BLYMYER
ENGINEERS, INC.

December 23, 2004
BEI Job No. 202016

Mr. Robert Schultz
Alameda County Health Care Services Agency
Environmental Protection Division
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Subject: **Workplan for Additional Investigation and Letter Report**
6393 Scarlett Court
Dublin, California
ACHCSA Site # 4322

Dear Mr. Schultz:

On behalf of Mr. Michael Fitzpatrick, Executor of the Estate of Michael Dolan (Estate), Blymyer Engineers, Inc. (Blymyer Engineers) is pleased to forward this workplan for additional subsurface investigation as requested in the Alameda County Health Care Service Agency (ACHCSA) letter titled *Fuel Leak Case No. RO0000210, Dublin Rock & Ready Mix, 6393 Scarlett Court, Dublin, California*, dated November 15, 2004. As you may be aware, the subject property (Figure 1) has been sold to Dublin Honda contingent upon obtaining City approval for facility construction. The contingency period ends on April 1, 2005, and facility construction can commence, including corrective action for the release from the former underground storage tank (UST). Based on the current knowledge of the site, the preference of the Estate is to conduct remediation by overexcavation; however, as discussed the referenced ACHCSA letter, this is subject to change with the generation of additional data. The specific purpose of the requested and proposed investigation is to fill potential gaps in the vertical and lateral distribution of contaminants at the site in order to best tailor corrective actions to site specifics. The workplan is specifically intended to address Request Nos. 1, 7, and 8 in the aforementioned letter.

Background

A 600-gallon UST was removed in February 1990 from the subject site (Figure 2). Although the UST had reportedly stored diesel more recently, soil and groundwater samples collected for laboratory analysis indicated that the contaminant of concern at the site was gasoline. Files maintained by the ACHCSA do not contain waste manifests for the disposal of soil, although a *Uniform Hazardous Waste Manifest* is present documenting the disposal of a 600-gallon UST. This suggests that contaminated soil may not have been removed from the site. In October 1990, five soil bores were installed at the site, and soil and grab groundwater samples were collected. Additional delineation work was conducted in November 1991, when groundwater monitoring wells MW-1 through MW-4 were installed to a depth of 20 feet below grade surface (bgs). Soil and groundwater samples were collected. In November 1992, 14 additional soil bores were installed, and soil and

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grab groundwater samples were collected from selected bore locations. Although there were several data gaps in the perimeter zone of soil and groundwater delineation, the soil and groundwater plumes were largely defined as a result of this investigation. The groundwater plume did not appear to extend offsite; however, a thin free-phase layer was present immediately adjacent to the former UST basin, and potentially at a location approximately 40 feet to the east. Additional wells were proposed to fill the existing gaps in data around the perimeter of the plume, and to monitor the lateral extent of impacted groundwater and free-phase. As a consequence, in March 1995, wells MW-5 and MW-6 were installed to a depth of 10 feet bgs. Intermittent groundwater sample collection or groundwater monitoring has occurred at the facility since 1991. In an August 1998 letter, the ACHCSA suggested that a health risk analysis or the installation of an oxygen releasing compound (ORC) might be appropriate for the site. The ACHCSA also stated in the August 1998 letter that groundwater sampling of wells MW-1, MW-3, MW-5, and MW-6 could be discontinued and that the sampling interval could be decreased to a semiannual basis, and requested resumption of groundwater monitoring.

In May 2002, Blymyer Engineers was retained by Mr. Michael Fitzpatrick, on behalf of Mr. Michael Dolan, to conduct semiannual groundwater sampling of wells MW-2 and MW-4, and to conduct a file review to help determine the next appropriate step at the site.

In May 2002, Blymyer Engineers relocated and rehabilitated the wells at the site. Well MW-5 required the most extensive rehabilitation work, and will require resurveying due to a change in well casing elevation. In June 2002, wells MW-2 and MW-4 were sampled, while depth to groundwater was measured in all of the wells. Except for a slight increase in benzene in groundwater from well MW-4, the concentration of all analytes in the two wells decreased from the previous sampling event in August 1997. Based upon a review of the results, the ACHCSA recommended that well MW-5 be incorporated into the sampling program, that TPH as diesel be included in the analytical suite, and that quarterly groundwater monitoring resume in order that contaminant concentrations and contaminant trends could be quickly generated for a recommended health risk assessment.

Two additional quarters were completed prior to the death of Mr. Dolan. Groundwater monitoring has been on hold since about January 2003 as the Estate has become established. During the most recent groundwater monitoring event in December 2002, analysis for fuel oxygenates was conducted by EPA Method 8260B. All fuel oxygenates were found to be non-detectable at good limits of detection. Consequently, all sporadic occurrences of methyl tert-butyl ether (MTBE) previously detected at the site have been attributed to 3-methyl-pentane, another gasoline related compound. This suggests that the release predates the use of MTBE and other fuel oxygenates as gasoline additives. All available data from the site has been tabulated on Tables I through V.

On November 15, 2004, the ACHCSA generated the previously referenced letter requesting additional investigation of the site. The letter contained approximately nine areas for additional data or data presentation, including a request for further site investigation based on an observation that the total vertical depth of contaminated media may not be defined, a request for a feasibility study, a review of appropriate cleanup levels, a review of soil reuse, an evaluation of various bioparameters, a request for the evaluation of the applicability of use of the ORC at the site, a request for a conduit study, and resumption of quarterly groundwater monitoring. The ACHCSA letter requested a workplan to begin to address some of these issues, and set a December 31, 2004, deadline for the workplan.

Although not intended as a part of this workplan, but due to the Estate's desire to proceed with corrective actions by April 1, 2005, quarterly groundwater monitoring resumed on December 15, 2004, at the site per the request of the ACHCSA letter (Request No. 9). Due to the length of time since all wells had been sampled, all six existing wells were included in the groundwater contaminant analytical program, including TPH as gasoline and TPH as diesel by Modified EPA Method 8015; BTEX and MTBE by EPA Method 8021B; with select samples to be resubmitted for fuel oxygenates and the lead scavengers EBD and 1, 2-DCA. Per Request No. 5 of the ACHCSA letter, groundwater samples for bioparameter analysis, including pH, dissolved oxygen, oxygen reduction potential, and dissolved ferrous iron (each conducted with field instrumentation), as well as methane by Method RSK 174; nitrate by EPA Method 300.1; sulfate by EPA Method 300.1; and carbon dioxide by EPA Method 4015.1, have been collected from the six existing wells. A separate report will be generated in order to document standard protocols and to report the results. A recommendation for a reduction in the contaminant analytical program may be appropriate after the data has been reviewed. Other conclusions and recommendations will be included, as warranted.

Scope of Work

1.0 Secure all required permits

Upon acceptance of the workplan by the ACHCSA, soil bore or groundwater monitoring well permits will be obtained from the Zone 7 Water Agency.

2.0 Modify the existing site-specific health and safety plan

The existing site-specific health and safety plan will be updated for the proposed work and will outline potentially hazardous work conditions and contingencies for an emergency.

3.0 Locate utilities

Offsite utilities will be marked for location by Underground Service Alert (USA). Additionally, proposed bore locations will be marked for clearance by a private utility location service. Concurrently a site vicinity conduit survey will be conducted in order to locate utility laterals and utility corridors that pass through or near the site, per Request No. 7 of the November 15, 2004, ACHCSA letter.

4.0 Install two Geoprobe® bores

A Geoprobe® rig will be scheduled to install two probe bores for the purpose of determining the vertical extent of soil and groundwater contamination at the site, as requested in the ACHCSA letter (Request No. 1). It is intended that the Geoprobe® bores be installed near or through the former UST basin as generally depicted in Figure 3. This will allow further investigation at the point of the release, presumed to be the worst-case location with respect to the vertical extent of contamination. The Geoprobe® soil bores will be hydraulically pushed to an estimated depth of approximately 35 feet below grade surface (bgs). A continuous soil core will be collected from each bore. The bores will be backfilled with tremied concrete grout upon completion.

5.0 Field screen and collect soil samples for laboratory analysis

At a minimum of 4-foot intervals, selected soil samples will be collected from the soil cores for field screening using a Photoionization Detector (PID) and for lithologic description. All soil samples will be collected in accordance with the previously forwarded Blymyer Engineers' *Standard Operating Procedure No. 4, Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment.*

Up to three soil samples will be collected from the bores for laboratory analysis. Because existing data documents increasing soil concentrations below groundwater before an apparent decrease at approximately 20 feet bgs, sample collection will include the sample displaying the highest PID reading, but will also include a sample collected at an intermediate depth, and a sample collected below the deepest level of documented soil contamination. The soil samples will be analyzed for Total Petroleum Hydrocarbons (TPH) as gasoline and TPH as diesel by modified EPA Method 8015; and for benzene, toluene, ethylbenzene, total xylenes, (BTEX) and MTBE by EPA Method 8021. The soil sample with the highest concentration of TPH as gasoline from each bore will be resubmitted for the lead scavengers ethylene dibromide (EDB) and 1, 2-dichloroethane (1, 2-DCA), and fuel oxygenates using EPA Method 8260B. The soil samples will be submitted to a California-certified laboratory on a standard 5-day turnaround.

6.0 Collect two grab groundwater samples per Geoprobe® bore for laboratory analysis

Because the Geoprobe® bores are dual-walled, up to two depth-discrete grab groundwater samples can be obtained per borehole. Consequently, two depth-discrete grab groundwater samples will be collected per Geoprobe® bore in an attempt to determine the vertical distribution of known contamination, and in an attempt to determine the vertical extent of groundwater contamination (Request No. 1). Blymyer Engineers proposes to collect grab groundwater samples at approximately 8 feet bgs and 18 feet bgs in one borehole, and at an undefined, but deeper, level in the second borehole. All grab groundwater samples will be collected in accordance with the previously forwarded Blymyer Engineers' *Standard Operating Procedure No. 4, Soil and Grab Groundwater Sampling Using Hydraulically-Driven Sampling Equipment.*

The grab groundwater samples will be analyzed for TPH as gasoline and TPH as diesel by modified EPA Method 8015; and for BTEX and MTBE by EPA Method 8021. The grab groundwater sample with the highest concentration of TPH as gasoline from each bore will be resubmitted for the lead scavengers EDB, 1, 2-DCA, and fuel oxygenates using EPA Method 8260B. The grab groundwater samples will be submitted to a California-certified laboratory on a standard 5-day turnaround.

7.0 Contingency installation of up to four groundwater monitoring wells

In the event that a deeper water-bearing zone is suspected as being impacted, delineation of the lateral extent of impacted soil and groundwater will be required in the lower water-bearing zone or aquifer. Consequently a hollow-stem auger drill rig will be scheduled to install up to four permanent groundwater monitoring wells. A hollow-stem auger will be utilized to advance a soil bore in order that a conductor casing can be installed for the purpose of preventing groundwater from the upper water-bearing zone(s) from entering the well and cross-contaminating lower water-bearing zone(s). It is presumed that the conductor casing will be anchored in clay at an approximate depth of 20 feet bgs; however, the exact depth of anchoring will be based on the lithology encountered in the aforementioned Geoprobe® bore program. Permanent groundwater monitoring wells will be constructed through the conductor casing. For the purposes of this workplan, it has been assumed that the wells will be drilled to an approximate depth of 35 feet bgs. Soil samples will be collected at maximum 5-foot intervals using a split-spoon sampler for field screening with a PID and for lithological description. Up to three soil samples will be submitted for laboratory analysis, using the same methodology described for the Geoprobe® bore program. If no elevated PID readings are detected, the soil sample collected from the interval just above the depth that groundwater is first encountered, and at total well depth will be submitted for laboratory analysis. All soil samples will be collected in general conformance with Blymyer's *Standard Operating Procedure No. 1, Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig* (Appendix A).

The groundwater monitoring wells will be constructed of 2-inch-diameter Schedule 40 PVC casing, with factory-slotted 0.010-inch screen. The exact screened interval below the conductor casing will be determined after drilling the Geoprobe® bores.

The annulus between the borehole wall and the PVC casing will be filled with filter sand from the bottom of the borehole to approximately 2 feet above the screened interval. Two feet of bentonite pellets will then be placed in the annulus and hydrated to form a surface seal. The remaining annular space will be filled with concrete grout, and a lockable flush-mounted well box will be set in concrete over the top of the monitoring well.

The monitoring well installation will be performed in general conformance with Blymyer's *Standard Operating Procedure No. 2A, Completion of Borings as Groundwater Monitoring Wells* (Appendix A).

8.0 Contingency monitoring well development and sampling procedures

Should monitoring wells be required, the wells will be developed by removal of a minimum of six well volumes of groundwater a minimum of 72 hours after installation to allow the grout and concrete to properly set. The well will be developed until the groundwater appears to be clear of sediment, or until a maximum of 10 well volumes of groundwater have been removed. The monitoring wells will be developed in general conformance with Blaine Tech Services, Inc. (Blaine Tech) Standard Operating Procedure, *Well Development* (Appendix A).

A groundwater sample will be obtained from each monitoring well a minimum of 72 hours after well development to allow the aquifer to recover from development. The monitoring wells be purged a minimum of three well volumes prior to sampling. Groundwater sample collection procedures will be performed in general conformance with Blymyer's *Standard Operating Procedure No. 3, Groundwater Monitoring and Well Sampling Using a Bailer or Hand Pump*, in conjunction with Blaine Tech's Standard Operating Procedures, *Water Level, Separate Phase Level and Total Well Depth Measurements (Gauging), Well Water Evacuation,* and *Sample Collection from Groundwater Wells Using Bailers* (Appendix A).

9.0 Groundwater monitoring wellhead survey

Site wells have not previously been surveyed to incorporate them into the GeoTracker data management system maintained by the State of California. The existing wells, as well as newly installed wells, will be surveyed with a GPS survey system that meets the requirements of the GeoTracker system. Surveying will include horizontal position and top-of-casing elevation.

10.0 Soil and groundwater handling

Due to the volume of soil that is anticipated to be generated, all soil cuttings will be stockpiled above and below 10-mil plastic sheets for later disposal by the owner. All development, purge, and decontamination water will be stored on-site in DOT-approved 55-gallon drums for later disposal by the owner. Should overexcavation proceed, the soil and water can be disposed of at that time for little additional cost.

11.0 Generate letter report

A letter report will be prepared for submission to the ACHCSA which will document all work performed and will include summaries of data, detailed soil bore and well construction logs, as appropriate, data tables, and conclusions and recommendations for further work or appropriate corrective actions, as warranted. The report will include data and a data analysis to address Requests Nos. 1, 7, and 8 of the November 15, 2004, ACHCSA letter. A recommendation for a feasibility study and evaluation of corrective alternatives (Request No. 2) in conjunction with a corrective action plan will be dependent upon the results of the additional subsurface investigation.

12.0 Generate a feasibility study and corrective action plan

Should a feasibility study and corrective action plan be appropriate and recommended as discussed in Task No. 10.0 above, Blymyer Engineers will proceed upon acceptance of the recommendations by the ACHCSA. Blymyer Engineers will generate a feasibility study and corrective action workplan for submission to the ACHCSA to detail the corrective actions identified as appropriate for the site (Request No. 2).

Schedule

Field work can commence within approximately one week of approval of this workplan. Due to the tight time frame involved prior to April 1, 2005, field work is tentatively scheduled to initiate the second week of January 2005. As requested, a Revised Corrective Action Plan is scheduled for submittal 90 days after workplan approval. As requested, a quarterly monitoring report will be submitted at the end of the first month of each quarter covering the events of the previous quarter.

Should you have any questions, please call Mark Detterman at (510) 521-3773.

Sincerely,

Blymyer Engineers, Inc.

By: Mark E. Detterman, C.E.G.
Senior Geologist

REGISTERED GEOLOGIST
MARK E. DETTERMAN
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By:
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Enclosures:

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Table II:	Summary of Groundwater Sample Hydrocarbon Analytical Results
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Figure 1:	Site Location Map
Figure 2:	Site and Proposed Bore and Well Locations
Appendix A:	Blymyer Engineers' *Standard Operating Procedure No. 1, Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig*
	Blymyer Engineers' *Standard Operating Procedure No. 2A, Completion of Borings as Groundwater Monitoring Wells*
	Blymyer Engineers' *Standard Operating Procedure No. 3, Groundwater Monitoring and Well Sampling Using a Bailer or Hand Pump*

Blaine Tech Services, Inc., Standard Operating Procedure, *Well Development*

Blaine Tech Services, Inc., Standard Operating Procedure, *Water Level, Separate Phase Level and Total Well Depth Measurements (Gauging)*

Blaine Tech Services, Inc., Standard Operating Procedure, *Well Water Evacuation (Purging)*

Blaine Tech Services, Inc., Standard Operating Procedure, *Sample Collection from Groundwater Wells Using Bailers*

Table I, Summary of Groundwater Elevation Measurements
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Well ID	Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-1	11/27/91	326.61	4.82	321.79
	9/30/92		5.34	321.27
	4/7/94		3.38	323.23
	8/12/94		4.23	322.38
	11/29/94		3.44	323.17
	3/21/95		1.00	325.61
	5/22/95		2.20	324.41
	8/24/95		3.45	323.16
	2/12/96		1.95	324.66
	8/6/97		3.60	323.01
	6/6/02*		2.89	323.72
	9/23/02		3.48	323.13
	12/13/02		3.18	323.43
MW-2	11/27/91	326.67	4.92	321.75
	9/30/92		5.42	321.25
	4/7/94		3.48	323.19
	8/12/94		4.18	322.49
	11/29/94		3.76	322.91
	3/21/95		1.25	325.42
	5/22/95		2.20	324.41
	8/24/95		3.57	323.10
	2/12/96		2.60	324.07
	2/5/97		1.72	324.95
	8/6/97		3.72	322.95
	6/6/02*		3.46	323.21
	9/23/02		4.14	322.53
	12/13/02		3.45	323.22

Table I, Summary of Groundwater Elevation Measurements
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Well ID	Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-3	11/27/91	326.58	4.96	321.62
	9/30/92		5.46	321.12
	4/7/94		3.66	322.92
	8/12/94		4.37	322.21
	11/29/94		3.60	322.98
	3/21/95		1.62	324.96
	5/22/95		2.73	323.85
	8/24/95		3.76	322.82
	2/12/96		2.45	324.13
	2/5/97		1.99	324.59
	8/6/97		3.83	322.75
	6/6/02*		3.66	322.92
	9/23/02		4.66	321.92
	12/13/02		3.66	322.92
MW-4	11/27/91	326.92	5.26	321.66
	9/30/92		5.78	321.14
	4/7/94		4.02	322.90
	8/12/94		4.81	322.11
	11/29/94		4.39	322.53
	3/21/95		1.80	325.12
	5/22/95		3.07	323.85
	8/24/95		4.09	322.83
	2/12/96		2.80	324.12
	2/5/97		2.32	324.60
	8/6/97		4.14	322.78
	6/6/02*		3.76	323.16
	9/23/02		4.14	322.78
	12/13/02		3.90	323.02

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BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Well ID	Date	TOC Elevation (feet)	Depth to Water (feet)	Water Surface Elevation (feet)
MW-5	3/21/95	326.50	2.10	324.40
	5/22/95		2.93	323.57
	8/24/95		1.57	324.93
	2/12/96		2.78	323.72
	2/5/97		2.24	324.26
	8/6/97		3.02	323.48
	6/6/02*	**	2.79	NM
	9/23/02		3.07	NM
	12/13/02		3.14	NM
MW-6	3/21/95	327.23	3.24	323.99
	5/22/95		4.70	322.53
	8/24/95		4.95	322.28
	2/12/96		4.50	322.73
	2/5/97		3.68	323.55
	8/6/97		4.79	322.44
	6/6/02*		4.81	322.42
	9/23/02		5.10	322.13
	12/13/02		4.88	322.35

Notes: TOC = Top of casing
* = Initial data set collected under direction of Blymyer Engineers, Inc.
** = Surveyed elevation not yet available
NM = Not measured

Elevations in feet above mean sea level

Table II, Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Date	Modified EPA Method 8015 (µg/L)		EPA Method 8020 or 8021B (µg/L)				
		TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-1	11/27/91	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
	9/30/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
	4/7/94	<50	NA	<0.5	<0.5	<0.5	<0.5	NA
	8/12/94	<50	NA	1	1	<0.3	<2	NA
	11/29/94	<50	NA	<0.5	<0.5	<0.5	<2	NA
	3/21/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	5/22/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	8/24/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/12/96	<50	NA	<0.5	<0.5	<0.5	<2	NA
	6/6/02*	NA	NA	NA	NA	NA	NA	NA
	9/23/02	NA	NA	NA	NA	NA	NA	NA
	12/13/02	NA	NA	NA	NA	NA	NA	NA
MW-2	11/27/91	170,000	NA	24,000	13,000	3,500	16,000	NA
	9/30/92	120,000	NA	24,000	15,000	3,800	17,000	NA
	4/7/94	120,000	NA	21,000	14,000	4,300	21,000	NA
	8/12/94	140,000	NA	17,000	10,000	4,300	18,000	NA
	11/29/94	90,000	NA	17,000	7,500	3,400	15,000	NA
	3/21/95	83,000	NA	17,000	8,000	3,800	17,000	NA
	5/22/95	82,000	NA	14,000	6,000	4,000	16,000	NA
	8/24/95	86,000	NA	13,000	8,100	3,700	16,000	NA
	2/12/96	78,000	NA	15,000	8,100	4,200	18,000	NA
	2/5/97	58,000	NA	11,000	6,900	3,500	15,000	480
	8/6/97	66,000	NA	7,000	9,200	3,500	16,000	<500
	6/6/02*	25,000 [a]	NA	2,900	50	2,700	2,200	<250
	9/23/02	14,000 [b]	4,300 [c]	2,700	81	2,100	1,800	<250
	12/13/02	26,900	4,000 [c]	1,120	91.0	1,480	2,370	197 [d]

Table II. Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Date	Modified EPA Method 8015 (μg/L)		EPA Method 8020 or 8021B (μg/L)				
		TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-3	11/27/91	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
	9/30/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
	4/7/94	<50	NA	**2.5**	**5.5**	**0.9**	**5.1**	NA
	8/12/94	<50	NA	<0.5	<0.5	<0.3	<2	NA
	11/29/94	<50	NA	<0.5	<0.5	<0.5	<2	NA
	3/21/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	5/22/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	8/24/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/12/96	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/5/97	<50	NA	<0.5	<0.5	<0.5	<0.5	<5
	6/6/02*	NA	NA	NA	NA	NA	NA	NA
	9/23/02	NA	NA	NA	NA	NA	NA	NA
	12/13/02	NA	NA	NA	NA	NA	NA	NA
MW-4	11/27/91	**11,000**	NA	**100**	**0.7**	**250**	**330**	NA
	9/30/92	**380**	NA	**3.5**	**2.4**	**8.9**	**3.4**	NA
	4/7/94	**1,100**	NA	**61**	**5.5**	**17**	**12**	NA
	8/12/94	**1,000**	NA	**3**	**1**	**8**	**4**	NA
	11/29/94	**1,100**	NA	**2**	**<0.5**	**10**	**6**	NA
	3/21/95	**1,400**	NA	**200**	**5**	**66**	**18**	NA
	5/22/95	**1,200**	NA	**60**	**1**	**12**	**8**	NA
	8/24/95	**400**	NA	**1**	<0.5	**1**	<2	NA
	2/12/96	**1,500**	NA	**130**	<0.5	**120**	**51**	NA
	2/5/97	**1,200**	NA	**250**	**4.9**	**94**	**12**	**16**
	8/6/97	**330**	NA	**1.5**	<0.5	<0.5	<0.5	<5
	6/6/02*	<50	NA	**1.7**	<0.5	<0.5	<0.5	<2.5
	9/23/02	<50	<48	<0.5	**1.3**	<0.5	<0.5	<2.5
	12/13/02	<50	**86** [c]	<0.5	<0.5	<0.5	<1.5	<0.5

Table II, Summary of Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Date	Modified EPA Method 8015 (μg/L)		EPA Method 8020 or 8021B (μg/L)				
		TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
MW-5	3/21/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	5/22/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	8/24/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/12/96	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/5/97	<50	NA	<0.5	<0.5	<0.5	<0.5	<5
	6/6/02*	NA	NA	NA	NA	NA	NA	NA
	9/23/02	<50	**310** [c]	<0.5	<0.5	<0.5	<0.5	<2.5
	12/13/02	<50	**97** [c]	<0.5	<0.5	<0.5	<1.5	**0.720** [d]
MW-6	3/21/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	5/22/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	8/24/95	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/12/96	<50	NA	<0.5	<0.5	<0.5	<2	NA
	2/5/97	<50	NA	<0.5	<0.5	<0.5	<0.5	<5
	6/6/02*	NA	NA	NA	NA	NA	NA	NA
	9/23/02	NA	NA	NA	NA	NA	NA	NA
	12/13/02	NA	NA	NA	NA	NA	NA	NA
RWQCB Groundwater ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table F-1b)		500	640	46	130	290	13	1,800
RWQCB Indoor Air ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table E-1a)		NV	NV	530	500,000	14,000	150,000	24,000

Table II, Continued; Summary of Groundwater Sample Hydrocarbon Analytical Results

Notes:	$\mu g/L$	=	Micrograms per liter
	TPH	=	Total Petroleum Hydrocarbons
	MTBE	=	Methyl *tert*-butyl ether
	NA	=	Not analyzed
	<x	=	Less than the analytical detection limit (x)
	EPA	=	Environmental Protection Agency
	[a]	=	Laboratory note indicates the result is an unidentified hydrocarbon within the C6 to C10 range.
	[b]	=	Laboratory note indicates the result is gasoline within the C6 to C10 range.
	[c]	=	Laboratory note indicates the result is a hydrocarbon within the diesel range but that it does not represent the pattern of the requested fuel.
	[d]	=	MTBE analysis by EPA Method 8260B yielded a non-detectable concentration at a detection limit of 0.50 $\mu g/L$. See Table III.
	*	=	Initial data set collected under direction of Blymyer Engineers, Inc.
	NV	=	No value established

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the respective RWQCB ESL value.

Table III, Summary of Groundwater Sample Fuel Oxygenate Analytical Results BEI Job No. 202016, Dolan Rentals 6393 Scarlett Court, Dublin, California						
Sample ID	Date	EPA Method 8260B				
		TBE (μg/L)	MTBE (μg/L)	DIPE (μg/L)	ETBE (μg/L)	TAME (μg/L)
MW-2	12/13/02	<2,000	<0.50	<0.50	<0.50	<0.50
RWQCB Groundwater ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table F-1b)		18,000	1,800	NV	NV	NV
RWQCB Indoor Air ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table E-1a)		NV	24,000	NV	NV	NV

Notes: TBE = *tert*-Butyl Alcohol
MTBE = Methyl *tert*-butyl Ether
DIPE = Di-isopropyl Ether
ETBE = Ethyl *tert*-Butyl Ether
TAME = Methyl *tert*-Amyl Ether
(μg/L) = Milligrams per liter
NV = No value

Table A-1, Summary of Available Water Supply Well Bore Data BEI Job No. 202016, Dolan Rentals 6393 Scarlett Court, Dublin, California			
Well ID.	Status	Screened Interval (feet bgs)	Notes
3S/1E 6E1	Destroyed	NA	---
3S/1E 6F2	Not relocated in 1977; presumed destroyed	NA	1st report 1959; drilled prior
3S/1E 6G1	Not relocated in 1977; presumed destroyed	NA	1st report 1959; drilled prior
3S/1E 6G4	Present	180 - 186	---
3S/1E 6G6	Present	285 - 292	---
3S/1E 6G5	Present	103 - 106 and 173 - 178	400 feet east of 3S/1E 6G6; outside 1/4- mile radius

Notes: bgs = below grade surface
NA = Not available

Table IIB, Summary of Miscellaneous Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Date	Modified EPA Method 8015 (μg/L)		EPA Method 8020 (μg/L)				
		TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
D1	10/3/90	**22,000**	NA	**250**	<30	**750**	**880**	NA
D3	10/3/90	**110,000**	NA	**600**	**200**	**800**	**1,000**	NA
D4	10/3/90	**15,000**	NA	**1,300**	<30	**700**	**1,000**	NA
D5	10/3/90	**420**	NA	**2.4**	<0.3	**14**	**4.2**	NA
D6	10/3/90	**320,000**	NA	**4,000**	**4,400**	**3,700**	**10,000**	NA
B-1	11/4/92	**Free Product**						
B-2	11/4/92	**Free Product**						
B-3	11/4/92	NA	NA	NA	NA	NA	NA	NA
B-4	11/4/92	**Free Product**						
B-5	11/4/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
B-6	11/4/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
B-7	11/4/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
B-8	11/4/92	**Free Product**						

Table IIB, Summary of Miscellaneous Groundwater Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Date	Modified EPA Method 8015 (µg/L)		EPA Method 8020 (µg/L)				
		TPH as Gasoline	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
B-9	11/4/92	**170**	NA	**1.7**	<0.3	**2.4**	**1.4**	NA
B-10	11/4/92	**7,800**	NA	**48**	**19**	**190**	**150**	NA
B-11	11/14/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
B-12	11/14/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
B-13	12/10/92	<50	NA	<0.3	<0.3	<0.3	<0.3	NA
RWQCB Groundwater ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table F-1b)		500	640	46	130	290	13	1,800
RWQCB Indoor Air ESL: Groundwater is Not a Current or Potential Drinking Water Resource (Table E-1a)		NV	NV	530	500,000	14,000	150,000	24,000

Table IIB, continued; Summary of Miscellaneous Groundwater Sample Hydrocarbon Analytical Results

Notes: μg/L	=	Micrograms per liter
TPH	=	Total Petroleum Hydrocarbons
MTBE	=	Methyl *tert*-butyl ether
NA	=	Not analyzed
<x	=	Less than the analytical detection limit (x)
EPA	=	Environmental Protection Agency
N/A	=	Not applicable

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the respective RWQCB ESL value.

Table IV. Summary of Soil Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Depth (ft)	Date	Modified EPA Method 8015 (mg/Kg)		EPA Method 8020 or 8021B (mg/Kg)				
			TPH as Gas	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
East of 600 gal tank	7	2/5/90	**740**	**1,100** [a]	**14**	**35**	**23**	**110**	NA
Dirt pile (composite)	---	2/6/90	**1,700**	**2,000** [a, b]	**15**	**78**	**37**	**210**	NA
D1-10*	11.0	10/3/90	**0.60**	NA	<0.005	<0.005	<0.005	<0.005	NA
MW1-4A	11.0	11/22/91	<1	NA	<0.003	<0.003	<0.003	<0.003	NA
MW2-4A	11.0	11/22/91	**140**	NA	**1.7**	**3.6**	**2.6**	**14**	NA
MW3-4A	11.0	11/22/91	<1	NA	<0.003	**0.005**	<0.003	<0.003	NA
MW4-2A	11.0	11/22/91	<1	NA	<0.003	**0.006**	**0.005**	<0.003	NA
B-1	5.0	11/3/92	**23**	NA	**0.13**	**0.033**	**1.4**	**0.038**	NA
B-1	10.0	11/3/92	**36**	NA	**0.095**	**0.030**	**0.69**	**1.7**	NA
B-2	5.0	11/3/92	**34**	NA	**0.28**	**1.4**	**0.63**	**4.1**	NA
B-2	10.0	11/3/92	**40**	NA	**1.3**	**0.63**	**0.98**	**4.8**	NA

Table IV, Summary of Soil Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Depth (ft)	Date	Modified EPA Method 8015 (mg/Kg)		EPA Method 8020 or 8021B (mg/Kg)				
			TPH as Gas	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
B-3	5.0	11/3/92	<1	NA	<0.003	**0.004**	<0.003	**0.008**	NA
B-3	10.0	11/3/92	**42**	NA	**1.1**	**0.13**	**0.86**	**4.7**	NA
B-4	5.0	11/3/92	**470**	NA	**2.3**	**8.6**	**6.6**	**38**	NA
B-4	10.0	11/3/92	**23**	NA	**0.89**	**0.22**	**0.47**	**2.3**	NA
SB-A-3.5	3.5	9/16/03	<1.0	<1.0	<0.005	<0.005	<0.005	<0.005	<0.05
SB-B-7.5	7.5	9/16/03	**5.9** [a]	**1.4** [b]	**0.024**	**0.17**	**0.098**	**0.019**	<0.05
SB-B-17	17	9/16/03	**49** [a]	**10** [b]	**0.022**	**0.17**	**0.30**	**0.67**	<0.05
SB-C-8.5	8.5	9/16/03	**150** [a]	**32** [b c d]	**3.1**	**1.2**	**2.4**	**11**	<0.50
SB-C-18	18	9/16/03	**640** [a]	**180** [b c d]	**9.9**	**7.1**	**11**	**42**	<2.5
SB-D-10	10	9/16/03	<1.0	<1.0	<0.005	<0.005	<0.005	<0.005	<0.05
SB-D-13	13	9/16/03	**5.2** [a]	**2.9** [b d]	**0.014**	**0.040**	**0.088**	**0.046**	<0.05
SB-E-13.5	13.5	9/16/03	**1.7** [a]	**2.6** [c d]	<0.005	**0.036**	<0.005	<0.005	<0.05

Table IV, Summary of Soil Sample Hydrocarbon Analytical Results
BEI Job No. 202016, Dolan Rentals
6393 Scarlett Court, Dublin, California

Sample ID	Depth (ft)	Date	Modified EPA Method 8015 (mg/Kg)		EPA Method 8020 or 8021B (mg/Kg)				
			TPH as Gas	TPH as Diesel	Benzene	Toluene	Ethylbenzene	Total Xylenes	MTBE
SB-F-17.75	17.75	9/16/03	**210** [a]	**62** [b c]	**0.27**	**0.56**	**2.1**	**1.0**	<5.0
SB-G-8	8	9/16/03	<1.0	<1.0	<0.005	<0.005	<0.005	<0.005	<0.05
SB-H-12	12	9/16/03	**65** [a]	**12** [b c d]	<0.025	**0.64**	**0.37**	**0.11**	<0.25
SB-I-3.5	3.5	9/16/03	**2,600** [a]	**1,500** [b c]	**3.1**	**3.4**	**51**	**20**	<10
SB-I-8.25	8.25	9/16/03	**1,600** [a]	**260** [b c]	**19**	**45**	**33**	**110**	<10
SB-I-13.5	13.5	9/16/03	**430** [a]	**110** [b c d]	**11**	**14**	**8.7**	**35**	<10
RWQCB ESL Commercial / Industrial Land Use; **Shallow Soils** (<3m); Groundwater is Not a Current or Potential Drinking Water Resource (Table B-2)			400	500	0.38	9.3	13	1.5	5.6
RWQCB ESL Commercial / Industrial Land Use; **Deep Soils** (>3m); Groundwater is Not a Current or Potential Drinking Water Resource (Table D-2)			400	500	0.5	9.3	13	1.5	5.6

Notes:

ft	=	feet
mg/Kg	=	Milligrams per kilogram
TPH	=	Total Petroleum Hydrocarbons
MTBE	=	Methyl *tert*-butyl ether
NA	=	Not analyzed
<x	=	Less than the analytical detection limit (x)
*	=	Depth mismarked in field.
EPA	=	Environmental Protection Agency
[a]	=	Laboratory note indicates an unmodified or weakly modified gasoline pattern.
[b]	=	Laboratory note indicates gasoline range compounds are significant.
[c]	=	Laboratory note indicates diesel range compounds are significant, with no recognizable pattern.
[d]	=	Laboratory note indicates oil range compounds are significant.

Bold results indicate detectable analyte concentrations.

Shaded results indicate analyte concentrations above the respective *commercial* RWQCB ESL value.

Table V, Summary of Miscellaneous Soil Sample Analytical Results BEI Job No. 202016, Dolan Rentals 6393 Scarlett Court, Dublin, California		
Sample ID	Date	Method SW 7010 (mg/Kg) Total Lead
SB-B-7.5	9/16/03	<3.0
SB-B-17	9/16/03	<3.0
SB-C-18	9/16/03	<3.0
SB-F-17.75	9/16/03	<3.0
SB-I-3.5	9/16/03	<3.0
SB-I-8.25	9/16/03	**7.6**
SB-I-13.5	9/16/03	<3.0
RWQCB ESL Commercial / Industrial Land Use; **Shallow Soils** (<3m) Groundwater is Not a Current or Potential Drinking Water Resource (Table B-2)		750
RWQCB ESL Commercial / Industrial Land Use; **Deep Soils** (>3m); Groundwater is Not a Current or Potential Drinking Water Resource (Table D-2)		750

Notes: mg/Kg = Milligrams per kilogram
<x = Less than the analytical detection limit (x)

Bold results indicate detectable analyte concentrations.
Shaded results indicate analyte concentrations above the RWQCB ESL values.

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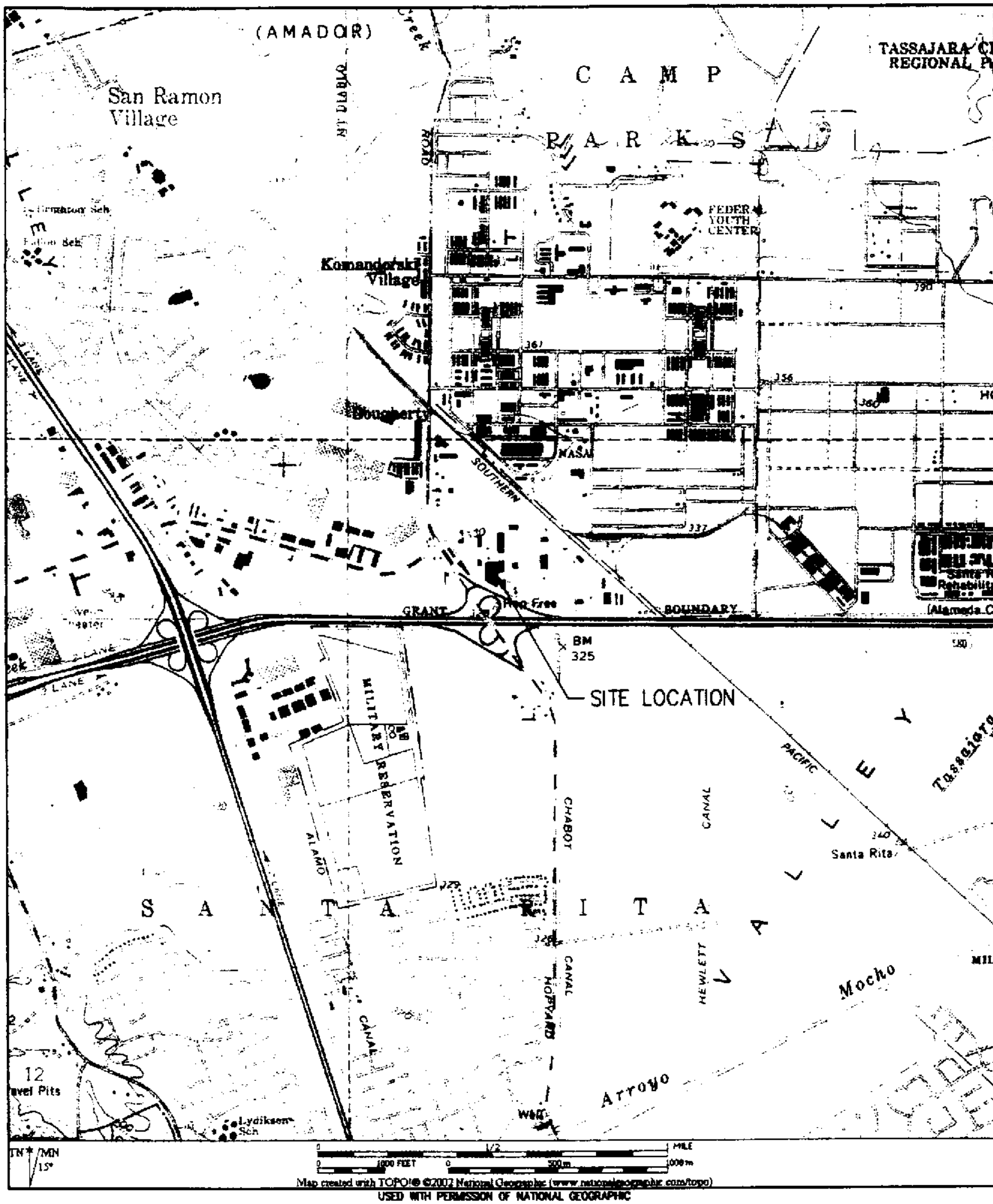
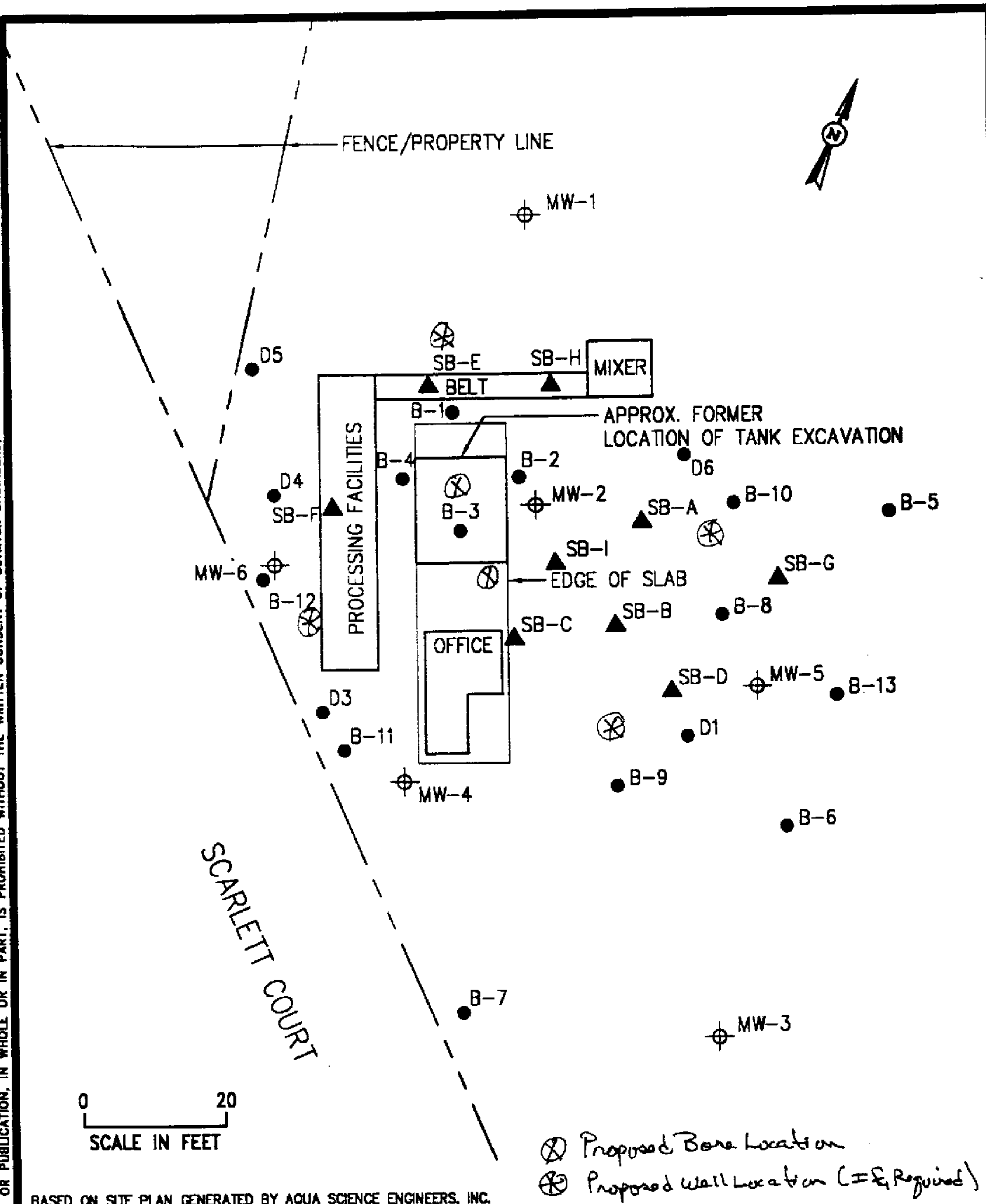


BLYMYER ENGINEERS, INC.	LEGEND	SITE LOCATION MAP	FIGURE
BEI JOB NO. 202016 — DATE 6-27-02		FORMER DOLAN RENTAL PROPERTY 6393 SCARLETT COURT DUBLIN, CA	1



BASED ON SITE PLAN GENERATED BY AQUA SCIENCE ENGINEERS, INC.

BLYMYER ENGINEERS, INC.

BEI JOB NO.	DATE
202016	10-10-03

LEGEND
- GROUNDWATER MONITORING WELL
- SOIL BORE (BY OTHERS)
- GEOPROBE SOIL BORE

SOIL BORE AND MONITORING WELL LOCATION PLAN
FORMER DOLAN RENTAL PROPERTY
6393 SCARLETT COURT
DUBLIN, CA

FIGURE 2

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 1

Soil and Grab Groundwater Sampling Using a Hollow-Stem Auger Drill Rig

Revision No. 1

Approved By:

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

5/31/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for drilling with the use of hollow-stem augers, soil sampling with the use of split-spoon samplers, and grab groundwater sampling through an open borehole. Drilling activities covered by this SOP may be conducted to obtain soil and grab groundwater samples or to create a borehole within which a well may be constructed. 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 augering techniques described in this SOP generally produce a borehole with a diameter corresponding to the outside diameter of the auger flights, a relatively small annulus of remolded soil surrounding the outside diameter of the auger flights, and limited capability for cross-contamination between subsurface strata as the leading flights of the augers 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 hollow-stem auger drilling and split-spoon soil sampling generally consist of initial decontamination, advancement of the augers, driving and recovery of the split-spoon sampler, logging and packaging of the soil samples, decontamination of the split-spoon and continued augering and sampling until the total depth of the borehole is reached. Withdrawal of the augers upon reaching the total depth requires completion of the borehole by grouting, by constructing a well, or other measures; well construction is not covered in this SOP.

2.0 Equipment and Materials

- Drill rig, drill rods, hollow-stem augers, and drive-weight assembly (for driving the split-spoon sampler) should conform to ASTM D 1586-Standard Method for Penetration Test and Split-Barrel Sampling of Soils, except: (1) hollow-stem augers may exceed 6.5 inches inside diameter as may be necessary for installing 4-inch diameter well casing, (2) hollow-stem augers should have a center bit assembly (end plug), (3) alternative drive-weight assemblies or downhole hammers are acceptable as long as the type, weight, and equivalent free fall are noted on the boring log.

- 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 log, 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 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 log forms, chain-of-custody forms, drum labels, Drum Inventory Sheet, 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 on the boring log.

- Pressure washer or steam cleaner.
- Large trough (such as a water tank for cattle), plastic-lined pit, or equivalent for decontamination of hollow-stem augers, 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.
- Steel, 55-gallon, open-top drums conforming to the requirements of DOT 17H, 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 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 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 rig, drill rods, hollow-stem augers, 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 hollow-stem auger, fitted with end plug, to the desired sampling depth. Note depth interval, augering conditions, and driller's comments on boring log. Samples should be taken at intervals of 5 feet or less in homogeneous strata and at detectable changes of strata.

8. Remove drill rod and the end plug from the hollow-stem auger and note presence of water mark on drill rod, if any. If below the groundwater table in clean sand, allow water level in hollow-stem auger to equilibrate prior to removing end plug and remove plug slowly so as to minimize suction at the base of the plug. Also, monitor the top of the hollow-stem auger using field organic vapor monitor, as appropriate. In situations where heaving sand occurs, the use of a clean, inert knock-out plate may be employed, if necessary, to set wells. Also, clean water may be introduced into the hollow-stem auger to create a positive head pressure to exceed the hydrostatic pressure of the heaving sand formation.

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 through hollow-stem of auger until sampler is resting on soil. Note in field notebook discrepancy between elevation of tip of sampler and leading edge of augers, if any. If more than 6 inches of slough exists inside the hollow-stem augers,

consider the conditions unsuitable and re-advance the hollow-stem augers and end plug to a new sampling depth.

11. Drive and recover split-spoon sampler according to the requirements of ASTM D 1586 - Standard Method for Penetration Test and Split-Barrel Sampling of Soils. Record depth interval, hammer blows for each 6 inches, and sample recovery on boring log (copy attached). 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 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 log.

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

16. If grab groundwater sample is to be collected, slowly lower bailer through the open borehole or partially retracted hollow-stem augers 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 or dry ice inside cooler.

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

18. Decontaminate hollow-stem augers, drill rod, and end plug 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 - Pending Analysis" labels to the drums.

21. Store bore cuttings on and cover with heavy plastic sheeting. If required by local regulations or due to site constraints, store bore cuttings in 17H steel drums. Affix completed "Caution - Analysis Pending" labels to drums.

22. Complete Drum Inventory Sheet (copy attached).

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:

- Field notebook
- Boring log
- Sample label
- Chain-of-custody form

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 log is listed below.

5.1 Sample Label

- Project name and project number
- Borehole or well 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 drill rig

- Inside and outside diameter of the auger flights of the hollow-stem augers, type and size of sampler, optional description of type of bit on end plug and leading edge of auger, optional description of the size of drill rod

- USCS classification

- Number of blow counts, 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 drill rig and appurtenant items (drill rod, hollow-stem augers, end plug, 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, hollow-stem augers, end plug, split-spoon sampler, shovels, troughs and buckets, etc.) should be decontaminated by steam cleaning or pressure washing. The drill 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 soil cuttings, 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 unless required to be containerized in 17H steel drums. 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 that is not to be completed as a monitoring well should be completely filled with a 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, 1986. RCRA Ground-Water Monitoring Technical Enforcement Guidance Document. U.S. EPA, 1986.

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BORING & WELL CONSTRUCTION LOG:

Job No.:	Driller:
Client:	Drilling Contractor:
Site:	Logged By:
	Drilling Equipment:
Date Drilled:	Bore Diameter:
Sample Container:	Total Depth: Ft.

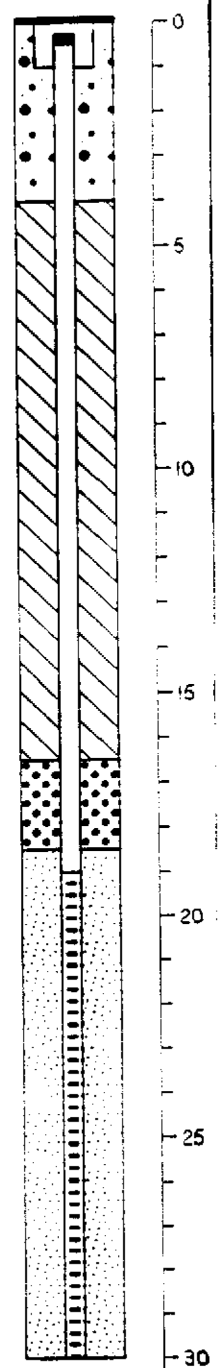
Well Completion Depth: '
Component Size/Type

Depths in Feet
From To

Initial Water Level: ▽
Stabilized water level: ▼

Surface Completion:
Blank Casing:
Slotted Casing:
Filter Pack:
Seal:
Annular Seal:
Surface Seal:
Bottom Seal:

Depth (ft)	Blows/6 In.	P.I.D. (ppm)	Samples	DESCRIPTION	Unified Soil Classification	Graphic Log	Water Depth
0							
5							
10							
15							
20							
25							
30							



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BLYMYER ENGINEERS DRUM INVENTORY FORM

Number of Drums	Date Generated	Person on-site when generated	Soil or Groundwater	Contents (Cuttings, Purge Water, Development Water, Decon Water, PPE)	% Full	Bore or Monitoring Well ID	Do Lab Results Exist for Contents?

Date Client Informed? ____________________

All drums labeled? ____________________

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 2A

Completion of Borings as Groundwater Monitoring Wells

Revision No. 1

Approved By:

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

6/22/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes methods for installation of a groundwater monitoring well within an existing borehole. The well construction techniques discussed in this SOP are generally suitable for construction of wells that are screened in one groundwater zone and that will be used for water quality sampling and/or observations of groundwater elevation (piezometers). Typically, 2- or 4-inch-diameter wells with total depths less than 80 feet will be installed using this SOP. Large-diameter or deeper wells may require modification of the methods described herein. Discussion of specific well casing and screen material is beyond the scope of this SOP, and well casing and screen material should be selected on a site-specific basis. The permitting activities of this SOP apply in California. Different permits are required in other locations.

The procedures for construction of wells generally consist of well permitting, well design, decontamination of well casing and screen, simultaneous assembly and lowering of casing and screen into the borehole, placement of the filter pack around the screen, installation of a bentonite seal above the filter pack, sealing of the remaining annular space with grout, and surface completion.

2.0 Equipment and Materials

- Pressure washer or steam cleaner.
- Equipment for mixing grout.
- Clean water.
- Hand tools (pipe wrenches, chain wrenches, pipe vise, shovels, rubber mallet, etc.).
- Tape measure long enough to reach the bottom of the boring.
- Well casing, screen, bottom plug, and well cap using threaded, flush-joints. Use Schedule 40 PVC unless noted otherwise. Well screen shall be factory slotted.
- Stainless steel machine screws.
- Centralizers (generally not required).

- Buckets and bristle brushes for decontamination.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- Tremie pipe (1.5-inch diameter).
- Filter pack material (typically clean sand of specified gradation).
- Bentonite pellets for seal above filter pack, unaltered sodium bentonite.
- Type I or Type II Portland cement for grout.
- Bentonite powder (for grout only).
- Locking well cap with lock.
- Emco Wheaton A721 Monitoring Well manhole traffic cover (or equivalent).
- Steel, 55-gallon drums that meet the specification of DOT 17H.
- Drum labels, Boring and Well Construction Log, Drum Inventory Sheet, DWR 188 (Water Well Drillers Report), and field notebook.
- Calculator.

Site-specific conditions may require other specialized equipment.

3.0 Typical Procedures

The following procedures apply to most well installations. However, normal field practice requires re-evaluation and modification of these procedures upon encountering unexpected situations during well construction. Deviations from the following procedures may occur and should be documented.

1. Determine local jurisdiction charged with regulation of wells and apply for required local permits or prepare required workplan. Local jurisdictions may include county, water district, or city. Determine special design considerations (such as minimum length of grout seal) and inspection requirements (such as witnessing the placement of the grout

seal).

2. Well design begins with the conception of the purpose for the well, and should include consideration of the analytes of interest, anticipated subsurface conditions at the intended well location, and the actual subsurface soil conditions encountered during drilling and recorded on the Boring and Well Construction Log (copy attached).

3. Prior to installation in the borehole, well casing and screen should be decontaminated and inspected. If not certified clean by the manufacturer and delivered to the site in a protective casing, decontaminate well casing and screen and all fittings prior to insertion into the borehole.

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

5. Assembly of the well screen and blank casing is accomplished simultaneously with insertion into the borehole. Initially, a bottom plug is screwed onto the bottom of the screen (or, if the bottom of the screen is cut, the plug is attached with stainless steel machine screws) and the screen is lowered into the borehole. The next length of casing (screen or blank depending on the specific well design) is attached and the process is repeated until the well extends from the bottom of the borehole to the ground surface. Various types of mechanical clamps are used to prevent dropping of the well screen into the well during assembly. It is useful to leave surplus blank casing extending above grade at this point to facilitate subsequent construction activities. Attached are Blymyer Engineers, Inc.'s Monitoring Well Construction Specifications for Unconfined Water-Bearing Zone and Monitoring Well Construction Specifications for Confined Water-Bearing Zone to be used as references once the hydraulic characteristics of the aquifer have been determined. The well casing and screen should be installed as straight vertically as possible. Centralizers should be used if necessary to center the casing in the borehole.

   Measure the length of well screen and blank casing inserted into the borehole and record the quantities on the Boring and Well Construction Log, a copy of which is attached. The total length of well screen and casing should be confirmed by taping. Cap the well casing temporarily so that no foreign materials may enter the well during installation.

6. Install the filter pack by pouring filter pack material into the annulus between the casing and borehole. Unless impractical due to site conditions or otherwise delineated in a Workplan, Quality Assurance Project Plan, or Sampling Plan, in an unconfined water-

bearing zone, install filter pack from an elevation approximately 6 inches beneath the elevation of the bottom plug of the well casing to approximately 2 feet above the top of the screened interval. In a confined water-bearing zone, install the filter pack from an elevation approximately 6 inches beneath the elevation of the bottom plug of the well casing to the approximate bottom of the confining layer which should correspond to the top of the screen interval.

If augers or drill casing remain in the ground during well construction, the annulus between the augers and the casing may be used as a tremie pipe. If the well is constructed in an open borehole that exceeds 20 feet of depth or is below the groundwater table, then the filter pack should be placed using a tremie pipe. The filter pack should be poured slowly into the borehole and the depth to the top of the filter pack should be tagged periodically with a tape. Adequate time should be allowed for the filter pack material to settle through standing water prior to tagging or the tape may be lost by burial. Tagging may be time consuming but provides reasonable precaution against filter pack bridging during installation.

If augers are being used as a tremie pipe, they should be withdrawn as the filter pack is placed. During placement, the elevation of the tip of the augers or temporary casing should be kept slightly above the top of the filter pack (but no more than 5 feet above the top of the filter pack). Minimizing the separation between the top of the filter pack and tip of the augers or temporary casing during filter pack placement will help prevent inclusions of formation material or slough into the filter pack. However, if the tip of the augers or temporary casing is not kept above the top of the filter pack and the filter pack is allowed to settle within the augers or temporary casing, a filter pack bridge may occur and the well casing may become "locked" inside the augers/temporary casing. The bridged material should be broken mechanically before installing more filter pack material.

The theoretical quantity of filter pack material required to fill the annulus should be calculated. The quantity of filter pack material actually installed in the well should be measured and compared to the calculated quantity. Both quantities should be recorded on the Boring and Well Construction Log.

7. The bentonite seal is installed by pouring bentonite pellets onto the top of the filter pack. The bentonite seal should be tamped down to ensure that no bridging has occurred. For wells deeper than 20 feet, a tremie pipe should be used to place the bentonite seal. Unless impractical due to site-specific conditions or otherwise delineated in a Workplan, Quality Assurance Project Plan, or Sampling Plan, the bentonite seal should extend

approximately 2 feet above the top of the filter pack. The manufacturer's name, quantity used, and type of bentonite used should be recorded on the Boring and Well Construction Log. The top of the bentonite seal should be measured by taping. A tremie pipe may also be used in small-diameter boreholes or in formations prone to bridging or collapse. The tremie pipe is lifted as the bentonite pellets are poured onto the top of the filter pack. If placed in the unsaturated zone, clean water (approximately 5 gallons) should be poured on top of the pellets after their installation and the pellets should be allowed to hydrate for approximately 10 minutes before proceeding with installation of the overlying grout seal.

8. Where the top of the screened interval is deeper than 5 feet, the grout seal should be tremied into the well to prevent inclusions of formation material or slough into the grout seal. Unless otherwise delineated in the Workplan, Quality Assurance Project Plan, or Sampling Plan, the grout seal should consist of neat cement grout (5.5 gallons of water in proportion to one 94-pound bag of Type I or Type II Portland cement (ASTM C-150)). Water used to hydrate the cement is to be free of contaminants and organic material. Bentonite powder may added to reduce shrinkage, retain flexibility to accommodate freeze/thaw conditions, and improve fluidity. If bentonite powder is to be used, add 3 to 5 pounds of bentonite powder with 6.5 gallons of water and one 94-pound bag of Type I or Type II Portland cement. The water and bentonite should be mixed first before adding the cement. Local requirements may require inspection of grout seal placement by the regulating authority.

   If augers or temporary casing remain in the borehole during grouting, the level of the grout should be kept above the tip of the augers or casing to help prevent inclusions of formation material in the grout seal.

   The volume of the grout actually used should be recorded on the Boring and Well Construction Log and compared to the theoretical annular volume of the sealed interval. Any discrepancies should be noted on the Boring and Well Construction Log.

9. Complete the surface of the well by installing an Emco Wheaton A721 Monitoring Well Manhole traffic cover (or equivalent) in accordance with the attached construction specification. Attach the locking cap and lock.

10. The completed well should be protected from disturbance while the bentonite seal hydrates and the grout cures. Further well activities, such as development or sampling, should be withheld for a period of 72 hours to allow these materials to obtain an initial set. Local requirements may require longer than 72 hours.

11. Complete and file form DWR 188 (Water Well Drillers Report) and submit to local agency.

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

13. Complete the Drum Inventory Sheet (copy attached) and the Boring and Well Construction Log.

14. Enter descriptions of field work performed in the field notebook.

4.0 Quality Assurance and Quality Control (QA/QC)

Quality assurance checks for well completion include comparison of theoretical versus actual volumes of filter pack, bentonite seal, and grout seal. Discrepancies that indicate actual "take" was less than theoretical may indicate inclusions of formation material or slough within the annulus. Specific attention to such discrepancies is necessary if the bentonite seal and grout seal are needed to separate contaminated from uncontaminated zones that may be penetrated by the well.

Other quality assurance checks include accurate measurement and documentation of the lengths and types of materials used to complete the well.

5.0 Documentation

Observations, measurements, and other documentation of the well completion effort should be recorded on the following:

- Field notebook
- Boring and Well Construction Log
- DWR 188 (Water Well Drillers Report)
- Drum Inventory Sheet

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposal of investigation-derived waste.

6.0 Decontamination

Materials used for filter pack, bentonite seal, and grout seal should be new at the beginning of each project. Damaged or partially-used containers of material that are brought on site by drillers or other material suppliers should not be used for well completion. If there is sufficient question regarding contamination of materials, obtain representative samples for later laboratory testing.

If not certified clean by the manufacturer and delivered to the site in a protective casing, decontaminate well casing and screen and all fittings prior to insertion into the borehole.

Between each borehole, appurtenant items that contacted downhole soil and groundwater should be decontaminated. The drill 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 insertion in each borehole, the measuring tape, and other materials and supplies that may directly contact the soil or groundwater, should be decontaminated. Decontamination of these items should consist of a soap wash (Alconox®, Liquinox®, or other low-residue, organic-free soap) followed by a clean water rinse. Decontamination liquids should be stored in labeled 17H drums.

Between each borehole, buckets and brushes should be decontaminated by steam cleaning or pressure washing. Before installation of each well 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 decontamination liquids and miscellaneous waste (paper, plastic, gloves, bags, etc.). These wastes should be containerized in 17H steel drums for each borehole. Wastes from multiple boreholes may be combined within a single drum if field observations (presence or absence of chemical staining and field organic vapor monitoring) indicate the boreholes are similarly uncontaminated or similarly contaminated. Given reasonable doubt, separate drums should be used for waste from each borehole.

Completed "Caution - Analysis Pending" labels should be affixed to each drum.

8.0 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.

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

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

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

BLYMYER ENGINEERS, INC.

BORE/WELL CONSTRUCTION LOG

BORE/WELL NO.:

Location:	Client:	Drilling Company:
	Project Site Address:	
	BEI Job No:	Driller:
	Logged By:	License No.:
	Sampling Method:	Drilling Method:
	Started Time:	Date:
Date: / Elevation (msl):	Completed Time:	Date:

Total Bore Depth/Diameter:	Water Depth:	Initial: (∇):		Stabilized: (▼):
Total Well Depth/Diameter:	Time:			
Surface Seal Type/Completion:	Date:			

Annular Seal Type/Interval:

Seal Type/Interval:

Sand Type/Interval:

Blank Casing Type/Diameter/Interval:

Screened Casing Type/Diameter/Interval:

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								

BLYMYER ENGINEERS, INC.

BORE/WELL CONSTRUCTION LOG (continued)

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

KEY TO BORE/WELL CONSTRUCTION LOGS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN NO. 200 SIEVE)	GRAVEL (MORE THAN HALF OF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE)	CLEAN GRAVEL WITH LESS THAN 5% FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES
		GRAVEL WITH OVER 12% FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVEL, GRAVEL-SAND-CLAY MIXTURES
	SAND (MORE THAN HALF OF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE)	CLEAN SAND WITH LESS THAN 5% FINES	SW	WELL GRADED SAND, GRAVELLY SAND
			SP	POORLY GRADED SAND, GRAVELLY SAND
		SAND WITH OVER 12% FINES	SM	SILTY SAND, SAND-SILT MIXTURES
			SC	CLAYEY SAND, SAND-CLAY MIXTURES
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE)	SILT AND CLAY (LIQUID LIMIT LESS THAN 50)		ML	INORGANIC SILT, ROCK FLOUR, SANDY OR CLAYEY SILT OF LOW PLASTICITY
			CL	INORGANIC CLAY OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAY (LEAN)
			OL	ORGANIC SILT AND ORGANIC SILTY CLAY OF LOW PLASTICITY
	SILT AND CLAY (LIQUID LIMIT GREATER THAN 50)		MH	INORGANIC SILT, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOIL, ELASTIC SILT
			CH	INORGANIC CLAY OF HIGH PLASTICITY, GRAVELLY, SANDY OR SILTY CLAY (FAT)
			OH	ORGANIC CLAY, ORGANIC SILT OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

FILL MATERIALS

C	CONCRETE
F	FILL
A	ASPHALT

WELL CONSTRUCTION MATERIALS

- CEMENT GROUT
- BENTONITE
- FILTER SAND

SEE ABOVE FOR CONCRETE SYMBOL

SOIL CONSISTENCY FROM DRIVE SAMPLER

NON-COHESIVE SOILS*		COHESIVE SOILS*		UNCONFINED COMPRESSIVE STRENGTH
SANDS & GRAVELS	BLOWS PER FOOT	SILTS AND CLAYS	BLOWS PER FOOT	[illegible]
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 1/4
LOOSE	4 - 10	SOFT	2 - 4	1/4 - 1/2
MED. DENSE	10 - 30	MEDIUM STIFF	4 - 8	1/2 - 1
DENSE	30 - 50	STIFF	8 - 16	1 - 2
VERY DENSE	OVER 50	VERY STIFF	16 - 32	2 - 4
		HARD	OVER 32	OVER 4

* = STANDARD PENETRATION RESISTANCE IS THE NUMBER OF BLOWS REQUIRED TO DRIVE A 2-INCH O.D. (1-3/8-INCH I.D.) SPLIT BARREL SAMPLER 12 INCHES USING A 140-POUND HAMMER FALLING FREELY THROUGH 30 INCHES. THE SAMPLER IS DRIVEN 18 INCHES AND THE NUMBER OF BLOWS ARE RECORDED FOR EACH 6-INCH INTERVAL. THE SUMMATION OF THE FINAL TWO INTERVALS IS THE STANDARD PENETRATION RESISTANCE.

SAMPLE INTERVAL SYMBOLS

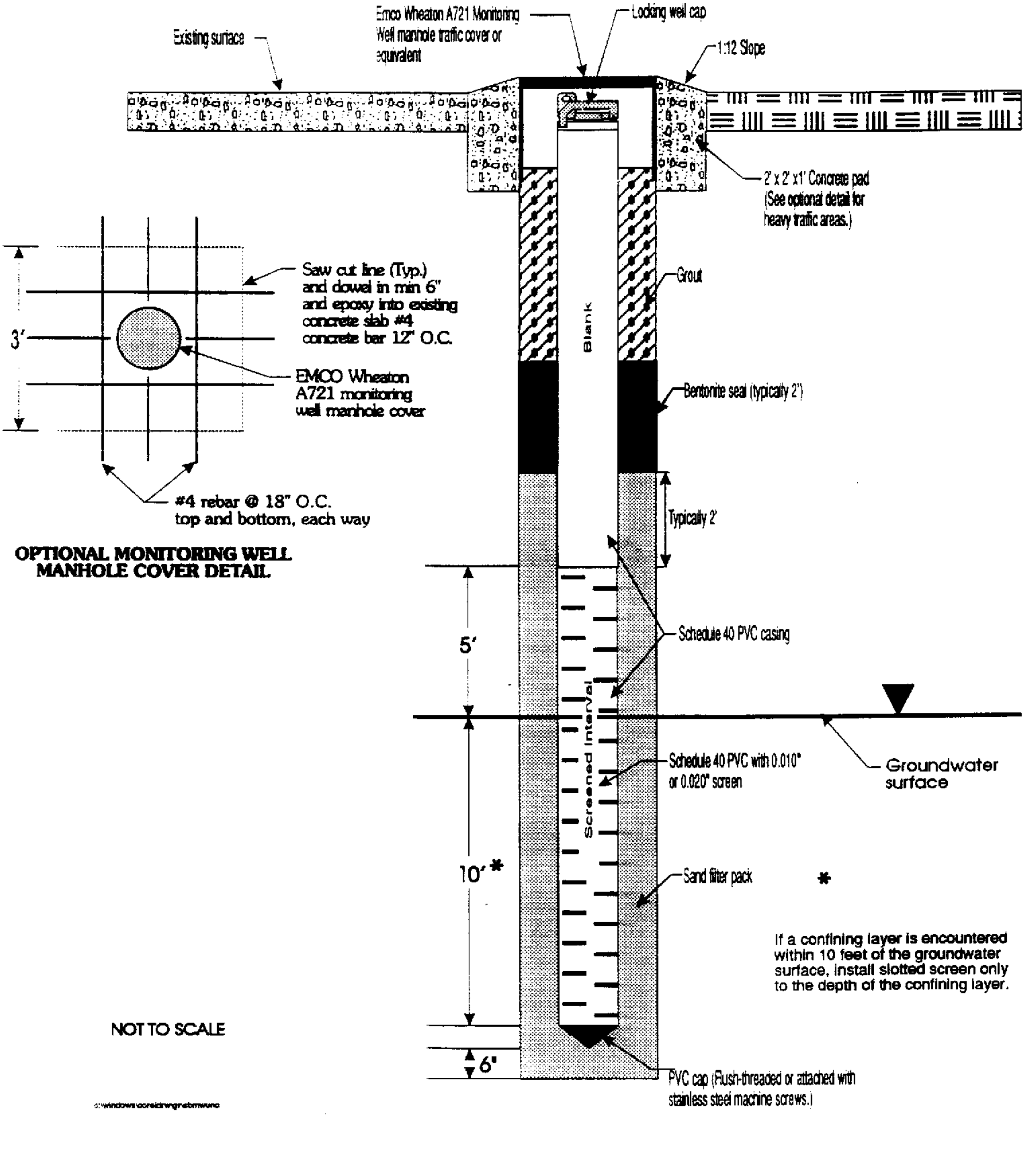
CORED/RECOVERED	CORED/RECOVERED/SAMPLED/ANALYZED
CORED/ NO RECOVERY	N/A NON APPLICABLE/NOT AVAILABLE
CORED/RECOVERED/SAMPLED	

BLYMYER ENGINEERS DRUM INVENTORY FORM

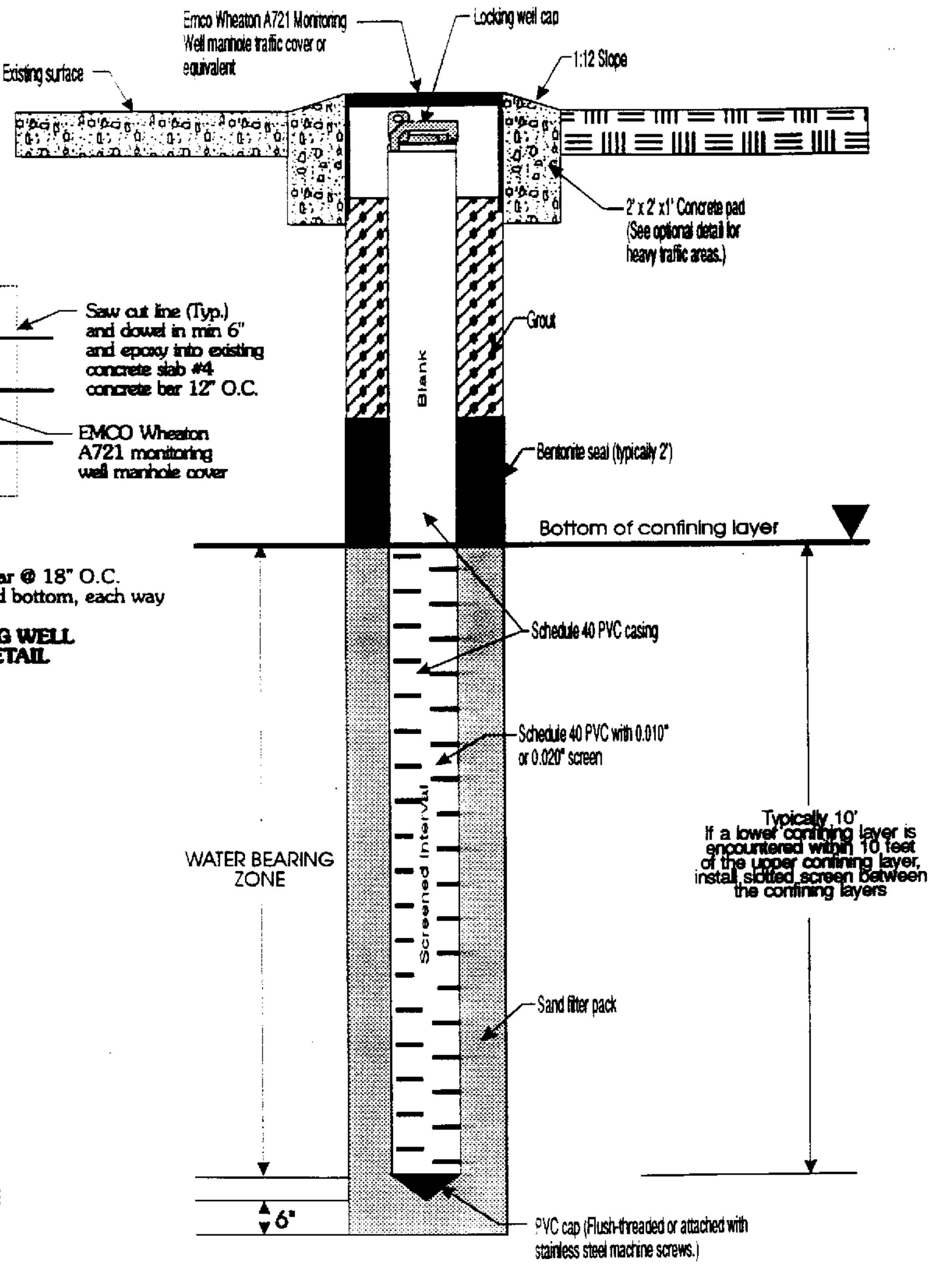
Number of Drums	Date Generated	Person on-site when generated	Soil or Groundwater	Contents (Cuttings, Purge Water, Development Water, Decon Water, PPE)	% Full	Bore or Monitoring Well ID	Do Lab Results Exist for Contents?

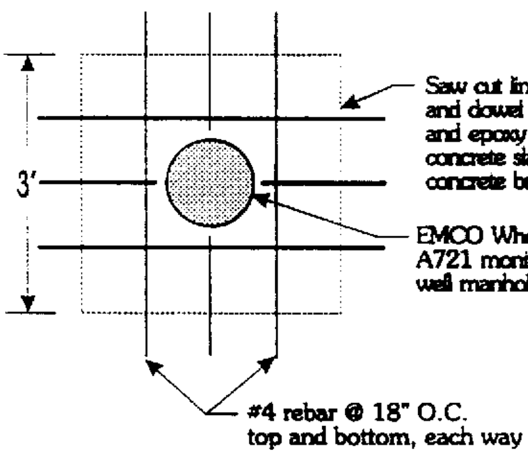
Date Client Informed? ______________________   All drums labeled? ______________________

MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR UNCONFINED WATER-BEARING ZONE



MONITORING WELL CONSTRUCTION SPECIFICATIONS FOR CONFINED WATER-BEARING ZONE





OPTIONAL MONITORING WELL MANHOLE COVER DETAIL

NOT TO SCALE

c:\windows\coreldrw\gr\abmwcon

BLYMYER
ENGINEERS, INC.

Standard Operating Procedure No. 3

Groundwater Monitoring and Well Sampling Using a Bailer or Hand Pump

Revision No. 1

Approved By:

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

9/14/94
Date

Table of Contents

1.0 Introduction and Summary

This Standard Operating Procedure (SOP) describes standard procedures to monitor, purge, and sample groundwater monitoring wells. This SOP will typically be used for 2- or 4-inch-diameter groundwater monitoring wells which have been properly installed and developed. The monitoring and sampling described herein is appropriate for a variety of groundwater analyses, including total and dissolved metals, volatile and semivolatile organic compounds, and general minerals. For newly installed and developed wells, the purging and sampling described in this SOP is typically performed at least 72 hours after well development to allow ambient groundwater conditions to re-establish in the vicinity of the well.

The procedures described in this SOP should be modified for domestic wells or wells with dedicated sampling equipment. The procedures should also be modified if product is observed in the well. These procedures may have to be modified if a sample of floating product (floater) or a sample of an immiscible dense layer (sinker) is to be collected.

Typical groundwater well monitoring, purging, and sampling activities include decontaminating equipment, measuring the potentiometric surface elevation and floating product thickness, purging the stagnant water from the well casing and filter pack, measuring field parameters, purging, terminating the purging process when field parameters stabilize, collecting groundwater samples, and labeling and preserving the collected samples.

2.0 Equipment and Materials

- Buckets and bristle brushes for decontamination.
- Low-residue, organic-free soap such as Liquinox® or Alconox®.
- If sampling is to be performed for metals, dilute (10%) reagent-grade nitric acid (for decontamination).
- Clean water (for decontamination).
- Distilled water (for decontamination and quality control blank samples).
- Cooler with ice (do not use blue ice or dry ice).
- Steel, 55-gallon, open-top drums, DOT 17H.

- Drums labels. Well Purging and Sampling Data form. Drum Inventory Sheet, chain-of-custody form. and field notebook.

- Field organic vapor monitor. The make, model, and calibration information of the field organic vapor monitor (including compound and concentration of calibration gas) should be documented.

- Laboratory-cleaned containers of proper type and size for the analytical parameters (refer to Table I).

- Reagent-grade chemicals for sample preservation, as required for the analytical parameters (refer to Table I).

- If field filtration will be performed for dissolved metals analyses, at least three 45-micron cellulose acetate filters for each well and one filtering device. Alternate filter type and size (cellulose nitrate, Teflon®, or glass-fiber pre-filters) may be required. Do not use polycarbonate-screen filters. The make, type, and size of filter, including disposable filters, should be documented.

- PVC hand pump.

- Glass beaker, $\pm$250-milliliter, for measurement of field parameters. A similar flow-through cell may also be used.

- Electronic water level meter or oil-water interface probe with a minimum accuracy of 0.01 feet.

- pH, temperature, and specific conductivity instruments, including pH and specific conductivity standards approximating or spanning the natural groundwater parameters. Oxidation-reduction potential (ORP) or dissolved oxygen meters may also be required.

- Bailers: polyethylene or Teflon®. Dedicated or new bailer rope. If samples are collected for volatile organic compound analysis, bailer should also be fitted with bottom-emptying device.

- Disposable polyethylene bailer (if groundwater is suspected or known to be contaminated). If groundwater is not suspected to be contaminated or due to preference, a Teflon® bailer may be used.

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

3.0 Typical Procedures

The following procedures are intended to cover the majority of monitoring, purging, and sampling conditions. However, normal field practice requires re-evaluation of these procedures and implementation of alternate procedures upon encountering unusual or unexpected conditions. Deviations from the following procedures are to be expected and should be documented.

1. Remove well cap and perform field organic vapor monitoring of well casing.

2. Decontaminate monitoring, purging, and sampling equipment. Section 6.0 of this SOP contains decontamination procedures.

3. Using the electronic water level meter, measure static water level and total well depth from the top-most portion of the well casing (either marked or notched) and compare to historic measurements. If floating product or an immiscible dense layer is suspected or is found to be present, use the oil-water interface probe instead of the electronic water level meter. Collect at least two of all measurements to verify accuracy and consistency. Two consecutive measurements should agree within 0.04 foot. Remeasure if discrepancies are noted with historic data. If the water level has not stabilized, collect at least three measurements at equal time intervals as the water level approaches stabilization. Repeat this process using successive sets of three measurements until the water level stabilizes. Document observation of product layer(s), if appropriate. Calculate volume of standing water in casing. Record the following observations during monitoring:

    - Well identification and elevation of the top of the well casing.
    - Description of measuring device.
    - Date and time of reading.
    - Name of person monitoring the well.
    - Depth to floating or immiscible dense product layer and initial water level and bottom depth of well readings.

- Stabilized water level with the procedures, data, and computations noted in the field notebook and Well Purging and Sampling Data form to document determination of the stabilized water level.

4. Purge well by repeatedly lowering the bailer into the well, allowing the bailer to fill, removing the bailer, and emptying the collected groundwater into a 55-gallon drum or other suitable container. If using a hand pump, pump the discharge water directly into a drum. Record the following observations at the beginning of purging, periodically during purging, and during sampling:

   - Purge volume and time.
   - pH, temperature, and specific conductivity (measure initially and after removal of each casing volume).
   - Turbidity (clarity and color).
   - Approximate drawdown and well yield during purge.
   - Whether well was purged dry.
   - Other observations (such as presence of product) as appropriate.

5. Terminate purging when one of the following conditions is observed:

   Quick Recharge Wells:
   Well shows stabilized field parameters (three consecutive readings of each parameter within 15% of one another) and at least 3 casing volumes of standing water have been removed. If field parameters have not stabilized after removal of 10 casing volumes of standing water, terminate purging anyway. Wells should be allowed to recover to at least 80% of the original standing water depth prior to sampling.

   Slow Recharge Wells:
   Wells that are initially purged dry, and do not recover to 80% of the original standing water depth within 2 hours, should be sampled when sufficient recovery has occurred to submerge the sampling bailer. Generally, 3 feet of recovery may be considered sufficient recovery for normal bailer submergence. However, never bail a well dry if the recharge rate causes the formation of water to vigorously cascade down the sides of the screen and

cause an accelerated loss of volatiles. If this condition is anticipated, purge three well casing volumes from the well at a rate that does not cause recharge water to be excessively agitated.

6. If recharge has submerged the entire screened interval, sample from mid-depth of screened interval. Otherwise, sample from mid-depth of water column at time of sampling.

7. If field filtration will be performed for dissolved metals analyses, filter sample. If the sample is moderately turbid or very turbid, collect companion filtered and unfiltered samples.

8. Slowly lower bailer through the well casing to minimize agitation and aeration of the sampled water. Transfer the groundwater sample into sample container(s) as designated in Table I, such that the sample containers designated for the most volatile analytes are filled first in descending order of volatility. Containers should generally be filled to capacity. Forty-milliliter glass vials should be filled from the bottom using a sample discharge tube (bottom-emptying device for bailer). Forty-milliliter vials should not have any headspace (air pocket). Replace well cap after sampling.

9. Label sample container(s), place packing materials around containers, and place on ice inside cooler.

10. Change decontamination solutions and clean decontamination buckets and brushes between wells.

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

12. Complete Drum Inventory Sheet (copy attached).

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

4.0 Quality Assurance and Quality Control (QA/QC)

Depending on the level of data validation required on a given project, quality control sampling may consist of none, one, or any combination of the following samples, to be collected at a pre-established frequency (i.e., one quality control sample for every 10 natural samples):

- Duplicate samples, using 40-milliliter vials only.

- Equipment blank - prepared by collecting a sample of deionized water which has been passed over and through decontaminated sampling equipment.

- Trip blanks - typically if analyses require collection of samples in 40-milliliter vials (typical frequency of 1 per day of sampling). A trip blank consists of a laboratory-supplied sample container filled with analyte-free water that is sent to the field in a sealed container and transported back to the laboratory. It is not opened in the field.

- Other quality control samples, including standard reference materials and natural matrix spikes.

Meters for measurements of field parameters should be calibrated at least once per day. Calibration standards should generally approximate or span natural groundwater characteristics. Recalibration may be appropriate if unusual measurements are noticed. Calibration activities should be documented in the field notebook.

5.0 Documentation

The following information should be compiled prior to sampling and taken into the field for reference:

- Well completion schematic
- Summary of historic water level, total depth, and field parameter measurements

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

- Field notebook
- Well Purging and Sampling form
- Drum Inventory Sheet

Documentation should include any deviations from this SOP, as well as documentation of the containerization and disposal of sampling-derived waste.

6.0 Decontamination

Prior to purging and sampling each well, down-well equipment and equipment that will contact the sample (except sample containers) should be decontaminated according to the following procedure:

- Steam clean or pressure wash (optional unless oily contamination covers equipment)
- Wash with low-residue, organic-free soap
- Rinse with clean water
- Rinse with distilled water

If metals are included in the analytical parameters, the decontamination procedures should include:

(1) a dilute nitric acid rinse, and
(2) a second clean water rinse, prior to rinsing with distilled water

Prior to leaving the site, monitoring, purging, and sampling equipment should be decontaminated.

7.0 Investigation-Derived Waste

Purge water, excess sample, and decontamination liquids should be containerized in steel 17H drums. Drums should be labeled with "Caution - Analysis Pending" labels, including: Generator's name, well designation, and accumulation date. Generally, liquids from different wells may be combined, but liquids that are anticipated to be contaminated should not be mixed with liquids that are not thought to be contaminated.

8.0 References

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.

Korte, N. and Kearl, P., 1985. Procedures for the Collection and Preservation of Groundwater and Surface Water Samples and for the Installation of Monitoring Wells: Second Edition, GJ/TMC-08, U.S. Department of Energy, Technical Measurements Center, Grand Junction Projects Office, 1985.

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 Technical Guidance. U.S. EPA, 1992.

[illegible]

Standard Operating Procedure No. 3

Groundwater Sample Containers, Preservation, and Holding Time

Analytical Parameter	Method	References
Halogenated VOCs by GC	EPA 8010	1,2
Aromatic VOCs by GC	EPA 8020	1,2
Organochlorine Pesticides and PCBs	EPA 8080	1,2
Polynuclear Aromatic Compounds	EPA 8100, EPA 8310	1
Chlorinated Herbicides	EPA 8150	1,2
VOCs by GC/MS	EPA 8240	1,2
Semi-VOCs by GC/MS	EPA 8270	1,2
Total Recoverable Petroleum Hydrocarbons	EPA 418.1	1
TPH as Diesel	EPA 3550/8015M	3
TPH as Gasoline with BTEX Distinction	EPA 5030/8015M/8020	3
Metals	EPA 6010	1,2

References

(1) United States Environmental Protection Agency, 1986. Test Methods for Evaluating Solid Waste. U.S. EPA, 1986.

(2) Wagner, R.E., 1992. Guide to Environmental Analytical Methods. Genium Publishing Corp., Schenectady, NY, 1992.

(3) State of California LUFT Task Force, 1988. LUFT Manual: Guidelines for Site Assessment, Cleanup and Underground Storage Tank Closure. State of California, 1988.

Table [illegible] (Continued)
Standard Operating Procedure No. 3
Groundwater Sample Containers, Preservation, and Holding Time

Analytical Parameter	Containers	Preservation	Max. Holding Time
Halogenated VOCs by GC	Two 40-ml glass vials	Cool to 4°C*	14 days
Aromatic VOCs by GC	Two 40-ml glass vials	Cool to 4°C, HCl or H_2SO_4 to pH <2*	14 days
Organochlorine Pesticides and PCBs	Two 1-liter glass bottles	Cool to 4°C*	Extract within 7 days, analyze extract within 40 days
Polynuclear Aromatic Hydrocarbons	Two 1-liter glass bottles	Cool to 4°C, store in dark*	Extract within 7 days, analyze extract within 40 days
Chlorinated Herbicides	Two 1-liter glass bottles	Cool to 4°C*	Extract within 7 days, analyze extract within 40 days
VOCs by GC/MS	Two 40-ml glass vials	Cool to 4°C, HCl or H_2SO_4 to pH <2*	14 days
Semi-VOCs by GC/MS	Two 1-liter glass bottles	Cool to 4°C*	Extract within 7 days, analyze extract within 40 days
Total Recoverable Petroleum Hydrocarbons	Two 1-liter glass bottles	Cool to 4°C, H_2SO_4 to pH <2	28 days
TPH as Diesel	Two 1-liter glass bottles	Cool to 4°C	Extract within 14 days, analyze extract within 40 days
TPH as Gasoline with BTEX Distinction	Two 40-ml glass vials	Cool to 4°C, HCl to pH <2*	14 days
Metals	Two 500-ml polyethylene bottles	HNO_3 to pH <2 (after field filtration)	6 months

* Add 0.008% sodium thiosulfate ($Na_2S_2O_3$) if residual chlorine is present, such as in drinking water and treated sewage

Note: Use Teflon®-lined caps for all sample containers for organic compound analysis.

Well Purging and Sampling Data

Date	Project Number	Project Name
Well Number	Boring Diameter	Casing Diameter

Column of Liquid in Well	Volume to be Removed	
Depth to product	Gallons per foot of casing	=
Depth to water	Column of water	x
Total depth of well	Volume of casing	=
Column of water	No. of volumes to remove	x
	Total volume to remove	=

Method of measuring liquid	
Method of purging well	
Method of decontamination	

Physical appearance of water (clarity, color, particulates, odor)	
Initial	
During	
Final	

Field Analysis	Initial	During		Final
Time				
Temperature (F)				
Conductivity (us/cm)				
pH				
Method of measurement				
Total volume purged				
Comments				

Sample Number	Amount of Sample

Signed/Sampler	Date
Signed/Reviewer	Date

BLYMYER ENGINEERS DRUM INVENTORY FORM

Number of Drums	Date Generated	Person on-site when generated	Soil or Groundwater	Contents (Cuttings, Purge Water, Development Water, Decon Water, PPE)	% Full	Bore or Monitoring Well ID	Do Lab Results Exist for Contents?

Date Client informed? ____________________ All drums labeled? ____________________

Blaine Tech Services, Inc.
Standard Operating Procedure

WELL DEVELOPMENT

Use Swab as a plunger to flush out debris from the slots of the screen. Run the Swab up and down through the entire screen interval. The recommended amount of time spent swabbing depends on the length of the screen, usually one minute per foot. If no screened interval is provided, then swab well for 15 minutes.

Using a stainless steel (1.75" diameter) pneumatic pump begin purging at 0.5 – 1.0 GPM. Place the pump near the well bottom and remove the accumulated sediment until the well bottom feels hard and clean. During purging, move pump up and down through the screen interval, continuing to agitate the pump until all the sediment is removed.

Take the required water quality parameter readings at each casing volume removed. At a minimum, water quality measurements include pH, temperature, electrical conductivity (EC), and turbidity (NTU). Measure Depth to Water (DTW) while purging to confirm the height of the water column. If the well begins to de-water, then the pump may have to be slowed or shut off until enough water recharges into the well. Make notes of the recharge rate. Remove the required number of casing volumes. At a minimum, remove at least 10 case volumes of purge-water. After the minimum volume of water has been purged and all the sediment has been removed from the well, take a final Total Depth measurement. If a required turbidity level must be reached, continue purging until the desired reading has been attained.

Blaine Tech Services, Inc.
Standard Operating Procedure

WATER LEVEL, SEPARATE PHASE LEVEL AND TOTAL WELL DEPTH MEASUREMENTS (GAUGING)

Routine Water Level Measurements

1. Establish that water or debris will not enter the well box upon removal of the cover.
2. Remove the cover using the appropriate tools.
3. Inspect the wellhead (see Wellhead Inspections).
4. Establish that water or debris will not enter the well upon removal of the well cap.
5. Unlock and remove the well cap lock (if applicable). If lock is not functional cut it off.
6. Loosen and remove the well cap. CAUTION: DO NOT PLACE YOUR FACE OR HEAD DIRECTLY OVER WELLHEAD WHEN REMOVING THE WELL CAP. WELL CAP MAY BE UNDER PRESSURE AND/OR MAY RELEASE ACCUMULATED AND POTENTIALLY HARMFULL VAPORS.
7. Verify and identify survey point as written on S.O.W.
   TOC: If survey point is listed as Top of Casing (TOC), look for the exact survey point in the form of a notch or mark on the top of the casing. If no mark is present, use the north side of the casing as the measuring point.
   TOB: If survey point is listed as Top of Box (TOB), the measuring point will be established manually. Place the inverted wellbox lid halfway across the wellbox opening and directly over the casing. The lower edge of the inverted cover directly over the casing will be the measuring point.
8. Put new Latex or Nitrile gloves on your hands.
9. Slowly lower the Water Level Meter probe into the well until it signals contact with water with a tone and/or flashing a light.
10. Gently raise the probe tip slightly above the water and hold it there. Wait momentarily to see if the meter emits a tone, signaling rising water in the casing. Gently lower the probe tip slightly below the water. Wait momentarily to see if the meter stops emitting a tone, signaling dropping water in the casing. Continue process until water level stabilizes indicating that the well has equilibrated.
11. While holding the probe at first contact with water and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Water column.
12. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable)

Water Level and Separate Phase Thickness Measurements in Wells Suspected of Containing Separate Phase

1. Establish that water or debris will not enter the well box upon removal of the cover.
2. Remove the cover using the appropriate tools.
3. Inspect the wellhead (see Wellhead Inspections).
4. Establish that water or debris will not enter the well upon removal of the well cap.

5. Unlock and remove the well cap lock (if applicable). If lock is not functional cut it off.
6. Loosen and remove the well cap. CAUTION: DO NOT PLACE YOUR FACE OR HEAD DIRECTLY OVER WELLHEAD WHEN REMOVING THE WELL CAP. WELL CAP MAY BE UNDER PRESSURE AND/OR MAY RELEASE ACCUMULATED AND POTENTIALLY HARMFULL VAPORS.
7. Verify and identify survey point as written on S.O.W.
   TOC: If survey point is listed as Top of Casing (TOC), look for the exact survey point in the form of a notch or mark on the top of the casing. If no mark is present, use the north side of the casing as the measuring point.
   TOB: If survey point is listed as Top of Box (TOB), the measuring point will be established manually. Place the inverted well box lid halfway across the well box opening and directly over the casing. The lower edge of the inverted cover directly over the casing will be the measuring point.
8. Put new Nitrile gloves on your hands.
9. Slowly lower the tip of the Interface Probe into the well until it emits either a solid or broken tone.
   BROKEN TONE: Separate phase layer is not present. Go to Step 8 of Routine Water Level Measurements shown above to complete gauging process using the Interface probe as you would a Water Level Meter.
   SOLID TONE: Separate phase layer is present. Go to the next step.
10. Gently raise the probe tip slightly above the separate phase layer and hold it there. Wait momentarily to see if the meter emits a tone, signaling rising water in the casing. Gently lower the probe tip slightly below the separate phase layer. Wait momentarily to see if the meter stops emitting a tone, signaling dropping water in the casing. Continue process until water level stabilizes indicating that the well has equilibrated.
11. While holding the probe at first contact with the separate phase layer and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Product column.
12. Gently lower the probe tip until it emits a broken tone signifying contact with water. While holding the probe at first contact with water and the tape against the measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Depth to Water column.
13. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable).

Routine Total Well Depth Measurements

1. Lower the Water Level Meter probe into the well until it lightens in your hands, indicating that the probe is resting at the bottom of well.
2. Gently raise the tape until the weight of the probe increases, indicating that the probe has lifted off the well bottom.
3. While holding the probe at first contact with the well bottom and the tape against the well measuring point, note depth. Repeat twice to verify accuracy. Write down measurement on Well Gauging Sheet under Total Well Depth column.

4. Recover probe, replace and tighten well cap, replace lock (if applicable), replace well box cover and tighten hardware (if applicable).

Blaine Tech Services, Inc.
Standard Operating Procedure

WELL WATER EVACUATION (PURGING)

Purpose
Evacuation of a predetermined minimum volume of water from a well (purging) while *simultaneously* measuring water quality parameters is typically required prior to sampling. Purging a minimum volume guarantees that actual formation water is drawn into the well. Measuring water quality parameters either verifies that the water is stable and suitable for sampling or shows that the water remains unstable, indicating the need for continued purging. Both the minimum volume and the stable parameter qualifications need to be met prior to sampling. This assures that the subsequent sample will be representative of the formation water surrounding the well screen and not of the water standing in the well.

Defining Casing Volumes
The predetermined minimum quantity of water to be purged is based on the wells' casing volume. A casing volume is the volume of water presently standing within the casing of the well. This is calculated as follows:

Casing Volume = (TD – DTW) VCF

1. Subtract the wells' depth to water (DTW) measurement from its total depth (TD) measurement. This is the height of the water column in feet.
2. Determine the well casings' volume conversion factor (VCF). The VCF is based on the diameter of the well casing and represents the volume, in gallons, that is contained in one (1) foot of a particular diameter of well casing. The common VCF's are listed on our Well Purge Data Sheets.
3. Multiply the VCF by the calculated height of the water column. This is the casing volume, the amount of water in gallons standing in the well.

Remove Three to Five Casing Volumes
Prior to sampling, an attempt will be made to purge all wells of a minimum of three casing volumes and a maximum of five casing volumes except where regulations mandate the minimum removal of four casing volumes.

Choose the Appropriate Evacuation Device Based on Efficiency
In the absence of instructions on the SOW to the contrary, selection of evacuation device will be based on efficiency.

Measure Water Quality Parameters at Each Casing Volume
At a minimum, water quality measurements include pH, temperature and electrical conductivity (EC). Measurements are made and recorded at least once every casing volume. They are considered stable when all parameters are within 10% of their previous measurement.

Note: The following instructions assume that well has already been properly located, accessed, inspected and gauged.

Prior to Purging a Well
1. Confirm that the well is to be purged and sampled per the SOW.
2. Confirm that the well is suitable based on the conditions set by the client relative to separate phase.
3. Calculate the wells' casing volume.
4. Put new Latex or Nitrile gloves on your hands.

Purging With a Bailer (Stainless Steel, Teflon or Disposable)
1. Attach bailer cord or string to bailer. Leave other end attached to spool.
2. Gently lower empty bailer into well until well bottom is reached.
3. Cut cord from spool. Tie end of cord to hand.
4. Gently raise full bailer out of well and clear of well head. Do not let the bailer or cord touch the ground.
5. Pour contents into graduated 5-gallon bucket or other graduated receptacle.
6. Repeat purging process.
7. Upon removal of first casing volume, fill clean parameter cup with purgewater, empty the remainder of the purgewater into the bucket, lower the bailer back into the well and secure the cord on the Sampling Vehicle.
8. Use the water in the cup to collect and record parameter measurements.
9. Continue purging until second casing volume is removed.
10. Collect parameter measurements.
11. Continue purging until third casing volume is removed.
12. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.

Purging With a Pneumatic Pump
1. Position Pneumatic pump hose reel over the top of the well.
2. Gently unreel and lower the pump into the well. Do not contact the well bottom.
3. Secure the hose reel.
4. Begin purging into graduated 5-gallon bucket or other graduated receptacle.
5. Adjust water recharge duration and air pulse duration for maximum efficiency.
6. Upon removal of first casing volume, fill clean parameter cup with water.
7. Use the water in the cup to collect and record parameter measurements.
8. Continue purging until second casing volume is removed.

9. Collect parameter measurements.
10. Continue purging until third casing volume is removed.
11. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.
12. Upon completion of purging, gently recover the pump and secure the reel.

Purging With a Fixed Speed Electric Submersible Pump

1. Position Electric Submersible hose reel over the top of the well.
2. Gently unreel and lower the pump to the well bottom.
3. Raise the pump 5 feet off the bottom.
4. Secure the hose reel.
5. Begin purging.
6. Verify pump rate with flow meter or graduated 5-gallon bucket
7. Upon removal of first casing volume, fill clean parameter cup with water.
8. Use the water in the cup to collect and record parameter measurements.
9. Continue purging until second casing volume is removed.
10. Collect parameter measurements.
11. Continue purging until third casing volume is removed.
12. Collect parameter measurements. If parameters are stable, stop purging. If parameters remain unstable, continue purging until stabilization occurs or the fifth casing volume is removed.
13. Upon completion of purging, gently recover the pump and secure the reel.

Blaine Tech Services, Inc.
Standard Operating Procedure

SAMPLE COLLECTION FROM GROUNDWATER WELLS USING BAILERS

Sampling with a Bailer (Stainless Steel, Teflon or Disposable)

1. Put new Latex or Nitrile gloves on your hands.
2. Determine required bottle set.
3. Fill out sample labels completely and attach to bottles.
4. Arrange bottles in filling order and loosen caps (see Determine Collection Order below).
5. Attach bailer cord or string to bailer. Leave other end attached to spool.
6. Gently lower empty bailer into well until water is reached.
7. As bailer fills, cut cord from spool and tie end of cord to hand.
8. Gently raise full bailer out of well and clear of well head. Do not let the bailer or cord touch the ground. If a set of parameter measurements is required, go to step 9. If no additional measurements are required, go to step 11.
9. Fill a clean parameter cup, empty the remainder contained in the bailer into the sink, lower the bailer back into the well and secure the cord on the Sampling Vehicle. Use the water in the cup to collect and record parameter measurements.
10. Fill bailer again and carefully remove it from the well.
11. Slowly fill and cap sample bottles. Fill and cap volatile compounds first, then semi-volatile, then inorganic. Return to the well as needed for additional sample material.

    Fill 40-milliliter vials for volatile compounds as follows: Slowly pour water down the inside on the vial. Carefully pour the last drops creating a convex or positive meniscus on the surface. Gently screw the cap on eliminating any air space in the vial. Turn the vial over, tap several times and check for trapped bubbles. If bubbles are present, repeat process.

    Fill 1 liter amber bottles for semi-volatile compounds as follows: Slowly pour water into the bottle. Leave approximately 1 inch of headspace in the bottle. Cap bottle.

    Field filtering of inorganic samples using a stainless steel bailer is performed as follows: Attach filter connector to top of full stainless steel bailer. Attach 0.45 micron filter to connector. Flip bailer over and let water gravity feed through the filter and into the sample bottle. If high turbidity level of water clogs filter, repeat process with new filter until bottle is filled. Leave headspace in the bottle. Cap bottle.

    Field filtering of inorganic samples using a disposable bailer is performed as follows: Attach 0.45 micron filter to connector plug. Attach connector plug to bottom of full disposable bailer. Water will gravity feed through the filter and into the sample bottle. If high turbidity level of water clogs filter, repeat process with new filter until bottle is filled. Leave headspace in the bottle. Cap bottle.

12. Bag samples and place in ice chest.
13. Note sample collection details on well data sheet and Chain of Custody.