BLYMYER ENGINEERS, INC.

November 20, 1997
BEI Job No. 97104

Mr. Jim Thomson
Justin Realty
2310-1/2 Alameda Avenue
Alameda, California 94501

Subject: **Limited Subsurface Investigation**
2411 Webb Avenue
Alameda, California

Dear Mr. Thomson:

Blymyer Engineers, Inc. is pleased to present this letter report documenting the limited subsurface investigation conducted at the subject location on behalf of Justin Realty. This investigation was conducted to assess the presence of petroleum hydrocarbons in the vicinity of two underground storage tanks (USTs) located beneath the sidewalk at 2411 Webb Avenue. It is our understanding that the investigation was required for environmental disclosure purposes during transfer of the property. The work was conducted in general accordance with Blymyer Engineers' proposal dated July 11, 1997, with the exception of preparation of an UST closure plan and addendum to workplan.

1.0 Introduction

1.1 Background

Permit records located by the Alameda County Department of Environmental Health (ACDEH) indicate that two USTs, installed circa 1930, are located beneath the sidewalk at the property. According to the records, both tanks are 500-gallon capacity; one was used for gasoline storage and the other stored fuel oil. Historically, the site use has included a machine shop and an auto repair shop.

1.2 Site Conditions

The property is located in a commercial area of Alameda, California, near the intersection of Webb Avenue and Park Street (Figure 1). The building, which is constructed of unreinforced brick masonry, is approximately 50 feet wide and 100 feet long. The front of the building has two plate glass windows and a roll-up door.

On May 15, 1997, Blymyer Engineers conducted an inspection of the property to locate the USTs identified in the ACDEH records. The results of the inspection were presented in Blymyer

829 CLEMENT AVENUE ALAMEDA CA 94501-1395 PHONE 510-521-3773 FAX 510-865-2594
3475 LENOX ROAD NE SUITE 400 ATLANTA GA 30326 PHONE 404-467-1374 FAX 404-467-[illegible]

Engineers' *Underground Storage Tank Inspection* report, dated May 16, 1997. where is copy of report?

During the inspection, vent pipes were observed on the southwest exterior wall of the building, and two fill pipes were observed in access manholes located in the sidewalk adjacent to Webb Avenue. A separate access manhole adjacent to one UST allowed access to a product line that appears to run toward the building. The interior of the building was inspected for evidence of fuel dispensers or supply/return lines for a former furnace, but none were observed. An attempt to trace the product line into the building using a pipe locator was unsuccessful.

The fill pipes were gauged with a tape measure and the depth from grade to the bottom of the USTs was determnined to be approximately 88 inches. The top of each UST is estimated to be 3 feet below grade (bg), assuming that the 500-gallon USTs are 48 inches in diameter.

During tank gauging, no liquid was found in the northwestern UST, although a gasoline odor was noted. The other UST, located near the southeast corner of the building, appeared to contain approximately 1.5 feet of water. No petroleum odors were noted.

1.3 Scope of Work

Blymyer Engineers' completed the following scope of work during this limited subsurface investigation:

- Prepared a site-specific health and safety plan
- Obtained underground utilities clearance from Underground Service Alert
- Installed two GeoProbe® soil bores inside the building in proximity to the USTs
- Conducted field screening of soil samples using a photoionization detector (PID)
- Collected one soil sample and one grab groundwater sample from each of the soil bores
- Backfilled the soil bores with cement grout upon completion
- Chemically analyzed soil and grab groundwater samples for potential contaminants of concern
- Stored soil cuttings inside the building in a labeled 5-gallon bucket (for later disposal by the owner)

2.0 Environmental Setting

2.1 Regional Geology and Site Geology

The site is in the city of Alameda, an island that is separated from Oakland by the Oakland Inner Harbor. The area is located in the gently sloping East Bay Plain of the San Francisco Bay Area. Elevations in Alameda range from 0 to 30 feet National Geodetic Vertical Datum. The island is comprised of surficial deposits consisting of beach sand, Quaternary alluvium, and, in some areas, artificial fill.

The San Francisco Bay Area is a northwest-southeast trending region enclosed in the Coast Range Province of California. Rocks in the region range from a Jurassic sedimentary, metamorphic, and plutonic basement to Holocene alluvium. The topography of the region is dominated by a major fault system which includes the San Andreas Fault on the west side of San Francisco Bay and the Hayward Fault at the base of the Berkeley Hills on the east side of the Bay. These faults are a reflection of the forces that have uplifted the Coast Range and dropped the section now covered by the open water of San Francisco Bay and Quaternary alluvium (Goldman, H.B., 1967, *Geology of San Francisco Bay*: California Division of Mines and Geology, prepared for the San Francisco Bay Conservation and Development Commission, 58 p.).

2.2 Climate

The East Bay Plain exhibits a Mediterranean-type climate with cool, wet winters and warmer. dry summers. Mean annual precipitation in Berkeley, located nearby, is 23.24 inches, with a mean monthly precipitation of 5.30 inches in January and 0.11 inches in August. The mean monthly temperature in Berkeley is 49.7 degrees Fahrenheit in January and 62.2 degrees Fahrenheit in August (National Oceanic and Atmospheric Administration, 1982, *Monthly Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1951-80, California*, National Climatic Center, Asheville, NC).

3.0 Data Collection

3.1 Soil and Grab Groundwater Sample Collection

How was boring location determined?

On October 29, 1997, two 1.5-inch-diameter GeoProbe® soil bores were advanced inside the building on the subject property (Figure 2). The soil bores, located within approximately 5 feet of the two USTs, were placed in the building because numerous underground utilities are located beneath the sidewalk in front of the building. Furthermore, an encroachment permit from the City of Alameda would have been required for drilling in the sidewalk.

Gregg Drilling advanced the soil bores under the supervision of a Blymyer Engineers geologist. Soil bore SB-1, advanced to a depth of 14 feet bg, was located near the southeastern UST (believed to have stored fuel oil). Soil bore SB-2 was advanced to a depth of 12 feet bg near the former gasoline UST. Groundwater was encountered at approximately 13.5 feet in SB-1 and 11.8 feet in SB-2. Groundwater stabilized at a depth of approximately 10 feet bg in both soil bores, indicating that groundwater beneath the site is semi-confined.

Blymyer Engineers collected soil samples from each soil bore, logged the lithology, and field-screened the samples for organic vapors using a photoionization detector (PID). PID readings and soil descriptions, based on the Unified Soil Classification System, are presented on soil bore logs in Appendix A. One soil sample from each soil bore, collected at a depth between 11 and 12.3 feet bg, was submitted for chemical analyses.

One grab groundwater sample was also collected from each soil bore. Groundwater was allowed to accumulate approximately 20 minutes before collecting the samples. Following the collection of the soil and grab groundwater samples, the soil bores were backfilled with cement grout to grade.

All soil and grab groundwater samples were collected in accordance with Blymyer Engineers' *Standard Operating Procedure No. 4, Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment*, Revision No. 1, included as Appendix B.

3.2 Sample Analyses

The soil and grab groundwater samples were submitted to Sequoia Analytical, a California-certified laboratory. The following is a summary of the analyses conducted:

- Two soil samples and two groundwater samples were analyzed for Total Extractable

Petroleum Hydrocarbons (TEPH) as diesel by EPA Method 8015M

- The soil and grab groundwater samples from SB-2 were analyzed for Total Purgeable Petroleum Hydrocarbons (TPPH) as gasoline by EPA Method 8015M/8020

- All samples were analyzed for benzene, toluene, ethylbenzene, and total xylenes (BTEX) byEPA Method 8020; the soil and groundwater samples from SB-2 were also evaluated for methyl tert-butyl ether (MTBE) by EPA Method 8020

- The soil and groundwater samples from SB-2 were analyzed for total lead using EPA Method 6010

The analytical results are summarized in Table I and the laboratory report is included in Appendix C.

4.0 Data Interpretation

4.1 Site Stratigraphy

The concrete floor inside the building is approximately two inches thick and is underlain by approximately six inches of base rock fill. The stratum encountered beneath the fill consisted of a poorly graded, fine brown silty sand to a depth of approximately 9 feet bg. This stratum was underlain by a green silt that appeared to be approximately 4 feet thick in SB-1 and 2 feet thick in SB-2. A strong petroleum odor was noted in the samples of green silt from both soil bores. The soil bores were terminated in fine-grained, poorly graded, brown silty sand that appears to be the primary water-bearing stratum.

PID readings were 28 to 38 parts per million (ppm) in soil samples collected near the top of the green silt unit. This coincides with petroleum odors also noted in those samples.

4.2 Sample Analytical Results

TEPH as diesel was detected in soil and grab groundwater samples from both soil bores. Concentrations of TEPH in soil ranged from 3,300 ppm in SB-1 to 4,300 ppm in the sample from SB-2. Groundwater concentrations of TEPH were 4.3 and 9.4 ppm in the samples from SB-1 and SB-2, respectively. The laboratory indicated that the TEPH detected was weathered diesel (C9 to C24 chromatogram range).

The soil sample from SB-2 contained 320 ppm TPPH as gasoline, and the groundwater sample contained 1.4 ppm of TPPH. The laboratory noted that the TPPH detected was an unknown hydrocarbon in the chromatogram range of C9-C12.

Neither total lead nor MTBE were detected in the samples from SB-2. The only BTEX compound detected was xylene; soil samples from SB-1 and SB-2 contained 0.64 ppm and 0.59 ppm of total xylenes, respectively.

4.3 Conclusions

Because fuel oil is known to have been stored at this site, it is likely that the TEPH identified as weathered diesel (C9 to C24) is fuel oil. Fuel oil typically peaks in the C15 to C18 chromatographic range. Unidentified hydrocarbons in the C9 to C12 range may be weathered gasoline (fresh gasoline is typically in the C4 to C12 range) or, more likely, the lighter end of the diesel. The lack of BTEX compounds, with the exception of low concentrations of total xylenes in soil samples, suggests that the source of the leak was primarily the fuel oil UST.

4.4 Recommendations

Because the concentrations of petroleum hydrocarbon compounds detected in the soil and groundwater at the site indicate that a leak has occurred, the property owner is required by law to submit an unauthorized release form to the local oversight agency. Blymyer Engineers recommends notification of the ACDEH and the Regional Water Quality Control Board as soon as possible. Further investigation may be required by the ACDEH.

Because BTEX, MTBE, and lead were not detected in groundwater samples collected during this investigation, Blymyer Engineers recommends no active remediation of groundwater at this site. It is our understanding that, in the event of demolition of this building, the USTs will be removed. Overexcavation of impacted soil could be conducted at that time, if necessary.

Blymyer Engineers recommends that a copy of this report be submitted to the ACDEH.

5.0 Limitations

Services performed by Blymyer Engineers, Inc. have been provided in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. The scope of work for the project was conducted within the limitations prescribed by the client. This report is not meant to represent a legal opinion. No other warranty, expressed or implied, is made. This report was prepared for the sole use of the client.

If you have questions regarding the contents of this report or other project matters, please call Jeanna Hudson at (510) 521-3773.

Sincerely,

Blymyer Engineers, Inc.

REGISTERED GEOLOGIST JEANNA S. HUDSON NO. 4492 STATE OF CALIFORNIA

By: [signature]
Jeanna Hudson, R.G.
Senior Geologist

And: [signature]
Michael S. Lewis
Vice President, Technical Services

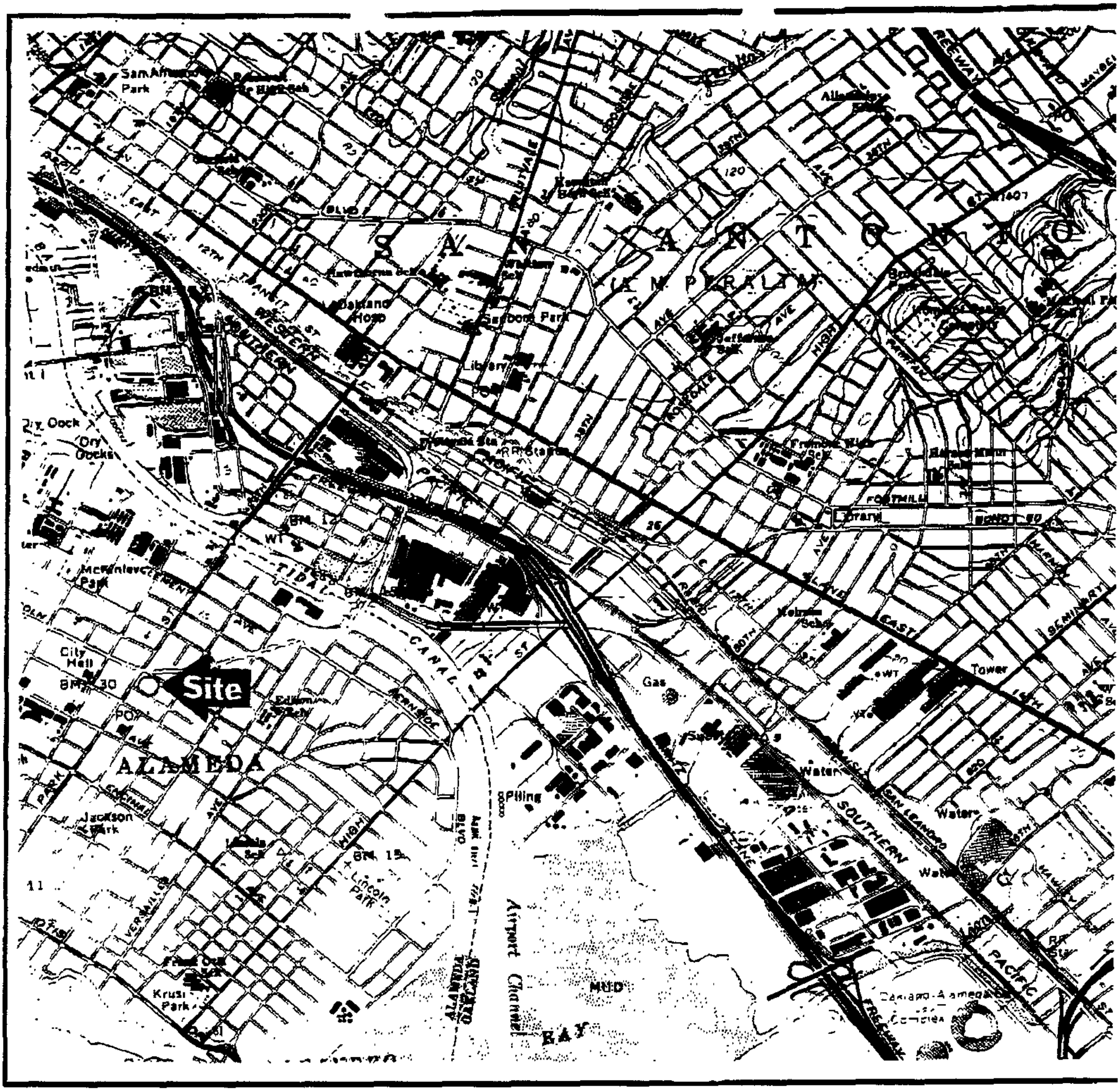
Tables:	Table I:	Summary of Analytical Results, Soil and Grab Groundwater Samples
Figures:	Figure 1:	Site Location Map
	Figure 2:	Underground Storage Tank and Soil Bore Location Map
Appendices:	Appendix A:	Soil Bore Logs
	Appendix B:	Blymyer Engineers, Inc.'s *Standard Operating Procedure No. 4, Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment*, Revision No. 1
	Appendix C:	Sequoia Analytical, analytical laboratory report, dated November 11, 1997

Table 1. Summary of Analytical Results, Soil and Grab Groundwater Samples
BEI Job No. 94107, Justin Realty
2411 Webb Avenue, Alameda, California

Sample Identification	EPA Method 8015M (ppm)	EPA Method 8015M/8020 (ppm)	EPA Method 8020 (ppm)					EPA Method 6010 (ppm)
	TEPH as diesel[1]	TPPH as gasoline[2]	Benzene	Toluene	Ethyl-benzene	Total Xylenes	MTBE	Total Lead
SB-1 soil 11.5-12.0'	3,300	NA	<0.5	<0.5	<0.5	0.64	NA	NA
SB-1 grab groundwater	4.3	NA	<0.005	<0.005	<0.005	<0.005	NA	NA
SB-2 soil 11.0-11.8'	4,300	320	<0.5	<0.5	<0.5	0.59	<2.5	<5.0
SB-2 grab groundwater	9.4	1.4	<0.0025	<0.0025	<0.0025	<0.0025	<0.012	<0.10

Notes:

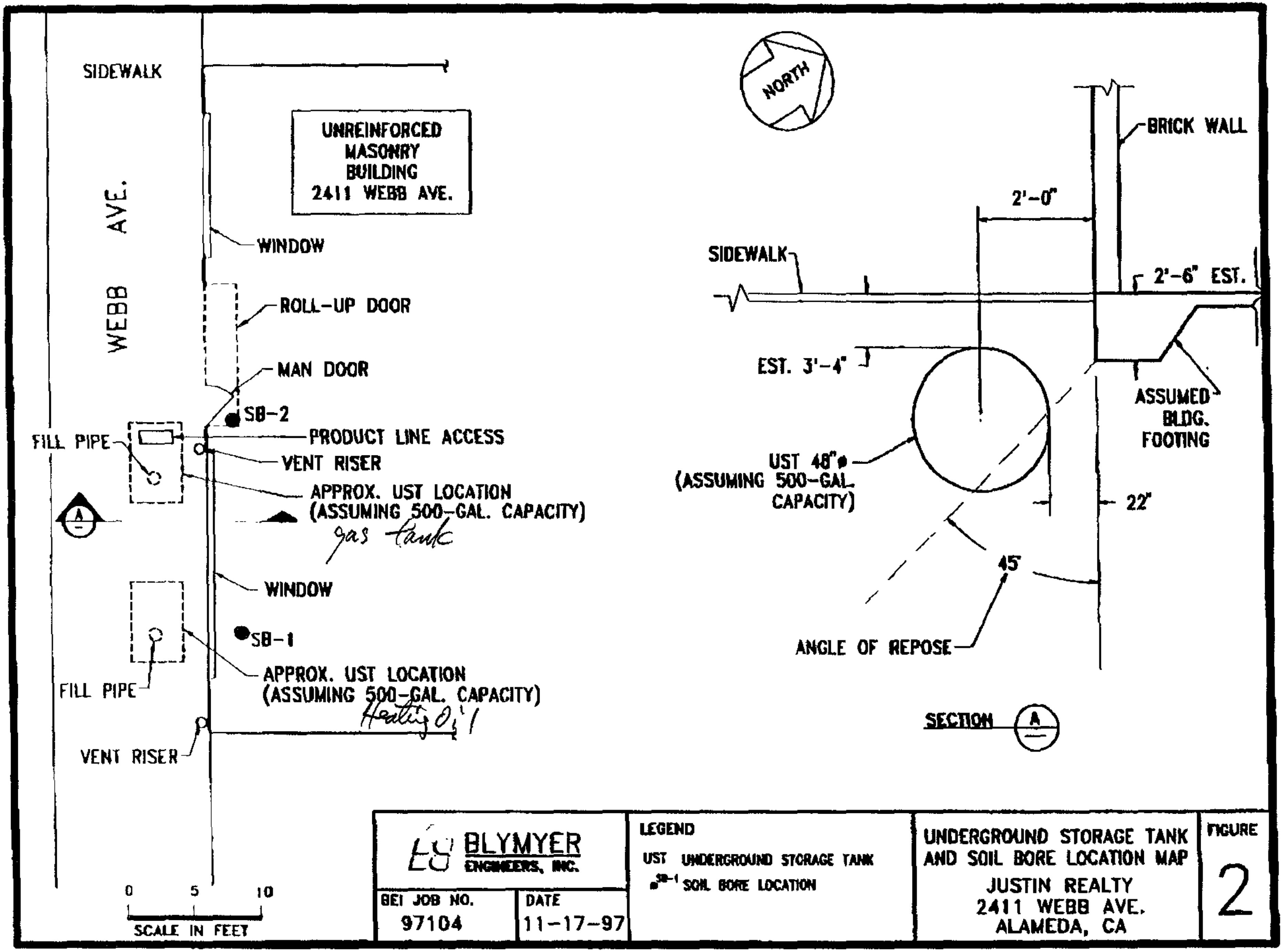
ppm – Parts per million (soil concentrations in milligrams per kilogram, water concentrations in milligrams per liter)
<0.5= Not present above indicated limit of detection
NA= Not analyzed
TEPH= Total Extractable Petroleum Hydrocarbons
TPPH= Total Purgeable Petroleum Hydrocarbons
1= Laboratory interpreted all TEPH concentrations as weathered diesel (C9-C24 chromatogram range)
2= Laboratory interpreted all TPPH concentrations as unidentified hydrocarbons (C9-C12 chromatogram range)



UNITED STATES GEOLOGICAL SURVEY 7.5' QUAD. "OAKLAND, CA" ED. 1959, PHOTOREVISED 1980.

QUADRANGLE LOCATION

BLYMYER ENGINEERS INC	0 1000 2000 SCALE IN FEET	SITE LOCATION MAP JUSTIN REALTY 2411 WEBB AVE. ALAMEDA, CA	FIGURE 1
BEI JOB NO. 97104 / DATE 11/17/97			



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APPENDIX A: Soil Bore Logs

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SOIL BORE LOG: SB-2

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Job No.: 97104
Client: Justin Realty
Site: 2411 Webb Avenue
Alameda, California
Date Drilled: October 29, 1997
Logged By: L. Buckman

Drilling Company: Gregg Drilling and Testing
Driller:
Drilling Equipment: GeoProbe 5400
Sample Method: 4 ft. HDPE sleeve
Soil Bore Diameter: 1.5 in.
Total Depth Drilled: 12 ft.
Initial Water Depth: ▽ 11.8 ft.
Stabilized Water Depth: ▼ 10.1 ft.

Depth (ft.)	Blows/6 in.	P.I.D. (ppm)	Sample Intervals	LITHOLOGIC DESCRIPTION	Unified Soil Classification	Graphic Log	Water Depth
0				Approximately 2 inches of concrete underlain by base rock fill	C/F		
				Brown SILTY SAND: fine grained, poorly graded, dry, no obvious odor	SM		
~4		2					
5							
~8		2.0					
~9.5		28.5					
10				Green SILT: with sand, moist strong odor	ML		▼ 10.1'
~11			■				▽ 11.8'
~11.8		3.2		Brown SILTY SAND: fine grained, poorly graded, moist-wet, no obvious odor	SM		
				Auger refusal: soil bore terminated at 12 feet below grade surface			
15							
20							

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SOIL BORE LOG: SB-1

Job No.: 97104
Client: Justin Realty
Site: 2411 Webb Avenue
Alameda, California
Date Drilled: October 29, 1997
Logged By: L. Buckman

Drilling Company: Gregg Drilling and Testing
Driller:
Drilling Equipment: GeoProbe 5400
Sample Method: 4 ft. HDPE sleeve
Soil Bore Diameter: 1.5 in.
Total Depth Drilled: 14 ft.
Initial Water Depth: ▽ 13.5 ft.
Stabilized Water Depth: ▼ 10 ft.

Depth (ft.)	Blows/6 in.	P.I.D. (ppm)	Sample Intervals	LITHOLOGIC DESCRIPTION	Unified Soil Classification	Graphic Log	Water Depth
0				Approximately 2 inches of concrete underlain by base rock fill	C/F		
				Brown SILTY SAND: fine grained, poorly graded, dry, no obvious odor	SM		
		0					
5							
		1.8					
				Brown SILTY SAND: with clay (2%), fine grained, poorly graded, moist, no obvious odor			
		38.4					
				Green SILT: with sand, moist, strong odor	ML		
10							▼ 10'
		2.8	■				
				Brown SILTY SAND: fine grained, poorly graded, moist-wet, no obvious odor	SM		▽ 13.5'
15				Soil bore terminated at 14 feet below grade surface			
20							

APPENDIX B: Standard Operating Procedure No. 4

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 4

Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment

Revision No. 1

Approved By:

Michael Lewis
Quality Assurance/Quality Control Officer
Blymyer Engineers, Inc.

4/1/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for drilling with the use of hydraulically-driven equipment, soil sampling with the use of split-spoon samplers, and grab groundwater sampling through an open borehole. Drilling activities covered by this SOP are conducted to obtain soil and grab groundwater samples. Soil samples may be obtained to log subsurface materials, to collect samples for chemical characterization, or to collect samples for physical parameter characterization.

The soil sampling techniques described in this SOP are generally suitable for chemical characterization and physical classification tests; because a driven split-spoon sampler is employed, the resulting soil samples should generally be considered "disturbed" with respect to physical structure and may not be suitable for measuring sensitive physical parameters, such as strength and compressibility. The techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the drill rods, a relatively small annulus of remolded soil surrounding the outside diameter of the drill rods, and limited capability for cross-contamination between subsurface strata as the leading drill rods pass from contaminated strata to uncontaminated underlying strata. However, should conditions require strict measures to help prevent cross-contamination or maintain the integrity of an aquitard, consideration should be given to augmenting the procedures of this SOP, for example, by using pre-drilled and grouted isolation casing.

The procedures for hydraulically-driven soil sampling generally consist of initial decontamination, advancement of the drill rods, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon and continued driving and sampling until the total depth of the borehole is reached. Withdrawal of the drill rods upon reaching the total depth requires completion of the borehole by grouting or other measures.

2.0 Equipment and Materials

- Drill rods and drive-weight assembly (hydraulic hammer or vibrator) for driving the drill rods and split-spoon sampler.

- Split-spoon sampler should conform to ASTM D 1586-Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) split-spoon should be fitted with liners for collection of chemical characterization samples, and (2) allowable split-spoon diameters include nominal 1.5-inch inside diameter by nominal 2-inch outside diameter (Standard Penetration Test split-spoon), nominal 2-inch inside diameter by nominal

2.5-inch outside diameter (California Modified split-spoon), or nominal 2-1/2-inch inside diameter by nominal 3-inch outside diameter (Dames & Moore split-spoon). The split-spoon type and length of the split barrel portion of the sampler should be noted on the Boring and Well Construction Log (copy attached), as should the use of a sample catcher if employed.

- Liners should be 3- to 6-inch length, fitted with plastic end caps, brass or stainless steel, with a nominal diameter corresponding to that of the inside diameter of the split-spoon sampler. The Boring and Well Construction Log should note whether brass or stainless steel liners were used.
- Teflon® sheets, approximate 6-mil thickness, precut to a diameter or width of the liner diameter plus approximately 1 inch.
- Plastic end caps.
- Adhesiveless silicone tape.
- Disposable polyethylene bailer.
- Type I/Type II Portland cement.
- Groundwater sample containers (laboratory provided only).
- Kimwipes®, certified clean silica sand, or deionized water (for blank sample preparation).
- Sample labels, Boring and Well Construction Logs, chain-of-custody forms, drum labels, Drum Inventory Sheet (copy attached), and field notebook.
- Ziploc® plastic bags of size to accommodate a liner.
- Stainless steel spatula and knife.
- Cooler with ice or dry ice (do not use blue ice) and packing material.
- Field organic vapor monitor. The make, model, and calibration information for the field organic vapor monitor (including compound and concentration of calibration gas) should be noted in the field notebook.

- Pressure washer or steam cleaner.
- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of drill rod and end plug.
- Buckets and bristle brushes for decontamination of liners, split-spoon sampler, and other small gear.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- Distilled water.
- Heavy plastic sheeting such as Visqueen.
- 55-gallon, open-top, DOT-approved, 17H drums
- 5-gallon open-top DOT-approved pails, if required.

As specified in the Site Safety Plan, additional safety and personnel decontamination equipment and materials may be needed.

3.0 Typical Procedures

The following typical procedures are intended to cover the majority of hydraulic drilling and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected subsurface conditions. Deviations from the following typical procedures may be expected and should be noted on the Boring and Well Construction Log.

1. Investigate location of the proposed boreholes for buried utilities and obstructions. At least 48 hours before drilling, contact known or suspected utility services individually or through collective services such as "Underground Service Alert."

2. Decontaminate drill rods, split-spoon sampler, and other drilling equipment immediately prior to mobilization to the site.

3. Calibrate field organic vapor monitor equipment in accordance with the manufacturer's specifications. Note performance of the calibration in the geologist's field notebook.

4. Conduct "tail-gate" meeting and secure the work area in accordance with the Site Safety Plan.

5. Core concrete, if required.

6. Using hand-augering device, hand auger to a depth of 5 feet, if feasible, to clear underground utilities and structures not located by a utility service or on drawings. As appropriate, retain private buried utility location services or geophysical investigation services to search for buried utilities and obstructions. During initial advancement of each borehole, drill cautiously and have the driller pay particular attention to the "feel" of drilling conditions. The suspected presence of an obstruction, buried pipeline or cable, utility trench backfill, or similar may be cause for suspension of drilling, subject to further investigation.

7. Advance drill rods, or nested drill rods, to the desired sampling depth using hydraulic hammer or vibrator. Note depth interval, augering conditions, and driller's comments on Boring and Well Construction Log. Samples should be collected at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.

The sampling procedure varies depending on whether the drill rods are nesting-type. With nesting-type drill rods, the inner and outer drill rods are driven simultaneously. As they are driven, soil is forced into the lined inner drill rod. The outer drill rod is left in place and the inner drill rod is relined with sample sleeves and replaced for the next sampling segment. Where nesting-type drill rods are not used, a split-spoon sampler is used. The following sampling procedures cover sampling with a split-spoon sampler:

8. Remove drill rod and note presence of water mark on drill rod, if any. Also, monitor the top of hollow drill rods using field organic vapor monitor, as appropriate.

9. Decontaminate split-spoon sampler, liners, spatulas and knives, and other equipment that may directly contact the chemical characterization sample. Fit the split-spoon sampler with liners and attach to drill rod.

10. Lower split-spoon sampler until sampler is resting on soil. If more than 6 inches of slough exists inside the borehole, consider the conditions unsuitable and re-advance the drill rods and sampler to a new sampling depth.

11. Drive and recover split-spoon sampler. Record depth interval and sample recovery on Boring and Well Construction Log. Monitor the recovered split-spoon sampler with the field organic vapor monitor, as appropriate.

12. Remove either bottom-most or second-from-bottom liner (or both) from split-spoon sampler for purposes of chemical characterization and physical parameter testing. Observe soil at each end of liner(s) for purposes of completing sample description. Place Teflon® sheet at each end of liner, cover with plastic caps, and tape plastic caps with adhesiveless silicone tape (do not use electrical or duct tape) to further minimize potential loss of moisture or volatile compounds. Label liner(s) and place in Ziploc® bag on ice or dry ice inside cooler.

13. Extrude soil from remaining liner(s) and subsample representative 1-inch cube (approximate dimensions). Place subsample in Ziploc® bag and seal. Allow bag to equilibrate at ambient conditions for approximately 5 minutes and screen for organic vapors by inserting the probe of the field organic vapor monitor into the bag. Record depth interval, observed sample reading, and ambient (background) reading on the Boring and Well Construction Log. Discard bag and sample after use in the solid waste stockpile.

14. Classify soil sample in approximate accordance with ASTM D 2488-Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) and in accordance with the Unified Soil Classification System (USCS). Description should include moisture content, color, textural information, group symbol, group name, and odor. Optional descriptions, especially if classification is performed with protective gloves, include particle angularity and shape, clast composition, plasticity, dilatancy, dry strength, toughness, and reaction with HC1. Add notes on geologic structure of sample, as appropriate. Record depth interval, field organic vapor monitor reading, USCS classification, and other notes on the Boring and Well Construction Log.

15. Repeat steps 7 through 14 until total depth of borehole is reached.

16. If a grab groundwater sample is to be collected, slowly lower bailer through the open borehole to minimize agitation and aeration of the sampled water. Transfer the grab groundwater sample into sample container(s). Label sample container(s), place packing materials around containers, and place on ice inside cooler.

17. After drill rods are removed, complete borehole according to the requirements specified elsewhere or by abandonment in accordance with section 8.0.

18. Decontaminate drill rods between boreholes and after finishing last borehole prior to drill rig leaving site.

19. Change decontamination solutions and clean decontamination trough, buckets, and brushes between boreholes.

20. Containerize decontamination liquids in 17H steel drums. Affix completed "Caution - Analysis Pending" labels to the drums.

21. Store any excess soil sample on and cover with heavy plastic sheeting. If required by local regulations or due to site constraints, store excess soil sample in 5-gallon pails. Affix completed "Caution - Analysis Pending" labels to drums.

22. Complete Drum Inventory Sheet.

23. Complete pertinent portion of the chain-of-custody form and enter descriptions of field work performed in the field notebook.

4.0 Quality Assurance and Quality Control (QA/QC)

Optional quality control sampling consists of sequential replicates, collected at an approximate frequency of one sequential replicate for every 10 collected soil samples. Sequential replicates are collected by packaging two adjacent liners of soil from a selected split-spoon drive. Each sample is labeled according to normal requirements. The replicate samples obtained in such a manner are suitable for assessing the reproducibility of both chemical and physical parameters. Interpretations of data reproducibility should recognize the potential for significant changes in soil type, even over 6-inch intervals. Accordingly, sequential replicates do not supply the same information as normally encountered in duplicate or split samples. Duplicate or split samples are better represented by the laboratory performing replicate analyses on adjacent subsamples of soil from the same liner.

Optional quality control samples may be collected to check for cross-contamination using field blanks. Field blanks may be prepared by (1) wipe sampling decontaminated liners and split-spoon with Kimwipes®, (2) pouring clean silica sand into a decontaminated split-spoon sampler that has been fitted with liners, or (3) pouring deionized water over the decontaminated liners and split-spoon sampler and collecting the water that contacts the sampling implements for aqueous analysis. Field blanks may be prepared at the discretion of the field staff given reasonable doubt regarding the efficacy of the decontamination procedures.

The comparability of the field soil classification may be checked by conducting laboratory classification tests. Requests for laboratory testing verification of the field classification should be left to the discretion of the field staff.

Field decisions that may also affect the quality of collected data include the frequency of sampling and the thoroughness of documentation. Subject to reasonable limitations of budget and schedule, the completeness, comparability, and representativeness of data obtained using this SOP will be enhanced by decreasing the sampling interval (including collecting continuous samples with depth) and increasing the level of detail for sample classification and description of drilling conditions. More frequent sampling and more detailed documentation may be appropriate in zones of chemical concentration or in areas of critical geology (for example, zones of changing strata or cross-correlation of confining strata).

As required, rinse or wipe samples may be collected from the sampling equipment before the initial sampling is conducted to establish a baseline level of contamination present on the sampling equipment. Rinse or wipe samples may also be collected at intervals of decontamination wash and rinse events or after the final decontamination wash and rinse event.

5.0 Documentation

Observations, measurements, and other documentation of the drilling and soil sampling effort should be recorded on the following:

- Sample label
- Boring and Well Construction Log
- Field notebook
- Chain-of-custody form
- Drum Inventory Sheet

Documentation should include any deviations from this SOP, notations of unusual or unexpected conditions, and documentation of the containerization and disposal of investigation-derived waste. Information to be documented on the sample label and Boring and Well Construction Log is listed below.

5.1 Sample Label

- Project name and project number
- Borehole number
- Sample depth interval (feet below ground surface), record the depth interval using notation similar to "19.2-19.7;" generally do not record just one depth "19.2" because of uncertainty regarding the location such depth corresponds to (midpoint, top, etc.)
- Sample date and sample time
- Name of on-site geologist
- Optional designation of orientation of sample within the subsurface, for example, an arrow with "up" or "top" designated

5.2 Boring Log

- Project name, project number, and name of on-site geologist
- Borehole number
- Description of borehole location, including taped or paced measurements to noticeable topographic features (a location sketch should be considered)
- Date and time drilling started and completed
- Name of drilling company and name of drilling supervisor, optional names and responsibilities of driller's helpers
- Name of manufacturer and model number of sampling rig
- Type and size of sampler, optional description of the size of drill rod
- USCS classification
- Sampling interval and total depth of borehole

- Depth at which groundwater was first encountered with the notation "initial" and any other noted changes in groundwater movement or stabilized water level
- Field organic vapor monitor readings
- Method of boring completion
- Other notations and recordings described previously in section 2.0, Equipment and Materials, and section 3.0, Typical Procedures

6.0 Decontamination

Prior to entering the site, the sampling rig and appurtenant items (drill rods, split-spoon sampler, shovels, troughs and buckets, driller's stand, etc.) should be decontaminated by steam cleaning or pressure washing. Between each borehole, appurtenant items that contacted downhole soil (essentially all appurtenant items including drill rod, split-spoon sampler, shovels, troughs, and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. The sampling rig should be steam cleaned or pressured washed as a final decontamination event. On-site decontamination should be conducted within the confines of a trough or lined pit to temporarily contain the wastewater. Between each borehole and prior to demobilization, the trough or lined pit should be decontaminated by steam cleaning or pressure washing. If a rack or other support is used to suspend appurtenant items over the trough or lined pit during decontamination, only the rack or other support needs to be decontaminated between boreholes.

Prior to collection of each sample, the split-spoon sampler, liners, sample catcher, spatulas and knives, and other equipment or materials that may directly contact the sample should be decontaminated. Decontamination for these items should consist of a soap wash (Alconox®, Liquinox®, or other organic-free, low-residue soap), followed by a clean water rinse. If testing for metals, a final rinse of deionized water should be conducted. Wastewater should be temporarily contained.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before installation of each borehole is begun, fresh decontamination solutions should be prepared. Decontaminated equipment should be kept off of the ground surface. Cleaned equipment should be placed on top of plastic sheeting, which is replaced after completion of each borehole, or on storage racks.

More rigorous decontamination procedures may be employed if necessary to meet sampling or QA/QC requirements.

7.0 Investigation-Derived Waste

Wastes resulting from the activities of this SOP may include excess soil samples, decontamination liquids, and miscellaneous waste (paper, plastic, gloves, bags, etc.).

Solid waste from each borehole should be placed on and covered with heavy plastic sheeting or containerized in DOT-approved 5-gallon pails. Solids from multiple boreholes may be combined within a single stockpile if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the solids are similarly uncontaminated or similarly contaminated. Given sufficient space and reasonable doubt, separate stockpiles should be used for solid waste from each borehole.

Decontamination liquids for each borehole should be placed in individual 17H steel drums with completed "Caution - Analysis Pending" labels affixed. Liquids from multiple boreholes may be combined, subject to the same limitations as solids.

8.0 Borehole Abandonment

Each borehole should be completely filled with neat cement (5.5 gallons of water in proportion to one 94-pound bag of Type I/Type II Portland cement, ASTM C-150) from the bottom of the bore to grade surface. Water used to hydrate cement should be free of contaminants and organic material. Bentonite may be added to reduce shrinkage and improve fluidity. Add 3 to 5 pounds of bentonite with 6.5 gallons of water and one 94-pound bag of Type I/Type II Portland cement. The water and bentonite should be mixed first before adding the cement. The borehole should be filled from the bottom first to grade surface. A tremie pipe should be used in small diameter boreholes or in formations prone to bridging or collapse. The tremie pipe should be lifted as the cement grout is poured. but should never be lifted above the surface of the neat cement. In boreholes deeper than 50 feet, the neat cement may need to be applied with pressure.

9.0 References

Aller, L., Bennett T.W., Hackett G., Petty R.J., Lehr J.H., Sedoris H., and Nielson D.M., 1989. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells. National Water Well Association, Dublin, OH, 1989.

American Society for Testing and Materials, 1992. ASTM Standards On Ground Water and Vadose Zone Investigations. ASTM, Philadelphia, PA, 1992.

Driscoll, F.G., 1986. Groundwater and Wells. Johnson Filtration Systems Inc., St. Paul, MN, 1986.

Neilson, D.M., 1991. Practical Handbook of Ground-Water Monitoring. Lewis Publishers, Chelsea, MI, 1991.

United States Environmental Protection Agency, 1992. RCRA Ground-Water Monitoring: Draft Guidance Document. U.S. EPA, 1992.

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SOIL BORE/WELL CONSTRUCTION LOG

SOIL BORE/WELL NO.:

Location:

Scale:

Elevation (msl):

Client:

Project Site Address:

BEI Job No:

Logged By:

Sampling Method:

Started Time:

Completed Time:

Drilling Company:

Driller:

License No:

Drilling Method:

Date:

Date:

Total Bore Depth/Diameter:

Total Well Depth/Diameter:

Surface Seal Type/Completion:

Annular Seal Type/Interval:

Seal Type/Interval:

Sand Type/Interval:

Blank Casing Type/Diameter/Interval:

Screened Casing Type/Diameter/Interval:

Water Depth:	Initial: (SZ)		Stabilized: (SZ)
Time:			
Date:			

LITHOLOGIC DESCRIPTION	U.S. Classification/ Contact Type	Depth (ft)	Sample Intervals (symbols)	Sample Number	Blows/6 in	Inches Driven	Inches Recovered	PID Readings (ppm)	Screened/Blank Casing Intervals	Sand/Seal Intervals
		1								
		2								
		3								
		4								
		5								
		6								
		7								
		8								
		9								
		10								
		11								
		12								
		13								
		14								
		15								

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SOIL BORE/WELL CONSTRUCTION LOG (continued)

SOIL BORE/WELL NO.:

Notes:

LITHOLOGIC DESCRIPTION	U.S.C./ Contact Type	Depth (ft)	Sample Interval	Sample Number	Blows/6 in.	Inches Driven	Inches Recovered	PID Readings (ppm)	Casing Intervals	Sand/Seal Intervals