Sampling Protocols

# APPENDIX G:
# SES GROUNDWATER STANDARD SAMPLING PROTOCOLS

## SAMPLING AND ANALYSIS PERSONNEL

Sampling and analysis is conducted by Blaine Tech Services, a subcontractor to SES, which uses appropriately trained personnel to perform the water level measurements, sampling, and analyses of key natural attenuation indicators.

## SUMMARY OF SAMPLING PROCEDURES

Activities that will occur during groundwater sampling are summarized as follows:

- Pre-arrangement with testing laboratory
- Assembly and preparation of equipment and supplies
- Groundwater sampling
  - water-level measurements
  - immiscible material measurements (with an interface probe, if applicable)
  - visual inspection of borehole water
  - well bore evacuation
  - sampling
- Sample preservation and shipment
  - sample preparation
  - onsite measurement of parameters using direct read instruments
  - sample labeling
- Completion of sample records
- Completion of chain-of-custody records
- Samples placed in chilled cooler
- Sample shipment

Detailed sampling and analysis procedures are presented in the following sections.

## ARRANGEMENTS WITH ANALYTICAL LABORATORY

Prior to sampling, arrangements will be made with an analytical laboratory to conduct the sample analyses. Samples will be analyzed by Curtis and Tompkins, Ltd. (C&T), an analytical laboratory in Berkeley, California. C&T has the required Department of Toxic Substances Control (DTSC) certification to perform the analyses, and will provide a sufficient number of sample containers for the wells to be sampled and the blanks to be included. C&T will determine the proper type and size for the containers based on the analyses requested. For samples requiring chemical preservation, preservatives will be added to containers by the C&T prior to shipping containers to the facility. Shipping containers (ice chests with adequate container padding) will be sent to the facility with the sample containers.

## PREPARATION FOR SAMPLING

Prior to the sampling episode, equipment to be used will be assembled and its operating condition verified, calibrated (if required), and properly cleaned (if required). In addition, all record-keeping materials will be prepared.

### Equipment Calibration

Where appropriate, equipment will be calibrated according to the manufacturer’s specifications prior to field use. This applies to the equipment for making onsite chemical measurements of pH, conductivity, water temperature, and photoionization detector (PID).

### Equipment Cleaning

Portions of sampling and test equipment that will come into contact with the sample will be thoroughly cleaned before use. Such equipment includes water-level probe, bailers, lifting line, and other equipment or portions thereof which may be immersed. The procedure for cleaning non-dedicated equipment is as follows:

- Clean with potable water and phosphate-free detergent;
- Rinse with potable water;
- Rinse with distilled or deionized water; and
- Air dry the equipment prior to use.

Any deviations from these procedures will be documented in the permanent record of the sampling event.

Laboratory-supplied sample containers will be cleaned and sealed by the laboratory before shipping. The type of container provided and the method of container cleaning should be in the laboratory's permanent record of the sampling event.

Sampling equipment to be disposed of after use will be cleaned with potable water and phosphate-free detergent before disposal as solid waste. Rinse water will be stored in properly labeled 55-gallon drums for proper disposal, pending receipt of laboratory results of groundwater and soil sample analyses with assistance from SES.

## SAMPLING PROCEDURES

Special care will be exercised to prevent contamination of the groundwater and extracted samples during the sampling activities. Contamination of a sample can occur through contact with improperly cleaned equipment. Cross-contamination of the groundwater can occur through insufficient cleaning of equipment between wells. Pre-cleaned disposable sampling equipment will be rinsed with distilled water prior to use. Sampling equipment and sample containers will be thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures discussed above. In addition to the use of properly cleaned equipment, two further precautions will be taken:

- A new pair of clean, disposable latex (or similar) gloves will be worn each time a different well is sampled.
- Sample collection activities will progress from the least affected (upgradient) area to the most affected (downgradient) area. Wells described as "background" or "upgradient" wells will be sampled first.

The following paragraphs present procedures for the several activities that comprise groundwater sample acquisition. These activities will be performed in the same order as presented below. Exceptions to this procedure will be noted in the permanent sampling record.

### Preparation of Location

Prior to starting the sampling procedure, the area around the well will be cleared of foreign materials, such as brush, rocks, debris, etc. A clean (new) disposable plastic sheet will be placed around the well casing so that the sheet is flat on the ground. The sheet will be placed such that the flush-mount well projects through the center of the sheet. This preparation will prevent sampling equipment from inadvertently contacting the ground or exterior parts of the well.

### Water-Level Measurement

The first sampling operation will be water-level measurement. An electrical probe or a weighted tape will be used to measure the depth to groundwater below the datum to the nearest 0.01 foot.

The datum, usually the top of the inner casing (inside and below the protective steel cover), will be described in the monitoring well records. A permanent mark or scribe will be marked on the inner casing.

If the wells to be sampled are closely spaced, the water levels at all of the closely-spaced wells will be measured before any of the wells are evacuated. The water-level probe or weighted tape will be cleaned with phosphate-free detergent in distilled water and with a distilled water rinse between usage at different wells.

### Total Depth Measurement

Once the water level and immiscible material thickness is measured and recorded, the water-level probe or weighted tape will be slowly lowered to the bottom of the well. The depth to the bottom will be measured and recorded. The probe or tape will then be slowly withdrawn from the well. The bottom of the probe or tape will be observed after withdrawal to determine any evidence of viscous, heavy contaminants. Descriptions (and measurements, if possible) of such materials will be made from observation of the probe or tape.

### Visual Inspection of Well Water

Prior to well evacuation, a small quantity of water will be removed with a bailer that is not completely immersed. The recovered sample is representative of the top of the water column in the well casing. If immiscible materials are present as measured by the interface probe at the top of the water column, this technique can allow their detection. The water will be observed for the presence of any floating films or other indications of immiscible materials. Any sample odors will be noted. Observations regarding odor or visual evidence of immiscible materials will be recorded in the sampling record.

The well water sample will be discarded unless the site-specific protocol calls for retention of this sample. The sample will be placed in a labeled container for proper disposal.

### Well Bore Evacuation

Water contained within and adjacent to the well casing can potentially reflect chemical interaction with the atmosphere (by diffusion of gases down the casing) or the well construction materials (through prolonged residence adjacent to the casing).

Observations of this water will be recorded during removal and prior to it being discarded. Onsite parameter measurements of the purged water, as described in this section, will indicate when water-quality parameters have stabilized, and also will be recorded.

The volume of water contained within the well bore at the time of sampling will be calculated, and 4 times the calculated water volume will be removed from the well and discarded. A bailer will be used for well evacuation. The volume of water to be evacuated will be calculated as follows:

Number of Bailers:

$$\text{Number of bailers} = 4 \times \frac{\text{Volume of water in well (Vw)}}{\text{Volume of bailer (Vb)}}$$

Volume of Water in Well:

$$\frac{Vw = 3.142 \times dw^2 \times Lw}{4}$$

where: Vw = water volume in well ($ft^3$)
dw = inside diameter of well (ft)
Lw = length of water column in well (ft)

Volume of Water in Full Bailer:

$$\frac{Vb = 3.142 \times db2 \times Lb}{4}$$

where: Vb = water volume in bailer ($ft^3$)
db = inside diameter of bailer (ft)
Lb = length of bailer (ft)

Wells that can be evacuated to a dry state will be evacuated completely; samples will be taken as soon as sufficient water for sampling is present. Sample compositing—sampling over a lengthy period by accumulating small volumes of water at different times to eventually obtain a sample of sufficient volume—will not be conducted.

Water produced during well evacuation will be contained in a suitable container and temporarily stored onsite pending proper disposal.

Some chemical and physical parameters in water can change significantly within a short time of sample acquisition. The following parameters cannot be accurately measured in a laboratory located more than a few hours from the facility, and will be measured onsite with portable equipment:

- pH
- Specific conductance
- Temperature
- Turbidity units

These parameters will be measured in unfiltered, unpreserved, "fresh" water, using the same sampling technique as for laboratory analyses. The measurements will be made in a clean glass container separate from those intended for laboratory analyses. The tested sample will be discarded after use. The measured values will be recorded in the sampling record.

### Natural Attenuation Field Measurements

In addition to the meter reading above, following the indicators that groundwater has been purged sufficiently to represent water within the water bearing materials, natural attenuation parameters were measured by the Blaine Tech sampling personnel. These include meter readings for:

- Oxidation reduction potential;
- Dissolved oxygen; and
- Dissolved ferrous iron.

### Sample Extraction

Natural attenuation parameters are measured before the water is purged and sampled. Care will be taken during insertion of sampling equipment to prevent undue disturbance of water in the well.

The pump or bailer will be lowered into the water gently to prevent splashing, and extracted gently to prevent creation of an excessive vacuum in the well. The sample will be transferred directly into the appropriate container. While pouring water from a bailer, the water will be carefully poured down the inside of the sample bottle to prevent significant aeration of the sample. Unless other instructions are given by the analytical laboratory, the sample containers will be completely filled so that no air space remains in the container. Excess water taken during sampling will be placed in a container for proper disposal.

## SAMPLE HANDLING

### Sample Preservation

Water samples will be properly prepared for transportation to the laboratory by refrigeration and chemical preservation, as necessary. The laboratory providing sample containers will add any necessary chemical preservatives to the sealed containers provided prior to shipment.

### Container and Labels

Glass containers and appropriate container lids will be provided by the laboratory. The containers will be filled and container lids tightly closed. Sample container lids will be sealed so as to make obvious any seal tampered with or broken. The label will be firmly attached to the container side (rather than the lid). The following information will be written with permanent marker on the label:

- Facility name;
- Sample identification;
- Sample type (groundwater, surface water, etc.);
- Sampling date;
- Sampling time; and
- Preservatives added, and sample collector’s initials.

### Sample Shipment

In most instances, the concentration and type of compounds present in the groundwater are considered by the U.S. Department of Transportation to be non-hazardous. Thus, the following packaging and labeling requirements for the sample materials are appropriate for shipping the sample to the testing laboratory:

- Package sample so that is does not leak, spill, or vaporize from its packaging
- Label package with:
    - sample collector’s name, address, and telephone number
    - laboratory’s name, address, and telephone number

- description of sample
- quantity of sample
- date of shipment

To comply with packaging regulations and prevent damage to expensive groundwater samples, SES will follow packaging and shipping instructions supplied by the certified testing laboratory.

### Chain-of-Custody Control

After samples are obtained, chain-of-custody procedures will be followed to establish a written record concerning sample movement between the sampling site and the testing laboratory. Each shipping container will contain a chain-of-custody form to be completed by the sampling personnel packing the samples. The chain-of-custody form for each container will be completed in triplicate. One copy of this form will be maintained at the site; the other two copies will remain at the laboratory. One of the laboratory copies will become a part of the permanent record for the sample and will be returned with the sample analyses.

The record will contain the following minimum information:

- Collector’s sample number
- Signature of collector
- Date and time of collection
- Place and address of collection
- Material type
- Preservatives added
- Analyses requested
- Signatures involved in the chain of possession
- Inclusive dates of possession

The shipping container will be sealed so as to make obvious any seal tampered with or broken. The chain-of-custody documentation will be placed inside the container so that it is immediately apparent to the laboratory personnel receiving the container, but could not be damaged or lost during shipping.

## SAMPLING RECORDS

To provide complete documentation of sampling, detailed records containing the following information will be maintained during sampling:

- Sample location (facility name)
- Sample identification (name and sample number)
- Sample location map or detailed sketch
- Date and time of sampling
- Sampling method
- Field observations of sample appearance and odor
- Weather conditions
- Samples identification
- Any other significant information

# APPENDIX H

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## GeoTracker Certified Groundwater Monitoring Well Survey

# APPENDIX I

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## Soil and Groundwater Waste Profiling and Disposal Documentation

# Pumped Groundwater

# APPENDIX J

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## Certified Analytical Laboratory Reports and Chain-of-Custody Documentation